2015 Raptor Research Foundation

ANNUAL CONFERENCE

NOV 4–8, SACRAMENTO, CA

SACRAMENTO, CA 2015
RAPTOR RESEARCH FOUNDATION

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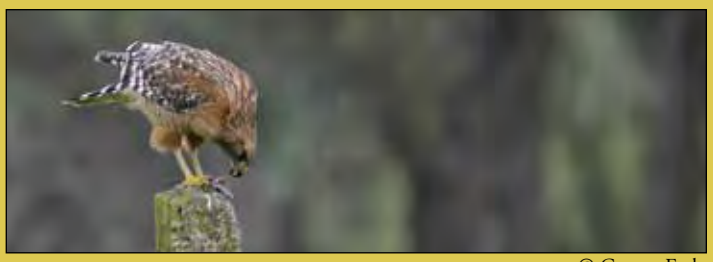

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www.parksconservancy.org/ggro

For over 30 years, the Golden Gate Raptor Observatory (GGRO) has been a program of the Golden Gate National Parks Conservancy in cooperation with the National Park Service.

The GGRO's mission is to conduct long-term studies of the seasonal movements of birds of prey along the Pacific Coast, particularly over the Marin Headlands, to further the understanding and preservation of raptor populations. The GGRO was formed in the early 1980s to track the Golden Gate migration, an annual flight of tens of thousands of hawks, eagles, falcons, and vultures. Learn more about GGRO on their website.

Raptor Research Foundation

www.raptorresearchfoundation.org

Founded in 1966, RRF is a non-profit scientific society formed to accumulate and disseminate scientific information about raptors in order to inform the scientific and lay public about the role of raptors in nature and to promote their conservation.

The RRF membership, which includes nearly 1,000 individuals from over 50 countries, consists of academic researchers, government employees, and others interested in birds of prey. The *Journal of Raptor Research* is issued quarterly to members and contains the latest research results from raptor studies around the world.

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CONFERENCE QUICK SCHEDULE

Wednesday, November 4		
8:00 am - 5:00 pm	Raptor Research Foundation Board Meeting	El Camino
8:00 am - 5:00 pm	California Golden Eagle Working Group	Garden/Terrace
8:00 am -10:00 am	ECRR Workshop—Raptor Trapping & Handling for Research	Feather
10:30 am - 5:00 pm	ECRR Workshop—Raptor Marking & Field Techniques	Feather
8:30 am - 4:00 pm	ECRR Workshop—Harnessing Raptors with Transmitters	Rubicon
8:30 am - 12:00 pm	ECRR Workshop—Safely Accessing Raptor Nests Session One (vanpool meets in hotel lobby)	Sacramento State University
1:00 pm- 4:30 pm	ECRR Workshop—Safely Accessing Raptor Nests Session Two (vanpool meets in hotel lobby)	Sacramento State University
9:00 am - 5:00 pm	ECRR Workshop—Raptor Necropsy Workshop (shuttle leaves hotel lobby at 8:00 am)	CDFW Lab, Rancho Cordova
1:00 pm- 5:00 pm	ECRR Workshop - Raptor Identification & Molt	Maxi's
6:00 pm - 8:00 pm	Icebreaker Reception	Garden/Terrace

Thursday, November 5		
8:00 am - 9:30 am	Plenary Speaker, Pete Bloom, "50 Years of California Raptor Conservation"	California 2/3/4
10:00 am - 5:00 pm	Golden Eagle Symposium	California 2/3
12:00 pm - 7:00 pm	Vendors	California 1
1:40 pm - 5:00 pm	Island Ecology Symposium	Redwood
6:00 pm - 8:00 pm	Poster Reception	California 2/3

Friday, November 6		
8:00 am - 8:00 pm	Poster Session	California Foyer
8:00 am - 7:00 pm	Vendors	California 1
8:20 am - 12:00 pm	Wind Turbine Symposium	California 2/3
10:00 am - 5:00 pm	Climate Change Symposium	Redwood
6:00 pm - 8:00 pm	ECRR Reception	California 2
6:00 pm - 8:00 pm	California Raptor Center Alumni Reception	California 3
8:00 pm - 9:30 pm	Special Evening Lecture—Bill Clark & John Schmitt introduce two new raptor field guides	Maxi's

Saturday, November 7		
8:00 am - 9:40 am	Plenary Panel - 50th Anniversary Madison Conference	California 2/3/4
8:00 am - 4:00 pm	Poster Session	California Foyer
8:00 am - 5:00 pm	Vendors	California 1
5:00 pm - 5:30 pm	RRF Members Business Meeting	California 2/3/4
7:00 pm - 10:00 pm	Banquet and Photography showcase	Capitol Ballroom

Sunday, November 8		
8:00 am - 3:00 pm	Altamont Wind Pass Region field trip	*See page 9 for details*
8:30 am - 2:30 pm	Solano Grasslands & Jepson Prairie field trip	*See page 9 for details*
9:00 am - 1:30 pm	Cosumnes River Reserve & Eastern Delta field trip	*See page 10 for details*
10:00 am - 2:00 pm	California Raptor Center field trip	*See page 10 for details*

For conference sessions details, please see pages 17-89.

ACKNOWLEDGMENTS

Many people came together over a two-year period to create the 2015 RRF Conference in Sacramento. The Conference Booklet was a collaboration between designer Lynn Bantley and editors Allen Fish and Laura Young, with editing and proofing help from, Kris Vanesky, and Allison Pennell. Numerous people from our Golden Gate National Parks community came together to support the conference, including Svetlana Tkachenko, Jan Nunes, J Mark Jenkins, Mike Moser, Simon Chow, Zachary Rattay, Sharon Farrell, Bill Merkle, Daphne Hatch, Garrett Lee, Robert Leiber, Elizabeth Siahaan, Hayden Murray, Melissa Bennett, and Cathie Barner. We are also grateful to key DoubleTree staff Megan Chappell, Gloria Aguilar, and Jackie Quiambao.

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Raptor Photography

Birds of prey are gorgeous! We all enjoy looking at them, whether in-flight, perched, or in-hand. We'd like to thank the very generous photographers that have donated their work to enhance the 2015 RRF conference program. Each photograph is copyrighted by the photographer.

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Hancock House Publishers | Author David Ellis

www.hancockhouse.com

Biologist David Hancock started publishing in the late 1960s, incorporating Hancock House Publishers in 1975. Hancock's focus is on non-fiction regional titles, emphasizing western and far north history and biographies, native culture, nature, and wildlife. Hancock has also gained an international presence with books on wildlife conservation and falconry. Author David Ellis will be on-hand to show copies of his newest book *Enter the Realm of the Golden Eagle*.

Nick Dunlop Photography

www.nickdunlop.com

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

Raptors of the Rockies

www.raptorsoftherockies.org

Raptors of the Rockies is a non-profit 501(c)(3) raptor education project located in Western Montana. Active since 1988. Executive Director Kate Davis is a raptor photographer, educator, and the author of several popular book on birds of prey.

© David Harper

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KEVIN JOHNSON
MAYOR

CITY OF SACRAMENTO
CALIFORNIA

November 4, 2015

Greetings!

As Mayor of the City of Sacramento, it gives me great pleasure to welcome you to the 2015 Raptor Research Foundation conference hosted by the Golden Gate Raptor Observatory November 4–8, 2015. Sacramento is honored to have been chosen as the location for this event.

The Sacramento area is home to raptors of various species, and the home of UC Davis which has been known for its raptor research contributions as well as many state and federal employees who play a significant role in wildlife monitoring and protection. This meeting provides as excellent opportunity to educate members and enthusiasts of the Raptor Research Foundation (RRF) and today's raptor conservation issues. I commend RRF and its members for their efforts to accumulate and disseminate information about these important birds of prey.

While you are here, I hope you have an opportunity to enjoy the many attractions Sacramento has to offer. Sacramento, one of the oldest historic Cities in California, is home to the State Capitol, Sutter's Fort, the Sacramento Kings, Crocker Art Museum, and the California Auto Museum. Old Sacramento, a unique, 28-acre National Historic Landmark and State Historic Park located along the Sacramento River, has a variety of attractions including shopping, dining, entertainment, and world-renowned museums set within the time of the California Gold Rush and Transcontinental Railroad.

I extend my congratulations to the Raptor Research Foundation on its 50th Anniversary and thank members, organizers, and attendees for their work in making this conference possible.

Best wishes for a memorable and successful event.

Sincerely,

Kevin Johnson
Mayor

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PRE-CONFERENCE

Pre-Conference Meeting of the California-Nevada Golden Eagle Working Group

November 4th, 2015, 8:00 am - 5:00 pm

The November 4th California-Nevada Golden Eagle Working Group meeting will provide updates from various agencies and the Working Group's subcommittees during the morning. The afternoon is dedicated to a symposium focused on Golden Eagle prey ecology, but will also address use of terms in raptor ecology. The Golden Eagle working group is hosted by the California Department of Fish and Wildlife and the US Fish and Wildlife Service.

© George Eade

The November 5th Golden Eagle Symposium, hosted by the University of Nevada, Reno and the US Fish and Wildlife Service will have a broader western North America focus on Golden Eagle ecology, emphasizing the results of recent research efforts. Topics from both symposia have been coordinated and will result in a publication.

For more information on the Golden Eagle Working Group Meeting, contact organizers Heather Beeler (heather_beeler@fws.gov) or Carie Battistone (carie.battistone@wildlife.ca.gov).

© Joe DiDonato

EVENING LECTURE

Special Evening Lecture: Two New Raptor Field Guides: Africa, and Mexico/Central America

November 6th, 2015, 8:00 am - 9:00 pm

William S. Clark, with John Schmitt

Raptor specialist and field guide author Bill Clark will show color plates, photos and some maps from his upcoming guide, *African Raptors*, to be published by Bloomsbury Press next year. His co-author and the artist is Rob Davies.

Clark will also describe his new field guide for Latin American raptors, showing photos and range maps, and colored plates by California artist/ornithologist John Schmitt. Known for his feather-perfect paintings of birds from field guides, magazines, and Peregrine Fund publications, Schmitt will also be on-hand to discuss preparation of the plates, and to show some originals from the forthcoming Latin American guide.

© John Schmitt

FIELD TRIPS

Altamont Pass Wind Region

Sunday Nov 8th, 8:00 am – 3:00pm
Departs DoubleTree Hotel
Leader: Douglas Bell
Fee: $75 per person

Vasco Caves, part of the East Bay Regional Park District, is at the heart of the Altamont Pass wind region. The 360-degree view from the caves are the perfect location for a visual and historical overview about wind farms and their impacts on birds of prey. This trip will include time to observe the turbines and watch for hawks and eagles, as well as one or two short hikes depending upon time. Driving time from the DoubleTree Hotel in Sacramento to the Altamont Pass region is about 2 hours one way.

Douglas Bell is the Wildlife Biologist for the East Bay Regional Park District, one of the largest urban parks in the world, encompassing 120,000 acres. Doug obtained his PhD at University of California, Berkeley, conducting research on genetics and hybridization in gulls. He did post-doctoral research at California Academy of Sciences, contributing to research on sparrow dialects and the Socorro Island Dove. Doug's raptor research has included extensive studies of genetics and demographics of Peregrine Falcons, nesting ecology and movements of Prairie Falcons and of Golden Eagles, as well as the impact of wind farms on birds of prey. Doug Bell is also an adjunct professor of biology at California State University, Sacramento.

© Joe DiDonato

Solano Grasslands & Jepson Prairie

Sunday Nov 8th, 8:30am – 2:30 pm
Departs DoubleTree Hotel
Leaders: Zach Smith & Bob Power
Fee: $30 per person

One of the last remnants of native short-grass prairie in California's Central Valley, the Solano Grasslands region is home to a rich raptor fauna in the fall and winter. Adjacent to the Jepson Prairie, a vernal pool region managed by UC Davis, the Solano Grasslands is a fall and winter home to hundreds of birds of prey, including four falcons, five buteos, two eagles, White-tailed Kites and Northern Harriers. Other grassland birds can be seen as well, such as Long-billed Curlew, American Pipit, Horned Lark and numerous sparrows. This is one of just a few spots in the state to see flocks of Mountain Plovers. We will travel by van, with multiple stops and limited walking on trails or gravel roads.

© David Harper

Zach Smith grew up in San Diego and spent much of his youth honing his soccer skills. A move to Davis, California for college eventually introduced him to the world of science, particularly raptors. After graduation, he embarked on a life of vagrancy as a freelance field biologist that has led him to many wild parts of California, the Gulf Coast of Texas, the southern New Jersey shore, Chile's Atacama Desert, the humid lowlands of Veracruz, and the Canary Island. In recent years he has become interested in dragonflies, and is somewhat obsessed with photographing these predatory insects.

Bob Power is an eco-tour guide, recently retired as the Executive Director for Santa Clara Valley Audubon Society. Bob is a leader for the Golden Gate Raptor Observatory's Hawkwatch research, and has led trips for Golden Gate Audubon, San Francisco Bay Bird Observatory, Oakland Bird Club, Wild Bird Center, Paradise Birding, and Elder Hostel International.

FIELD TRIPS

Cosumnes River Reserve & Eastern Delta

Sunday Nov 8th, 9:00am – 1:30 pm
Departs DoubleTree Hotel
Leaders: Ron Melcer, Jr. & Rachel Gardiner
Fee: $30 per person

The Sacramento-San Joaquin Delta is an incredibly important region for wintering raptors – supporting accipiters, buteos, falcons, kites, and vultures with its diverse habitats. This trip will visit riparian forest, wetlands, and agricultural lands in an effort to observe many of the 17 possible raptors as well as Loggerhead Shrikes. We also hope to witness the recent arrival of hundreds of thousands of waterfowl and Sandhill Cranes, who also depend on the Delta region's habitat resources. Possible destinations include Cosumnes River Preserve Visitor's Center, Desmond Road, Woodbridge Road, and Staten Island. We will travel by van, with multiple stops and limited walking on trails or gravel roads.

Ron Melcer Jr. has studied breeding, wintering, and migrating birds within California, Washington, and southern British Columbia over the past 15 years. Ron is currently a senior scientist with the California Department of Water Resources, and a PhD student at the University of California, Davis, conducting conservation planning and studying riparian ecosystem dynamics within the Sacramento and San Joaquin River watersheds.

Rachel Gardiner is a wildlife biologist with over 13 years of research experience specializing in riparian and wetland avian ecology throughout northern California. Rachel has been working at ICF Jones and Stokes in Sacramento for the past three years, continuing to focus on the conservation of birds and their habitats in the Central Valley. She is also the coordinator for the Greater Sandhill Crane Technical Advisory Committee.

© Step Wilson

California Raptor Center

Sunday Nov 8th, 10:00 am – 2:00 pm
Departs DoubleTree Hotel
Leaders: Michelle Hawkins & Bret Steadman
Fee: $30 per person

Just 30 minutes from the DoubleTree Hotel is the internationally known California Raptor Center, part of the One Health Institute at the University of California, Davis. Established in the mid 1970s, the Raptor Center is staffed by volunteers from the University and the Davis community who contribute more than 7000 hours volunteer time each year. CRC treats more than 300 birds annually with a 60% release rate. Some 35 non-releasable raptors are kept at the Raptor Center as educational birds, glove-trained for use at schools, bird festivals, and other events.

Dr. Michelle Hawkins received her veterinary degree from the University of Pennsylvania in 1997 and completed a residency and fellowship in Companion Avian and Exotic Animal Medicine and Surgery at the University of California, Davis. She became board-certified in Avian Practice by the American Board of Veterinary Practice in 2002. She joined the faculty of the University of California, Davis School of Veterinary Medicine in 2003. She is currently a Professor in Companion Avian and Exotic Animal Medicine and Surgery at the School of Veterinary Medicine, Univ. of CA, Davis and Director of the California Raptor Center.

Bret Stedman graduated from UC Davis with a B.S. in Zoology and started volunteering at the California Raptor Center in 1982. After volunteering for ten years, he was hired as the Operations Supervisor of the center and has worked in that capacity ever since. Bret was born and raised in Humboldt County, California, and has had a lifelong interest in wildlife and nature.

© Gavin Emmons

EARLY CAREER RAPTOR RESEARCH SKILLS

The **RRF Early Career Raptor Researcher (ECRR) Committee** will be hosting a day of raptor research skills short-courses for ECRRs at the annual meeting in Sacramento, CA on Wednesday, November 4th, 2015. Classes are only available to students and early career professionals (<3 years post-graduation). Contact the ECRR Committee Chair if you have questions on these courses.

Classes will be taught by leading experts and will focus on hands-on skill-building that is typically not available in traditional undergraduate or graduate classes. Course lengths will vary from 3-8 hours and will be scheduled to allow students to select from a variety of courses throughout the day. Class sizes will be small (8-16 students per class) to provide an intimate and interactive learning environment.

© George Eade

2015 Course Descriptions

Courses are scheduled before the conference begins on Wednesday, November 4th. Courses provide hands-on training to students and early career researchers interested in learning more about raptor research techniques. Registration is open to students and those who are early in their careers (started working professionally within the past three years). These events are sponsored by the Early Career Raptor Researcher Committee of RRF. Please follow us on Facebook.

ALL DAY COURSES

Harnessing Raptors with Transmitters

Steve Lewis & Brian Millsap
US Fish and Wildlife Service

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

One session: 8:30 am - 12:00 pm, 1:00 pm - 4:00 pm *(1 hr lunch)*

Location: DoubleTree Hotel

Class size: 16

© David Harper

Raptor Necropsy Workshop

Krysta Rogers
California Department of Fish and Wildlife

This class will discuss how to characterize and investigate raptor mortality, conduct a gross necropsy, and collect appropriate samples for disease and contaminant diagnostics. Permitting, zoonotic diseases, and common causes of raptor mortality will be covered. Class will consist of lecture/discussion in the morning and a practical necropsy session in the afternoon.

One session: 9:00 am - 4:30 pm *(meet at hotel at 8am for shuttle or arrange own transportation)*

Location: Wildlife Investigations Laboratory, California Dept. of Fish and Wildlife
1701 Nimbus Rd., Ste. D
Rancho Cordova, CA 95670

Class size: 12

EARLY CAREER RAPTOR RESEARCH SKILLS

PARTIAL DAY COURSES

Safely Accessing Raptor Nests

Joel Pagel, *US Fish and Wildlife Service*

This class will cover the following topics: safety (climber and raptors), gear and use, basic knots, rappelling, ascending fixed ropes, getting into nests, and bird handling while aloft. Much of the course emphasis will be on expedient ascent on fixed ropes to access nest sites, quickly but safely transferring to rappel gear, and then safely rappelling. Class will be taught at a local climbing wall or outdoor facility with strong emphasis on experiential learning while hanging from ropes. At this time, we believe climbing harnesses will be provided, but bring your own and your favorite rappel device if you have one. Though the course is geared towards beginners, students will need to lift much of their body weight while hanging from a rope. For safety reasons, we ask that male students who register for this course are capable of doing 3 pull-ups and female students, 1 pull-up.

© Joe DiDonato

Session 1: 8:30 am - 12:00 pm; **Session 2:** 1:00 pm - 4:30pm
(Morning and afternoon sessions are identical; register for only one session)

Class size: 6 students per session

Raptor Trapping and Handling Techniques for Scientific Research

Pete Bloom, *Western Foundation of Vertebrate Zoology*

This class will discuss safe trapping and handling methods, including the use of the Bal-chatri, Dho-Ghaza, bow nets, and other methods. Permitting, health and welfare of birds, trap construction, noose tying, and trap use will be covered, including hands-on instruction.

One session: 8:00 am - 10:00 am

Location: DoubleTree Hotel

Class size: 16 students

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

Dan Varland, *Coastal Raptors*
John Smallwood, *Montclair State University*

This course will give students hands-on experience in applying the following types of auxiliary markers to raptors: conventional US Geological Survey leg bands, colored leg bands, leg flags, patagial markers, dyes, and feathers (through feather imping). Students will also have the opportunity to learn and practice proper handling, measuring and blood sampling techniques.

One session: 10:30 am -12:00 pm, 1:00 pm - 5:00 pm
(1 hr lunch)

Location: DoubleTree Hotel

Class size: 20 students

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

Bill Clark, *Harlingen, TX*
Buzz Hull, *Golden Gate Raptor Observatory*

This class will begin with an overview of the ID of diurnal raptors, followed by raptor in-hand ID, ageing, and sexing. Then follows a short discussion of recent changes in taxonomy of raptors, especially changes in scientific names, most as result of DNA analyses. The second half of the class will focus on raptor remige molt and its use in ageing. This will include hands-on learning with hawk wings after a lecture on molt sequences, molt centers, and differences between Falconidae and Accipitridae molt.

One session: 1:00 pm - 5:00 pm

Location: DoubleTree Hotel

Class Size: 25

PLENARY SPEAKER—PETER H. BLOOM

Thursday, November 5, 2015, 8:15 am - 9:40 am, Opening Plenary

Peter H. Bloom

"Fifty Years of California Raptor Conservation — Success, Failure, Works in Progress, & Insights for Future Research"

California is rich in raptor diversity, and over the last 50 years, extensive and often successful measures have been undertaken to protect and recover California raptors. Case in point, while California was originally the sole home for California Condors, after decades of work, they now also occur in two other states and northwest Mexico. However, several other species continue on an ominous downward trend, some for obvious reasons, others not so clear. In this presentation, Pete Bloom will summarize the current status and likely trajectory of the 15 most conservation sensitive California raptor species. Pete will also present highlights from his 45 years of banding California raptors with an emphasis on the importance of long-term research to the study of natal dispersal, philopatry, vagrancy, and unique migration behaviors found in some common California raptors.

© Pete Bloom

About the Speaker

Pete Bloom received his Bachelor's (1979) and Master's (1989) in Biology from California State University, Long Beach, and his Ph.D. in Natural Resources from the University of Idaho, Moscow, in 2011. With the banding of his first nestling Barn Owls in 1970, Pete began his career when he was 18 years old. Since that time he has either personally banded or facilitated the banding of about 35,000 raptors of 25 species, mostly nestlings. His research interest focuses on increasing understanding of natal dispersal, philopatry, survivorship, territory fidelity, home range, unusual migrations and contaminants in raptors. Pete has authored or co-authored 40 peer-reviewed publications on raptors ranging from Flammulated Owls to California Condors. He established Bloom Biological, Inc. in 1977 and Bloom Research, Inc., a 501(c)(3) non-profit organization dedicated to research and conservation, in 2013—and as the president of both, seeks to blend original research, conservation and consulting together. Pete is also a research associate of the Western Foundation of Vertebrate Zoology. Pete headed up two statewide population assessments for the California Department of Fish and Wildlife and Bureau of Land Management on Swainson's Hawks (1980) and Northern Goshawks (1983), and while employed by the National Audubon Society, directed the field effort to capture all of the wild, free-flying California Condors, 1982-87.

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MADISON PEREGRINE CONFERENCE

Saturday, November 7, 2015, 8:15 am - 9:40 am, Plenary Panel

"Celebrating the Semicentennial of the Madison Peregrine Conference"

Sponsored by: THE PEREGRINE FUND

"During the years 1950 to 1965, a population crash of nesting Peregrine Falcons occurred in parts of Europe and North America on a scale that made it one of the most remarkable recent events in environmental biology." — *Professor Joseph Hickey*

Professor Joseph Hickey, organizer of the Madison Peregrine Conference (University of Wisconsin)

In August 1965, Professor Joseph J. Hickey of the University of Wisconsin, Madison, assembled nearly 60 biologists and other scientists from seven countries to compare data and discuss reasons for the sudden disappearance of the Peregrine Falcon and other birds of prey from parts of the world. The Madison Conference is one of the first moments in history where a group of scientists set an agenda toward resolving an urgent conservation problem, two decades before conservation biology was founded as a scientific field.

Although today we take it for granted that conservation and biology should be tightly linked, fifty years ago, the lines between activist and scientist were drawn and tightly guarded. How did participants in the Madison Conference negotiate these boundaries? How did they resolve to dissect the cause of the Peregrine crash? We've invited five distinguished biologists from the 1965 conference to Sacramento to ask them such questions, and to honor their immense contributions toward rescuing a magnificent species from wide-ranging extirpation if not complete extinction.

Panelists

Dan Anderson, Dan Berger, Steve Herman Grainger Hunt, Clayton White

Moderator

Joel "Jeep" Pagel

Madison Conference Panel Organizers

Jeep Pagel & Allen Fish

Madison Panel Advisors

Jimmie Parrish, Roland Clement, Robert Risebrough, Dan Anderson, Steve Herman, Hans Peeters

Other Members of the Madison Peregrine Conference

We regret that some of the living members of the 1965 Madison Peregrine Conference were not able to join us this week. In their absence we honor Sergej Postupalsky, Helmet Mueller, Richard Fyfe, Richard Banks, Charles Sindelar, Jean-François Terrasse, Michel Terrasse, Jim Enderson, David Hancock, and Tom Cade.

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Madison Peregrine Conference Panelist Bios

Dan Anderson

Dan Anderson did his Master's and PhD under Hickey's supervision at the University of Wisconsin, Madison, from 1964 through 1970. He's been at UC Davis since 1970, most recently Professor Emeritus in the Department of Wildlife Fish and Conservation Biology since 2009. Although his research scope has ranged from raptors through seabirds with a strong emphasis on ecotoxicology, Dan has contributed extensively to the knowledge base of Brown Pelican ecology on the Pacific Coast.

Dan Berger

Dan Berger became interested in raptors while in his teens. After meeting a local falconer, he learned the basics of trapping, which led to the founding of the Cedar Grove Ornithological Station with Helmut Mueller in 1950. In the early fifties, they began searching the Mississippi River cliffs for Peregrines. That led to Joe Hickey, who, in turn, asked Dan to repeat Hickey's Peregrine Survey from the mid thirties. In 1964 during three months of surveying known sites, Charles Sindelar and Berger found not a single bird.

Steve Herman

Steve Herman's doctorate in zoology is from the University of California, Davis. Now an Emeritus Member of the Faculty, he has taught at The Evergreen State College in Olympia, Washington since 1971. His research and teaching interests include raptors, shorebirds, pesticide-wildlife relationships, and abusive livestock grazing. He has taught in wild and semi-wild landscapes in western North America and several Latin American countries.

Grainger Hunt
Grainger Hunt wrote his master's thesis on Peregrines at Sul Ross University in 1966, and earned his doctorate from the University of Texas in 1970 in evolutionary genetics. He studied Golden Eagle ecology in central California from 1994-2001, and conducted four long-term comprehensive studies of both eagle species in the West together spanning 20 years. He has researched Peregrine nesting ecology in Texas, Mexico, and the Channel Islands. After retiring from UC Santa Cruz's Predatory Bird Research Group, he joined The Peregrine Fund as Senior Scientist.

Clayton White
Clayton White is an emeritus professor of zoology in the Department of Integrative Biology and the Curator of Ornithology, Brigham Young University. In addition to his affiliation with various universities and government agencies, he was a former two-term director of The Peregrine Fund and has been on the board or a scientific advisor for five other organizations. He served a five-year term on the advisory panel of the Division of Polar Programs for the National Science Foundation. He was editor of the journal *Raptor Research* for ten years.

Tom Cade *(in absentia)*
Tom Cade earned his master's and doctoral degrees at UCLA between 1955 and 1957. He served as a professor of zoology at Syracuse University, Cornell University, and Boise State University, Idaho, retiring in 1993. Tom's lifelong interest has been the birds of prey—falcons in particular. He is probably best known for founding The Peregrine Fund in 1970. In addition to field studies carried out in Alaska, Africa, Central America, Mauritius, and the southwestern United States, for more than 50 years he has been involved in solving the problems of breeding large falcons in captivity, with the aim of helping to preserve certain rare or endangered species.

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Quotes

At the end of August 1963, a group of falcon folks were summoned to the University of Wisconsin in Madison to talk to each other about Peregrines. Joe Hickey drew up the guest list. My invitation was in his precise and graceful handwriting. Hickey's purpose was to know what was wrong with Peregrines. He had been in touch with Derek Ratcliffe, an Englishman who had just learned of widespread eyries abandonment throughout England and Scotland.

About sixty people were guests at the Madison meeting. It was a strange and unlikely mix. There were falconers and anti-falconers, bird-watchers and gun hunters, professors and museum-people, and there were business folks and students. There were Canadians, Finns, Frenchmen, Englishmen, a Swiss, and a West German.

— James Enderson
Peregrine Falcon, Stories of the Blue Meanie
University of Texas Press, 2005

But at the Peregrine Conference, egg breakage was mentioned as one of many factors that needed to be considered in evaluating worldwide Peregrine population declines. Derek Ratcliffe went away from this conference with this on his mind and then had a talk with an English egg-collector, D. Nedersole-Thomson, who suggested that Ratcliffe take a look at eggs in collections. That's when it was first known that the eggshells themselves were affected. Ratcliffe devised an eggshell "thickness index" because he couldn't directly measure it; and he reported his astounding results to Hickey even before he went to press. Ratcliffe and Hickey were friends and were on the phone often.

I was just a graduate student at the time, and Hickey literally grabbed my hand one day and dragged me over to the UW Engineering Department where we talked to a technician. Several weeks later, our engineer had a perfect little device ready for us to take and use; and it could measure eggshell thickness through those tiny holes that our peculiar egg-collectors made. Just one more piece of beauty in the interdisciplinary exchange of academia.

— Dan Anderson
Joe Hickey, the Scientist, Unpubl. Essay, 2005

The main discussion room was populated with perhaps ten tables, each sitting about six people. I was at one of those, and Roger Tory was nearby. Frustrated by the foot dragging that preceded the pesticide discussion, Peterson stabbed his table with a yellow pencil. Nearby, Jim Rice, a falconer from Massachusetts shouted, "We're tired of this governmental flim-flam; let's talk about pesticides!"

— Steve Herman, in an email September 5, 2015

MADISON PEREGRINE CONFERENCE

My world view abruptly changed at the 1965 Peregrine Conference…. The scientific case against pesticides had dropped on the table like a stone, and all who returned home from the meeting knew they had things to do.

— Grainger Hunt
Return of the Peregrine, The Peregrine Fund, 2003

The falconers of the world owe a great debt to Dr. Joe Hickey and all the participants in the Madison Peregrine Conference. Seldom in the history of conservation has any group assembled to consider the plight of an endangered, non-economic species before it has definitely reached the threshold of extinction. Seldom also has it happened that those persons assembled have demonstrated such an extraordinary interest in their subject."

— Steve Herman, *Hawk Chalk* 4 (3), Nov-Dec 1965

At the end of that conference [Madison] a group of attending biologists and falconers got together to discuss what could be done to save the Peregrine from possible extinction in North America. Obviously, as Rachel Carson (1962) had already made clear in *Silent Spring*, elimination or reduction in the use of harmful pesticides was essential, but in 1965 such action seemed politically unrealistic in the face of strong agro-chemical interests touting the virtues synthetic pesticides. One of President Lyndon Johnson's scientific advisers at the Madison Conference said categorically that restriction on the use of DDT would never happen. That declaration became a challenge for many of us.

— Tom Cade & William Burnham
Return of the Peregrine, The Peregrine Fund, 2003

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Never before had so many people worked so well together to see a species return. They were heroes all. Some were superheroes.

— James Enderson
Peregrine Falcon, Stories of the Blue Meanie
University of Texas Press, 2005

Unfortunately, I cannot join you [in Sacramento] despite the great interest for me. At this time I am still working in the Pyrenees, where I am living, on *Gyps fulvus* and *Gypaetus barbatus*. Peregrines are for the moment in good condition in France (and Europe). They have recovered all the good habitats and are colonizing the towns. Their only serious enemy is the Eagle Owl *(Bubo bubo)* which is also growing again.

— Jean-François Terrasse, in a letter, October 1, 2015

It is my experience that most people working with Peregrines develop some form of ethic or stewardship philosophy, if not about falcons themselves, then about the birds within some larger ecosystem context. A few even become rabidly passionate and elevate Peregrines to godhood status after the fashion of ancient animists in Greek or Egyptian mythology. Despite my attraction to Peregrines, I do not afford them that status and when asked why I study falcons, I can only answer helplessly, "Why not? I enjoy them!"

—Clayton White
Peregrine Quest, Western Sporting Publishers, Publ. 2006

GENERAL SESSION ABSTRACTS

Assessing Possible Actions to Mitigate Take of Golden Eagles at Wind Energy Facilities

*TABER D. ALLISON (tallison@awwi.org), American Wind Wildlife Institute, Washington, D.C., U.S.A. JEAN FITTS COCHRANE, Grand Marais, MN U.S.A. ERIC LONSDORF, Biology Department, Franklin and Marshall College, Lancaster, PA, U.S.A. CAROL SANDERS-REED, Sandia Park, NM, U.S.A.

Wind energy has expanded rapidly in the past decade becoming a significant source of electricity, and a major element in a global strategy to reduce carbon emissions and the effects of climate change. Golden Eagles (*Aquila chrysaetos*) can collide with turbines, adding to the substantial mortality from other anthropogenic sources. These collisions pose a legal risk to wind energy companies and potentially hamper development in areas where the range of Golden Eagles overlaps areas of high wind energy potential. The U. S. Fish and Wildlife Service, through the Eagle Rule and the Eagle Conservation Plan Guidance, has designed a mitigation strategy for eagle conservation that allows wind energy companies to obtain programmatic take permits and comply with the Rule. However, the approach is challenged by a lack of data supporting scientifically rigorous strategies to mitigate eagle take, where mitigation is defined as efforts to avoid and minimize take, and compensate for unavoidable take. Because Golden Eagle mortality at most wind energy projects is infrequent, coordinated, collaborative research across multiple wind energy facilities is needed to improve our ability to produce scientifically robust mitigation strategies for eagle take at wind energy facilities. To meet this need, we have implemented a research framework that includes evaluating technologies intended to minimize eagle take and developing models for strategies to offset unavoidable eagle take, such as voluntary lead abatement, that can be quantified and verified. The impetus for these efforts is driven by the goal of improving implementation and compliance with the Eagle Rule. However, the results have benefits not just for Golden Eagles, but for other raptors and the ecological communities that include them.

Development and Mitigation of Raptor Habitat in Wyoming

*MATTHEW ALLSHOUSE (mallshouse@trihydro.com), Trihydro Corporation, Laramie, WY, U.S.A. and Peregrine Fund OBF Program, Boise ID, U.S.A.

Local, state, and Federal agencies require specific stipulations and protocols be followed regarding development and its effects on raptor habitat. Adherence to regulations requires coordination with land-management agencies and documentation of raptor and habitat occurrence within project areas. Permitting processes may require species-specific seasonal and spatial disturbance buffers to protect roosts, nests, and habitat. In Wyoming, raptor habitat and nesting surveys and associated development need to adhere to different spatial and temporal use stipulations. I will report on new and historic data used to develop site specific mitigation for raptors and their habitat.

Abundance and Density of Swainson's Hawks in California: A Statewide Sampling Framework for Population Monitoring

*RICHARD L. ANDERSON (danderson222@att.net) , J.L. DINSDALE, CARIE L. BATTISTONE, K.M. CRIPE, C.S.Y. CHUN, R.W. SCHLOFF, M.A. BRADBURY, J.A. ESTEP, and S.G. TORRES, Lincoln, CA, U.S.A.

The California Fish and Game Commission listed the Swainson's Hawk (*Buteo swainsoni*) as a state threatened species in 1983 due to statewide declines in the population. Human population increases, urbanization, and shifts in agricultural land use in California have likely affected, and will continue to affect, the state's Swainson's Hawk population. To determine the density and abundance of breeding pairs of Swainson's Hawks in the state, and to track future population levels, we developed a statewide sampling framework for population monitoring. We used a stratified random sampling design to conduct surveys in 2005 and 2006. In 2005, we surveyed the known Swainson's Hawk range in California. In 2006, to optimize abundance and density estimates, we modified the sampling strata based on data collected in 2005. Because data from 2005 indicated that the Central Valley contained the highest numbers and densities of breeding pairs of Swainson's Hawks in the state, we concentrated our sampling effort there. Based on our surveys, we estimated that there were 2,251 (95% CI: 1,811 to 2,690) breeding pairs of Swainson's Hawks in California during 2005-2006. The greatest densities occurred in northern San Joaquin and southern Sacramento Valleys. We recommend that this two-year sampling approach be repeated every ten to fifteen years to track the health of this threatened population.

Determining Mercury Contamination across a Suite of Raptor Species at Salt Lake City International Airport

*JOSEPH G. BARNES (jbarnes@ndow.org), Nevada Department of Wildlife, Las Vegas, NV, U.S.A. MIKE SMITH, Department of Wildlife Services, Salt Lake City, UT, U.S.A. GIB ROKICH, Salt Lake City International Airport, Salt Lake City, UT, U.S.A.

A major component of Salt Lake City International Airport's Wildlife Hazard Management Plan is an extensive trapping, banding, and relocation program mitigating the risk of bird strikes to aircraft. Dovetailing with this, we sought to understand mercury contamination of raptors in northern Utah, because mercury effects wildlife, and global deposition rates are increasing. We measured concentrations of total mercury (THg) in feathers of 412 individuals from 11 species of diurnal and four species of nocturnal

raptors sampled from January 2014 to March 2015. These included local breeders, migrants, and wintering individuals. All feather samples contained detectable levels of THg (range = 0.02–49.9 ppm). The highest concentrations of THg were in Peregrine Falcons (*Falco peregrinus*; n = 6, $\bar{x}$ = 10.06 ppm), Northern Harriers (*Cyrcus cyaneus*; n = 10, $\bar{x}$ = 6.73 ppm), and Rough-legged Hawks (*Buteo lagopus*; n = 15, $\bar{x}$ = 1.2 ppm), while Barn Owls (*Tyto alba*; n = 66, $\bar{x}$ = 0.23 ppm), Short-eared Owls (*Asio flammeus*; n = 13, $\bar{x}$ = 0.21 ppm), and Ferruginous Hawks (*Buteo regalis*; n = 34, $\bar{x}$ = 0.12 ppm) had the lowest concentrations. In all species except Barn Owls and Swainson's Hawks (*Buteo swainsoni*), we found higher levels of THg in older age classes, likely indicating bioaccumulation over time. Swainson's Hawks showed similar THg concentrations in hatch-year and after-second-year birds, with lower levels in second-year individuals. We detected no difference between THg concentration by sex in after-hatch-year Barn Owls or American Kestrels (*Falco sparverius*), the two species most reliably identified to sex in the field. Our project establishes a baseline of THg in a suite of raptors migrating and breeding in northern Utah. This is especially important given the increasing global atmospheric deposition rates of Hg over the past century.

Do Bald Eagles Capture Live Prey During Winter?

***JAMES C. BEDNARZ** (james.bednarz@unt.edu), Department of Biological Sciences, University of North Texas, Denton, TX, U.S.A. MARTIN K. RUANE, Natural Resources Conservation Program, Naval Base Ventura County, CA, U.S.A.

During the winters of 1997-98 and 1998-99, we captured and outfitted 26 Bald Eagles (*Haliaeetus leucocephalus*) with radio transmitters at DeGray Lake, Arkansas. We examined foraging ecology, behavior, and movements in an effort to better understand potential pathways of an unknown toxin that may have caused one of the largest winter die-offs of eagles ever recorded. The majority of the radio-tagged eagles did not remain on DeGray Lake long enough for us to observe foraging behavior ($\bar{x}$ = 7.3 d). However, we documented a total of 64 foraging attempts, including 33 attempts on fish and 31 attempts on American Coots (*Fulica americana*). Twenty of the eagle foraging attempts on fish were successful (60.6%); but most of these were on dead floating carcasses (70%; 14/20 captures). Excluding three successful captures in which we could not determine if fish were alive or dead, only 20% (3/15 capture attempts) of the attacks on live fish were successful. We observed eight successful foraging attempts on coots (26%; 8/31), and capture success on known live coots was 27% (4/15 capture attempts). However, we could not determine if the four live coots captured were diseased or impaired in some manner. Review of the literature indicated that many past researchers were unable to distinguish whether fish taken by eagles were alive or dead. Although some eagles, probably mostly adults, certainly take live fish in the winter, our data suggest that Bald Eagles primarily scavenge dead or crippled fish and other animals, and that live prey are only infrequently taken during this period. We encourage future observers to quantify the proportion of live and dead prey taken by eagles to improve our understanding of their foraging ecology and the susceptibility of eagle populations to diseases transmitted through scavenged prey.

Golden Eagle Migration Corridors along the Rocky Mountain Front and Intermountain Flyways

***BRYAN BEDROSIAN** (bryan@tetonraptorcenter.org), Teton Raptor Center, Wilson, WY, U.S.A. ROBERT DOMENECH, and ADAM SHREADING, Raptor View Research Institute, Missoula, MT, U.S.A. MATTHEW HAYES, Lone Pine Analytics, Laramie, WY, U.S.A. VINCENT SLABE, and STEP WILSON, Raptor View Research Institute, Missoula, MT, U.S.A.

Golden Eagles (*Aquila chrysaetos*) have been receiving increased attention in the western U.S. due to an increase in anthropogenic threats to the population, including wind and other industrial energy developments. Conservation of migratory Golden Eagles hinges on knowledge of threats within breeding ranges, migratory corridors, and over-wintering areas. Often, understanding threats along migration corridors can be difficult due to the short temporal use of migration paths and because pathways can often be dispersed across the landscape. We used satellite tracking data from three Golden Eagle studies across Montana to estimate key migration routes and bottlenecks for migratory Golden Eagles wintering or passing through Montana, with an emphasis on the Rocky Mountain Front. We gathered data from 21 adult and 14 sub-adult Golden Eagles. We created individual dynamic Brownian Bridge Movement Models (dBBMM) for each migration event to estimate migratory pathways of individuals. We also created a population level migratory pathway estimate to determine key migration corridors and bottlenecks by summing the individual dBBMMs after accounting for age and study location. These models can be used to assess risk from industrial energy developments and facilitate the conservation of Golden Eagle migration routes.

Seasonal Movements, Home Ranges, and Resource Selection of Great Gray Owls in Western Wyoming

***BRYAN BEDROSIAN** (bryan@tetonraptorcenter.org), KATHERINE GURA, and BETH MENDELSOHN, Teton Raptor Center, Wilson, WY, U.S.A. SUSAN PATLA, Wyoming Game and Fish Department, Jackson, WY, U.S.A.

Great Gray Owl (*Strix nebulosa*) are among the least studied raptors in the U.S.A. due to their secretive nature and typically low breeding densities. Great Gray Owls usually occupy boreal forests, which are at increasing risk from over harvesting, insect infestations, and disease outbreaks, all of which may be exacerbated in the future by climate change. As part of a large-scale, multi-year study, we have been investigating the movements and habitat use of Great Gray Owls in the Jackson Hole region of Western

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

Wyoming. From 2013-2015, we outfitted 35 owls with VHF and/or GPS transmitters and tracked individuals year-round. We investigated breeding season home range (1 March – 31 August) characteristics for adult owls, and winter ranges for all owls (breeders and sub-adults). We found that owls generally shifted winter ranges to lower elevation in riparian corridors as opposed to higher altitude, boreal forests during the breeding season. We also created predictive resource selection models for breeding season home ranges of adult owls to help inform future conservation and management.

Spatial and Temporal Patterns in Golden Eagle Diets in Central Utah

***GEOFFREY BEDROSIAN** (geoffrey_bedrosian@fws.gov), Division of Migratory Birds, U. S. Fish and Wildlife Service, Lakewood, CO, USA. JESSI L. BROWN, Academy for the Environment, University of Nevada, Reno, Reno, NV, USA. KENT R. KELLER, Salt Lake City, UT, USA.

We investigated Golden Eagle (*Aquila chrysaetos*) food habits in central Utah from 1970-2014 through the identification of prey remains at 254 nest locations. We identified 147 prey species representing 26,769 individuals at a minimum, with the majority of species occurring at low frequencies. Golden Eagle diets in the Central Basin and Range were dominated by Black-tailed jackrabbits (*Lepus californicus*), with cottontails (*Sylvilagus* species) and rock squirrels (*Otospermophilus variegatus*) also found frequently. Higher elevation nest locations in the Wasatch and Uinta Mountains were associated with more diverse diets, and the top three prey species were rock squirrel, Yellow-bellied marmot (*Marmota flaviventris*), and Black-tailed jackrabbit. Dietary breadth as measured by Levins' formula was 2.10 in the Central Basin and Range, and 8.40 in the Wasatch and Uinta Mountains. Preliminary results from partial canonical correspondence analysis (pCCA; controlling for sampling effort due to number of nest site visits) suggest that prey assemblages were associated with environmental variables, including: 1) forest cover and elevation versus shrub, grass, sagebrush, and pinyon cover; and 2) alfalfa, wetland, and crop cover versus grass. The proportion of rock squirrels in the diet of Golden Eagles appeared to increase in years where Black-tailed jackrabbit and cottontail use was lower. Our spatial analysis indicates that Golden Eagle diet varies within ecoregion boundaries and that prey availability is influenced by localized (four mile radius) environmental factors.

Current Status of Falcon Populations in Saudi Arabia

***ALBARA M. BINOTHMAN** (binothman.albara@sdstate.edu), SHUBHAM DATTA, WILL M. INSELMAN, and JONATHAN A. JENKS, Department of Natural Resource Management, South Dakota State University, Brookings, SD, U.S.A. MOHAMMED Y. SHOBRAK, Department of Biology, Taif University, Taif, Saudi Arabia. KENT C. JENSEN, and TROY W. GROVENBURG, Department of Natural Resource Management, South Dakota State University, Brookings, SD, U.S.A.

Falcons are widely used for falconry in the Middle East. Harvest of wild birds could negatively affect falcon populations in the region. We undertook a two-step study to explore these potential effects. To determine the status of falcons nesting in Saudi Arabia, we surveyed known historic and active nest sites of Barbary Falcon (*Falco pelegrinoides*) and Lanner Falcon (*Falco biarmicus*) and compared our results to previous survey results. We also surveyed falconers to document economic value of Lanner Falcon, Barbary Falcon, Saker Falcon (*Falco cherrug*), and Peregrine Falcon (*Falco peregrinus*) in Saudi Arabia. We then compared current market values to past values. During 2015, we visited 1,282 known nest sites of Lanner and Barbary Falcons, and interviewed 590 falconers. Approximately 14.7% (n = 111) of 752 Barbary Falcon nests were active and 3.46% (n = 26) of non-active nests were occupied by an unpaired male. Nesting in western Saudi Arabia declined approximately 7.69% from 2004 and no active Lanner Falcon nests were recorded in any of the survey sites. Between 2003 and 2014, the average price of an individual falcon increased 638% from$2,755 to $17,600 (USD). The average value of a falcon in 2014 was $5,741, and the total value of captive falcons identified through interviews was $5,983. Our results suggest that increased trapping pressure as a consequence of rising falcon prices may contribute to the population declines we documented. Moreover, the precipitous declines that we observed strongly suggest that Lanner and Barbary Falcons deserve protection in Saudi Arabia.

Implications of Study Design in Long-Term Environmental Contaminants Monitoring

***WILLIAM W. BOWERMAN** (wbowerma@umd.edu), H. TYLER PITTMAN, and LATICE FUENTES, Department of Environmental Science and Technology, University of Maryland, College Park, MD, U.S.A. TERYL GRUBB, Retired, Rocky Mountain Research Station, U.S. Forest Service, Flagstaff, AZ, U.S.A. SERGEJ POSTUPALSKY, Prairie du Sac, WI, U.S.A.

Long-term contaminant monitoring programs have traditionally reported results and trends over three to five year periods. We examined how the traditional study design (period) compares to the use of an annual stratified random study design (annual) for monitoring temporal and spatial trends in contaminants. We used data from the Michigan Bald Eagle (*Haliaeetus leucocephalus*) Biomonitoring Project to compare period and annual studies. We selected concentrations of 4,4'-DDE, and the sum of 22 PCB congeners estimated from 1,172 nestling Bald Eagles sampled under the period study design between 1999 and 2014. We then sub-sampled these data under an annual study design (n = 794). We selected an annual random stratified sub-sample of nestlings based on eight spatial categories. We analyzed the period data set using traditional methods to test for differences between temporal periods at four spatial scales. We analyzed the annual data set

using a new approach that described the data on an annual basis using trend models, as opposed to differences between temporal periods. We then assessed the results for significant differences and any changes in inference that were evident between the two study designs. The period study design indicated that concentrations of 4,4'-DDE and Sum PCB increased significantly at two of four spatial scales. In contrast, the annual study design indicated that linear trends were decreasing over the same period, and that there was considerable annual fluctuation. The results of the annual analysis suggest that increases observed in the period analyses were likely due to annual spikes in concentrations likely associated with environmental variables, rather than long-term increases in contaminant loads. We conclude that study design can significantly influence the inferences that can be made from monitoring projects.

Climate Change and Raptors — Can They Adapt?

***DOUGLAS A. BOYCE JR.** (daboyce@fs.fed.us), USDA Forest Service, Golden, CO, U.S.A. JEFFREY L. LINCER, Researchers Implementing Conservation Action (RICA), La Mesa, CA, U.S.A. NEIL PAPROCKI, HawkWatch International, Salt Lake City, UT, U.S.A. ZACHARY ORMSBY, RICA, Reno, NV, U.S.A.

Earth's climate has always been dynamic. Raptors are variably adaptable but may be vulnerable to accelerating environmental changes, including increased temperatures and changing precipitation patterns, anthropogenic influences, and their resulting impacts, including local extirpations, extinctions, food web simplification, species compositional shifts, and other alterations. Although variation in mean temperature is expected over time, the pace of change includes increased frequencies and intensities of previously-rare climatic events; specific conditions that could trigger population collapses. Hansen et al. (2015) found that the change in temperature is over twice the rate calculated by the Intergovernmental Panel on Climate Change for the period 1950–1999. The earth warmed an average of 0.113°C (.203 °F) per decade during this period. An anticipated 2°C increase in mean temperature is considered an ecological crisis. Evolution is generally a slow process occurring over thousands or millions of years as species adjust genetically to changing conditions. Because society is moving carbon stored below ground into the atmosphere quickly, the pace of environmental change exceeds the ability of species to adjust. Some scientists estimate extinction rates 100 times higher (from a variety of anthropogenic stressors) than background rates, and up to 20 to 50% of earth's species will become extinct by the turn of the century. Raptors are mobile and some may adjust. However, there are important limiting factors, such as physiological intolerance to elevated temperature or decreased food availability, which may negatively affect raptors and their prey. As climate induced stress mounts, we expect some species to experience reductions in total numbers, range contractions, regional extirpation and extinction. Conversely, some raptors may be unaffected or even increase numbers or distribution. We provide examples of contemporary species responses to climate change to illustrate these possibilities.

Availability of Roosting Sites Results in Eastward-Arcing Migration Route of Turkey Vulture (*Cathartes aura*) through the Great Plains of North America

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The Great Plains of North America are characterized by a strong west to east gradient in precipitation, soil moisture, and vegetation. Satellite tracking data show that during spring and autumn, Turkey Vultures (*Cathartes aura*) traveling between breeding grounds in Saskatchewan and wintering areas in northern South America follow an eastward-arcing route through this region, rather than flying directly over the semi-arid shortgrass prairie ecoregion. Because Turkey Vultures are adept at using thermal lift to power movements, we hypothesized that the arcing pattern of the satellite tracks resulted from limitations in the terrestrial environment, rather than selection based on atmospheric conditions. Using tracking annotation, we compared atmospheric and terrestrial conditions along the migration track with those along Directed Random Walks (DRWs) between south Texas and the breeding sites in Saskatchewan. We used the 2011 National Land Cover Dataset to analyze habitat near roost sites and movement points (> 5 km/hr) using the Normalized Difference in Vegetation Index (NDVI); pressure, temperature, and wind support at 30 m; and two measures of thermal strength - thermal uplift velocity and boundary layer height. We found that in comparison to the DRWs, the arcing migration route had significantly less thermal lift and lower boundary layer height, but greater NDVI greenness. Roost locations along the route had more tree cover, more water/wetlands, less shrub, and less agriculture than along the DRWs. This suggests that despite more conducive atmospheric conditions along the more direct path, Turkey Vultures selected the arcing route because of the greater availability of roost trees. Aerial images of roost sites showed vultures made extensive use of riparian corridors along the migration route, and such sites were scarce farther west along the more direct route. Planting of shelterbelts following the dust bowl era, and the construction of communication towers have provided alternative roost sites.

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Effects of Heat Stress on Golden Eagle Nest Survival Amplified by Lack of Nest Shade in Southwestern Idaho

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Excessive heat stress during the brood-rearing period is known to cause mortality of Golden Eagle (*Aquila chrysaetos*) nestlings, but the significance of this mortality factor is unknown. Understanding the physiological limitations of successful Golden Eagle reproduction is important given projections for increased ambient temperature throughout much of the Golden Eagle's range. We analyzed our long-term data set of Golden Eagle nesting attempts in and near the Morley Nelson Snake River Birds of Prey National Conservation Area in southwestern Idaho, using logistic-exposure nest survival models to assess the possible influence of ambient temperature and sun exposure on nest survival. We evaluated nest survival in relation to the number of days when the regional temperature exceeded 32 degrees C during brood-rearing (1 May–21 June). Preliminary results showed that regardless of ambient temperature, nesting attempts in locations where at least 25% of the nest was shaded during afternoon hours were more successful than sun-exposed nests. Our results suggest that some effects of high ambient temperature on Golden Eagle nest survival may be ameliorated by shade, and we suggest that this offers possible management opportunities.

Causes and Consequences of Avian Scavenger Declines

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The consumption of carrion by vertebrate scavengers has been largely overlooked in ecological studies, at least in part due to a human aversion to decomposing matter. However, recent research has begun to illuminate the significant and valuable role of scavengers in ecosystems. The world's 22 vulture species are the only obligate vertebrate scavengers and they play a predominant role in consuming carrion. Vulture populations are currently regarded as the most threatened avian functional guild in the world because populations of many species have been declining at catastrophic rates in the last few decades due largely to anthropogenic toxins found in carrion. Conversely, many facultative avian scavengers—including storks, gulls, starlings, ravens and crows—seem less affected by the factors causing declines of vultures. Here we 1) used a global database to identify all bird species for which scavenging is a major dietary component, 2) compiled data on the intrinsic ecological traits and extrinsic threats to these species, 3) use random forest models to identify correlates with extinction risk, and 4) discuss the implications of changes in abundances of avian scavengers. We identified 114 avian scavenger species from 16 families. Random forest models showed that large mass, long generation length, dietary reliance on carrion, and diet specialization were strongly positively correlated with extinction risk. Two ecological traits, average mass and scavenger rank, accounted for a surprising 37% of the variance in extinction risk in avian scavengers. The most important extrinsic threats were dietary toxins, decreasing food availability, persecution, habitat destruction, and, for marine scavengers, fishery bycatch. Rapid declines in vulture populations are expected to have profound impacts on ecosystems, including increased disease outbreaks and trophic cascades.

Continuing Shell Thinning of Eggs of the California Condor (*Gymnogyps californianus*) Is Attributed to Residual DDE Contamination of the Marine Food Web

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Low egg shell thickness triggered large scale declines of many species of raptors following the introduction of DDT into the environment. Some species continue to experience decreased shell thickness, including California Condors. Our research has shown that egg shell thickness of California Condors varied regionally, where condors reintroduced to the Big Sur region of central California in 2006-2010 had extreme egg shell thinning, whereas condors in interior southern California had normal shell thickness. Eggs with reduced shell thickness had high rates of water loss resulting in embryo mortalities in the central California population. Geographic variation in eggshell thickness suggests that differences in diet between the two populations may contribute to the variation we observed. Here we present eggshell thickness data from both central and southern California from 2011–2015 and DDE concentrations measured in eggs from both central and southern California from 2007–2015. We found a significant correlation between thinning and DDE, supporting the conclusions of previous studies that DDE is the primary if not the only significant cause of eggshell thinning in the wild. Furthermore, we found that the majority of DDE came from carcasses of California Sea Lions (*Zalophus californianus*) that condors regularly feed on. These sea lions are known to have migrated from the Southern California Bight (the curved coastline of Southern California from Point Conception to San Diego), or to have migrated through the Bight from colonies further to the

south, suggesting that the likely source of DDE contamination is the Southern California Bight. Such information is crucial to the conservation of the critically endangered California Condor.

Global Population Patterns and the Influence of Seasonal Migration on the Genetic Structure of Peregrine Falcons (*Falco peregrinus*)

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Peregrine Falcons have a worldwide distribution but they exhibit significant variation in behavior, morphology, and demographic history. A mix of migratory and resident breeding populations occurs in the Northern Hemisphere while exclusively resident breeding populations occur in the Southern Hemisphere where migrants from northern populations winter. To understand how Peregrines evolved their near-global distribution, we formulated two alternative hypotheses of range expansion and colonization: isolation by distance and suspension of migration. The second hypothesis considered whether changes in migratory behavior or breeding dispersal led to the formation of a distinct population structure. Our results, based on eleven microsatellite loci, showed low to moderate genetic differentiation among North American reintroduced Peregrine Falcons and Eurasian migrants. There was also significant differentiation between northern migrants and southern residents in both the Old and New World. In contrast, mitochondrial DNA control region data revealed a lack of differentiation between the Old and New World Peregrine Falcons with significant differentiation between northern and southern populations. Worldwide genetic patterns derived from multiple analyses supported the isolation by distance hypothesis where populations that overlapped in distribution were less differentiated than populations without overlap. Even though suspension of migration was not supported, analysis with mitochondrial DNA detected directionality of historical gene flow in Old and New World northern migrants from west to east, and in Old World Peregrines from south to north.

Changes in Diet and Breeding Performance of Chinese Goshawks

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Chinese Goshawks (*Accipiter soloensis*) are one of the most common migratory raptors in East Asia, but some local populations have declined over the last several decades, with habitat change believed to be a major contributing factor. However, it is still unknown what type of habitat change is the more important driver - habitat degradation represented by the shortage of preferred food sources (quality) or habitat loss of freshwater wetlands (quantity). In the context of global and local decline of amphibians, we hypothesized that long-term habitat degradation has caused a change in diet and associated breeding success of Chinese Goshawks, leading to decreased population trends. To test this hypothesis, we used video recordings and field observations to identify food items delivered to juveniles, and to document breeding performance of Chinese Goshawks in Korea. Evaluation of 409 prey items indicated that the goshawks fed on frogs in the early stage of breeding (the first week after hatching), but mainly relied on insects in the late stage (the third week), contrary to findings of previous studies. Perhaps due to the exhaustion of higher quality preferred prey resources. This suggests diets of goshawk nestlings were dependent on bottom-up effects such as prey availability. In spite of the significant change in diet between 1970s and 2000s, however, we failed to detect any difference in clutch size, hatching rates, or number of fledged juveniles per nest between two periods. This suggests that the quality of individual breeding habitat and amphibian declines have little impacts on the population trend of the goshawk and that habitat loss may be affecting local Chinese Goshawk populations. The rapid reduction of small rice paddies surrounded by forests in Korea may be a possible driving force of the population decline.

Extreme Variation in the Tails of Harlan's Hawks

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Harlan's Hawk was originally described by Audubon as *Buteo harlani*, based on a specimen he collected in Louisiana in 1830. The specimen, now in the British Museum, was a dark-morph adult and had a gray tail with distinctly different plumage characteristics than other Buteos. Despite this, the species is currently considered to be a sub-species of Red-tailed Hawk (*Buteo jamaicensis*). After examining more than 1,000 museum specimens, more than 30 individuals in-hand, and hundreds of photos of this taxon, I found that Harlan's Hawks vary greatly in the color and markings of their tails, with no two adult tails appearing exactly alike. I will present a sample of tail photos, showing the range of variation in adult tails and juvenile tails. Some juveniles had adult-like tails. Further, adult Harlan's' tails can show within tail differences in color and pattern among the individual feathers and even on single feathers. In contrast, the variation in tails of Red-tailed Hawks is minor, with only six major tail patterns. The variation in Harlan's tail patterns is not seen in Red-tailed Hawks, one of many traits leading to questioning the correctness of inclusion of harlani as a Red-tailed Hawk subspecies.

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Remige Molt of Harris's Hawk, with Examples of Skipped Feathers

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Harris's Hawks (*Parabuteo unicinctus*) typically replace their primaries in same sequence shown by all Accipitrid raptors, with primary molt ascendant, beginning with P1, and secondary molt from three molt centers, S1, S5, and S13. Adults usually show wave molt in the primaries, the result of not all primaries being replaced and P1 starting a new wave every year. First replacement primaries often differ from later adult primaries by showing a variable amount of pale stippling. Here I document cases of atypical molt of Harris's Hawk. I will show six cases of out-of-sequence molt in the primaries and one case in the secondaries, with feathers being skipped over. I have not seen such unusual molt sequences in hundreds of individuals of more than forty other species of Accipitrid raptors.

Habitat Selection and Factors Influencing Nest Survival of Golden Eagles (*Aquila chrysaetos*) in South-Central Montana

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Concern for Golden Eagle populations in western North America has recently intensified as a result of contradictory trend estimates and an increasing multitude of anthropogenic effects including extensive wind energy development. Understanding Golden Eagle resource requirements and factors influencing breeding success are essential to the creation of an effective conservation strategy. We assessed habitat selection across multiple spatial scales and tested the influence of environmental factors on nest survival of breeding Golden Eagles in south-central Montana. During the 2010–2013 nesting seasons, we located 45 nesting territories and confirmed 115 apparent nest initiations. We collected 15,182 GPS telemetry locations from 12 breeding Golden Eagles. Golden Eagles in our study area selected home ranges based on percent intermixed shrub and grassland and terrain ruggedness. Within their home ranges, Golden Eagles selected for western aspects, proximity to their nest site and proximity to prey habitat dependent on terrain ruggedness. Despite selection of rugged topography, we found Golden Eagle daily nest survival was negatively influenced by increased terrain ruggedness. Based on our results, we suggest that to maintain breeding pairs of Golden Eagles in areas similar to our study area, focus must be placed on preserving adequate prey habitat in and around rugged topography. However, territories with higher ruggedness may not be as productive; therefore, management goals should be clear and environmental factors influencing both habitat selection and reproductive success should be considered when possible.

Rapid Warming and Drought Negatively Impact Population Size and Reproductive Dynamics of Burrowing Owls in the Arid Southwest

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Avian communities of arid ecosystems may be particularly vulnerable to global climate change due to the magnitude of projected change for desert regions and the inherent challenges for species residing in resource limited ecosystems. How arid-zone birds will be affected by rapid increases in air temperature and increased drought frequency and severity is poorly understood because avian responses to climate change have primarily been studied in the relatively mesic northern temperate regions. We studied the effects of increasing air temperature and aridity on a Burrowing Owl (*Athene cunicularia*) population in the southwestern U.S. from 1998–2014. Over 17 years, the breeding population declined 94.2%, from 52 pairs to 3 pairs, and nest success and fledgling output also declined significantly. These trends were strongly associated with the combined effects of decreased precipitation and increased air temperature. Arrival on the breeding grounds, pair formation, nest initiation, and hatch dates all showed significant delays ranging from 8.8 to 26.4 days over 10 years, which have negative effects on reproduction. Adult and juvenile body mass decreased significantly over time, with a loss of 8.6% mass in adult males and 10.9% mass in adult females over 17 years, and a loss of 20.0% mass in nestlings over 8 years. Taken together, these population and reproductive trends have serious implications for local population persistence. The southwestern U.S. has been identified as a climate change hotspot, with projections of warmer temperatures, less winter precipitation, and an increase in frequency and severity of extreme events including drought and heat waves. An increasingly warm and dry climate may contribute to this species' decline, and may already be a driving force of their apparent decline in the desert southwest.

Ferruginous Hawk Ecology in the Northern Great Plains

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Ferruginous Hawks (*Buteo regalis*) are a grassland/shrubland obligate nesting raptor and prefer lightly grazed pasture or fallow fields for nesting. In the Dakotas, Ferruginous Hawks are at the eastern edge of their distribution and occupy short-and-mixed-grass prairies. In the Great Plains, breeding range, local abundance, and reproduction of several populations of Ferruginous Hawk

have declined. These declines may be a result of historic and continuing anthropocentric land-use changes. From 2013-2014, we studied the influence of local-and-landscape-level factors influencing the reproductive success and evaluated the influence of landscape variables on nest site selection of Ferruginous Hawks in the agricultural-dominated region of south-central North Dakota. We located and monitored nests from March–August. We used program MARK to assess nest survival and success, and associated landscape characteristics. Apparent nest success was 67% in 2013 (10 of 15) and 100% in 2014 (14 of 14). Fledglings per successful nest was 2.2 (n = 22) in 2013 and 2.9 (n = 40) in 2014. Survival was constant between years where estimated overall nest survival was 0.73 (95% CI = 0.66–0.81). We found that grassland and pasture were positively associated with nest site selection. Ferruginous Hawks in south-central North Dakota breed in low densities. High nest survival is therefore crucial for the population. Raptor populations which breed in such low densities may be further threatened by emerging infectious diseases like the West Nile virus. Low nesting density may be attributed to limited prey and continued conversion of grassland habitat in the Northern Great Plains. Significant changes in the raptor community were observed in our study area, which might also be associated with land-use changes. Land-use and management practices on private land may have impacts on populations of grassland obligate species and mitigation is imperative.

DNA Sequencing (Barcoding) Reveals Prey Selection in Migratory Raptors

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Migrating birds must fuel their flights with energy gathered from food. Raptors typically hunt while migrating, but prey selection of actively migrating raptors has been documented only rarely. We used a gene-matching (barcoding) approach to identify prey of Sharp-shinned Hawks (*Accipiter striatus*), Cooper's Hawks (*A. cooperii*), and other raptors migrating through the Manzano Mountains of central New Mexico (HawkWatch International's Capilla Peak site). Observed prey selection was broadly consistent with previous studies during breeding and other seasons, but we identified some previously unreported prey associated with atypical foraging habitats. Raptors appeared to take most species in proportion to their availability along the migration route. Some prey species, however, particularly medium-sized species, were taken out of proportion to their abundance, which may indicate selection for energetically rewarding prey. The co-occurrence of migrating predators and their prey suggests interesting feedbacks that likely influenced the evolution of migration strategies for both hawks and songbirds in this area.

Owl versus Owl: Experimental Removal Results and Implications from Managing Barred and Spotted Owls

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A long-term demography study of Northern Spotted Owls (*Strix occidentalis caurina*) on Green Diamond Resource Company timberlands in coastal northern California indicated a stable Spotted Owl population during the 1990's after which it began a downward trend that coincided with an increase in Barred Owls (*Strix varia*). Given this new threat, we initiated the first removal experiment to determine the feasibility of doing lethal removal and to test the impact of Barred Owls on site occupancy, survival and fecundity of spotted owls. From 2009-2014, we removed 104 territorial Barred Owls from the treated areas. We determined that lethal removal of Barred Owls was rapid, technically feasible, and cost-effective. There was no significant difference in any of the demographic or occupancy parameters for Spotted Owls between the treated and untreated areas prior to the removals. After treatment, there was a significant decrease in extinction rates and increase in survival rates and lambda for the Spotted Owls in treated versus untreated areas. The magnitude of the difference was biologically significant with Spotted Owls in treated areas increasing to a stable population (lambda = 1.029), while those in the untreated areas were in decline (lambda = 0.870). The rapid, positive effects on Spotted Owl demographics in our study area support the hypothesis that along with habitat conservation and management, Barred Owl removal may be able to slow or reverse Northern Spotted Owl population declines on at least a localized scale. We discuss the implications of this first removal experiment relative to recently initiated removal experiments throughout the Northwest and potential future range-wide Barred Owl management.

Wing-tagged Encounters of Golden Eagles (*Aquila chrysaetos*) Captured in Montana

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Recently, there has been an increase in concern for Golden Eagle populations in the western U.S. The concern stems from a marked decrease in the number of migrants and future threats from a variety of anthropogenic factors including industrial energy development. Thus, there is a need for more information on Golden Eagles including: where they winter, longevity, causes of mortality and critical habitat needs. Standard banding offers low

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encounter rates (ca. 7%) and satellite telemetry is cost prohibitive for large sample sizes. We began auxiliary marking Golden Eagles with vinyl wing-tag markers as a cost effective means to gather information on the species. Since 2004, we have wing-tagged over 214 eagles, and re-encountered 46 individuals, giving us a 21% encounter rate. This technique is proving considerably more effective than banding alone as a means of identifying individuals and receiving re-encounter information. We attribute this success, in part, to internet information sharing and the increasing use of remote cameras set up on carcasses to view scavenger activity. Given our observed encounter rates, we suggest utilizing wing-tags as a form of auxiliary marking to augment studies where standard banding is the lone marking method.

Integrating Ecological Immunology into Raptor Biology: Quantifying Individual Responses to Understand Population Health

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Both macroparasites (e.g., helminths, worms, and ectoparasites) and microparasites (e.g., viruses and bacteria) are strong selective forces acting on animal populations. Factors that determine the outcome of interactions between parasites and their hosts include the intensity, duration, and type of immune responses mounted by a host to prevent a parasite invasion and infection. Too little response can lead to sickness, morbidity, and even death, but too great of a response can lead to immunopathology and wasting resources that would be better invested in other activities, such as reproduction. Thus, immune responses are part of important life-history trade-offs, and they ultimately contribute to an individual's evolutionary fitness. Quantifying differences in immunity among individuals and populations will contribute to our understanding of population dynamics. Immunity, however, is often overlooked in studies of raptors, in part because of costs, but also because it can be difficult to measure immune function because of the lack of species-specific reagents. I will use case studies of raptors to demonstrate how immune function can be readily measured in samples collected during field studies, and give tips about the best way to handle samples to ensure that useful data can be extracted once back in the laboratory. I will also illustrate how integrating measures of immunity into population studies informs understanding of the health of raptor populations, and thus helps assess threats faced by populations, ultimately facilitating informed management decisions.

Prevalence and Risk Factors for Infection of *Trichomonas gallinae* in Western Golden Eagle Nestlings

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Avian trichomonosis, caused by the protozoan *Trichomonas gallinae*, is found primarily in species of Columbidae and can affect raptors that feed on infected prey. Previous studies have found high rates of trichomonosis in localized raptor populations that experienced habitat loss and changes in historical prey populations yet few have examined prevalence of trichomonosis at a regional scale. We examined the occurrence of *T. gallinae* in western Golden Eagle (*Aquila chrysaetos*) nestlings during the 2015 breeding season. We collected oral swabs from 166 nestlings and from 104 nests across 12 western states to estimate prevalence of *T. gallinae*. In southwestern Idaho, we examined whether evidence of columbids in nestling diet, nestling age, or oral pH predicted *T. gallinae* infection. Preliminary results indicate only 3 (2%) of 134 samples from sites outside Idaho tested positive for *T. gallinae*. However, issues with sample transport may have affected detection because lesions suggestive of trichomonosis were detected in an additional nine nestlings that did not test positive for *T. gallinae*. Conversely, in Idaho, 13 of 32 nestlings (41%) tested positive for *T. gallinae*. Age of first detected infection ranged from 14 to 35 days ($\bar{x}$ = 24.6 days) and the probability of infection increased with nestling age. We found oral pH significantly decreased as nestlings aged, and a higher pH was associated positively with the probability of *T. gallinae* infection. The presence of Rock Pigeons (*Columba livia*) in the diet increased the probability of

T. gallinae infection. Currently, trichomonosis appears to have little demographic impact on western Golden Eagles, however *T. gallinae* does occur across the West and factors related to land cover change and nestling diet may increase risks to local populations.

Anthropogenic Influences to Landscape-Scale Distribution and Density of Wintering Raptors

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Anthropogenic development has great potential to affect fragile desert environments. Large-scale development of renewable energy infrastructure is planned for many desert ecosystems. Development plans should account for anthropogenic effects to distributions and abundance of rare or sensitive wildlife; however, baseline data on abundance and distribution of such wildlife are often lacking. We surveyed for predatory birds in the Sonoran and Mojave Deserts of southern California, in an area designated for protection under the Desert Renewable Energy Conservation Plan, to determine how avian species are distributed across the landscape and how this distribution is affected by existing development. We developed species-specific models of resight probability to adjust estimates of abundance and density of each common species. We also developed combined-species models of resight probability for common and rare species so that we could make use of sparse data on the latter. We determined that many common species, such as Red-tailed Hawks (*Buteo jamaicensis*), Loggerhead Shrikes (*Lanius ludovicianus*), and especially Common Ravens (*Corvus corax*), are associated with human development and likely subsidized by human activity. Species-specific and combined-species models of resight probability performed similarly, although the former model type provided higher quality information. Comparing abundance estimates with past surveys in the Mojave Desert suggested numbers of predatory birds associated with human development have increased while other sensitive species not associated with development have decreased. This approach gave us information beyond what we would have collected by focusing either on common or rare species, thus it provides a low-cost framework for others conducting surveys in similar desert environments outside of California.

Power Pole Density Informs Spatial Prioritization for Mitigating Avian Electrocution

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Reports of raptor and corvid electrocutions collectively indicate continental conservation concerns for breeding, migrating, and wintering birds. Although concerns are widespread, mitigation is implemented primarily at local scales of individual electric utilities. By not considering landscape-scale patterns, conservation strategies may fail to focus mitigation where efforts are needed most. To enable resource managers to consider electrocution risk at larger scales, we developed a regional model of distribution power pole density in a grid of 1 square kilometer (km2) cells throughout Colorado and Wyoming. To do so, we obtained data on pole locations from a sample of electric utilities covering 31% of Colorado and Wyoming. We used these in a Random Forest machine learning classification procedure based on anthropogenic and natural land-cover characteristics to develop a predictive model of power pole density. We used out-of-sample validation to test the model, then predicted pole density across two U.S. states. Pole density was influenced by road lengths, number of oil and gas wells, slope, development, and land cover. Poles were densest in areas with high road lengths, high numbers of wells, and relatively flat terrain, and in areas developed for agriculture or human residences. When model predictions are viewed together with species-specific habitat maps, locations where high pole densities overlap high-quality habitat suggest areas where mitigating electrocution risk could be prioritized. As an example, we compared model predictions with Golden Eagle (*Aquila chrysaetos*) breeding season foraging habitat in the Bighorn Basin of Wyoming to identify candidate areas of high electrocution potential. If poles in these areas were not built or previously retrofitted to minimize electrocution risk, retrofitting measures focused there may offer substantial conservation impacts. Thus, the model provides a framework for systematic spatial prioritization in support of regional conservation planning.

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Ecology and Conservation of Sanford's Sea Eagle (*Haliaeetus sanfordi*) in the Solomon Islands: A Review of the Literature

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Considered one of the world's rarest raptors, Sanford's Sea Eagle of the Solomon Islands in the South Pacific is also one of the least known. Closely related to the White-bellied Sea Eagle (*H. leucogaster*) of Indomalaya and Australasia, it differs from most sea and fish eagles in possessing a plain or mottled brown adult plumage with no white areas. Endemic to the islands of Bougainville and Buka in Papua New Guinea and virtually all of the Solomon Islands, it inhabits small forested islets and reefs. Sanford's Sea Eagle is likely non-migratory, having never been recorded outside its breeding range. It shows no geographic variation and is an allospecies with the White-bellied Sea Eagle. The two have a breeding range separation of < 200 km of sea in the Bismarck Archipelago, but have evidently been long isolated. The Sanford's Sea Eagle appears to prefer forested coasts where it scavenges and kleptoparasitises Osprey (*Pandion haliaetus*), and hunts over deforested areas scavenging dead mammals. Nesting probably occurs in coastal mangroves, but no data are available on incubation or fledging periods. Sanford's Sea Eagle is a vulnerable species on the basis of a small estimated population of 250-1,000 individuals, which is suspected to be declining. The sea eagle is primarily threatened by deforestation, but over-fishing and silt run-off from logging and plantations are also likely threats, together with subsistence and sport hunting with the breakdown of traditional taboos, especially in the lowlands of the large islands. It is also killed in some villages to protect poultry and pets, and may suffer from competition with humans for favored prey species. It is well known to Solomon Islanders and is often featured in environmental articles and postage stamps. It has legal protection in some provinces, and recent initiatives are promoting its protection in inland community projects.

Measurement of Mercury in Forage Fish from Mexico and Central America and Implications for Osprey and Other Fish-Eating Birds

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Mercury (Hg) is a global contaminant of aquatic food chains. Aquatic, migratory birds such as the Osprey (*Pandion haliaetus*) can be exposed to mercury on both breeding and wintering ranges. We used satellite telemetry to track Osprey from Canada and the northern U.S. that wintered in Central and South America. We located 24 Osprey wintering sites identified from satellite telemetry and examined Hg levels in 14 fish taxa. Our main goal was to determine whether fish species that are a part of the diet of overwintering and resident birds reached toxicity thresholds for Hg. Mean Hg levels in whole fish carcasses ranged from a high of 0.18 µg/g (wet weight) in mackerel (*Scomberomus sierra*) to a low of 0.009 µg/g in Catostomidae. Average Hg levels were within the published toxicity threshold values for marine species only, e.g., mackerel, sea catfish (*Ariopus* species) and sardinas (*Centropomus* species), for only two sites in Mexico (Puerto Vallarta and San Blas Estuary). With the exception of one sample from sea catfish from Puerto Morazan, Nicaragua, none of the fish from sites in Central America had Hg levels that exceeded the thresholds. Non-metric multidimensional scaling (nMDS) revealed geographical differences in Hg levels with significant pairwise differences between sites along the Pacific Ocean (Mexico) versus the Bay of Campeche, partly due to differences in species composition of sampled fish (and species distributions). Hg increased with trophic level, as assessed by nitrogen stable isotope ratios (δ15N but not δ13C), in freshwater and marine, but not estuarine environments. The Hg concentrations in forage fish do not account for the elevated Hg reported for many Osprey populations on the breeding grounds, thus primary sources of contamination appear to be in the north.

Assessing Body Condition from Migrating American Kestrels as a Potential Cause of a Long-term Decline

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Over the past decade, American Kestrel (*Falco sparverius*) populations have been in noticeable decline across North America for undetermined reasons. Every fall, American Kestrels make energetically expensive migrations to southern wintering grounds. We assessed a potential cause of American Kestrel population declines by examining changes in body condition (residuals of a mass-wing chord regression). If population level metrics of body condition declined over time, then this could suggest that American Kestrel populations could be declining due to lack of food availability, resulting in low reproduction and/or poor survival. We developed a sex and age class-specific body condition index for American Kestrels captured at five migration monitoring sites from across North America. Specifically, we compared body condition trends within each age/sex group before and after declines in American Kestrel numbers in the late 1990s. Preliminary results indicate that male American Kestrels show declining body condition during population declines but not during stable periods. Our work is one of the first to use 25 years

of fall migration data from multiple sites nationwide to address a potential cause of American Kestrel population declines.

Safe Haven and Uncertain Threats: Examining Rodenticide Exposure for California Condors (*Gymnogyps californianus*) and Prairie Falcons (*Falco mexicanus*) at Pinnacles National Park and the Surrounding Region

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Pinnacles National Park is an island of public land amidst private ranches, farmland, and vineyards. The park provides critical nesting habitat for federally endangered California Condors and watch-listed Prairie Falcons. However, foraging habitat is limited and studies show that the majority of foraging by California Condors and Prairie Falcons occurs on land surrounding the park. Due to the wide-ranging nature of these birds, it is important to recognize both the benefits and the challenges of managing these species across boundaries and on the broader landscape. Private landowners are a key partner in conservation by providing habitat, food, and water sources on their ranches, farms, and vineyards. Nonetheless, land management practices may expose wildlife to toxins not used within the national park. We are now beginning to explore whether condors and Prairie Falcons encounter rodenticides while foraging outside of the park. Preliminary results of rodenticide testing indicate exposure in both species. Understanding the magnitude and incidence rate of these threats is a crucial step in working towards alleviating these stresses on sensitive and endangered species.

Post-construction Fatality Monitoring for Raptors: Balancing Cost vs Accuracy

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Raptor fatalities are a source of concern at wind energy facilities, particularly for eagle species. Although raptor fatalities occur relatively infrequently at most wind energy facilities (typically fewer than 1.0 fatalities/megawatt/yr), these fatalities often carry greater regulatory or public perception implications than fatalities of songbirds, waterbirds, or gamebirds. Consequently, regulatory agencies often expect wind farm fatality monitoring to include a component that is specific to detecting raptor fatalities. Monitoring to detect low frequency events, particularly where needed to verify permit compliance, requires methodology with a high detection probability and low variance; however, conventional monitoring methods makes this prohibitively expensive. We review the conceptual basis of post-construction fatality surveys, sampling designs, and analysis methods commonly used in the wind energy industry, including characteristics that contribute to variance in annual fatality estimates. We also describe characteristics of raptor fatality monitoring that differentiate it from other avian fatality monitoring. We discuss the implications of the relative rarity of raptor fatalities for the statistical estimation of annual fatality rates and review the current approaches to monitoring and analyzing for rare events. Fatality monitoring is only effective if it is performed, and it will only be performed if it is an affordable and predictable business expense for wind farms. We review weaknesses of current monitoring designs from this perspective and provide some suggestions for improvements or additional research.

Avian Mortality in Wind Farms: The State of the Art in Spain

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Wind power plants, despite representing a risk of bird mortality due to collision with turbines, are supported by conservationists groups worldwide because wind power is a part of the solution to greenhouse gas effects. Avian mortality complicates the development of new installations and generates a discussion among conservationists opposed and in favor of this kind of green energy. During the last decade, mitigating measures have been developed and evaluated to both reduce mortality rates in constructed wind farms and assess risk in future wind farms. Spain has experienced very uneven growth in wind energy due to its geography and wind conditions. A review of avian mortality from wind farms in Spain was done summarizing the beginning of wind farms studies, the most affected species and variables affecting bird mortality as well as mitigating methods. This review includes tools to aid planning and conservation. These measures have succeeded in reducing avian mortality in wind farms from Spain, and we hope are able to assess management of wind farms and future wind farms construction in order to decrease avian mortality without an appreciable reduction in total energy production.

Osprey (*Pandion haliaetus*) Telemetry and Banding Initial Data from Mono Lake — A Fishless Lake

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Osprey have been expanding their range in California since the 1970s. They were first documented nesting at Mono Lake Tufa State Natural Reserve in 1985. Mono Lake is a fishless hyper-saline lake east of the Sierra Nevada in Mono County, California at an elevation of approximately 1944 m. Mono Lake is surrounded by Great Basin Desert vegetation and has minimal development

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along the shoreline. Osprey nests are built upon calcium carbonate tufa towers which protrude from within the lake. Due to the salinity and alkalinity of the lake water it is inhospitable to fish. Therefore the only foraging waters for Osprey are the inlet creeks and surrounding lakes, which are 0.7 km to 6.4 km from reproductively successful Osprey nests. These waters are stocked by local and state programs with a variety of trout species. We initiated annual Osprey nest success monitoring in 2004, banding of nestlings in 2009, and deployment of transmitters in 2013 and 2015 to study the population status, dispersal, foraging behavior, and migration. During this study the nesting population increased from a low of four reproductively active pairs to a high of 15. A total of 95 nestlings and five adults have been banded, from which a single long-distance band was recovered near Corpus Christi, Texas. Telemetry data include migration of an adult female to Sinaloa, Mexico as well as local movement data of an adult male and juvenile male in the Mono Lake area.

Population Estimates for Northern Juvenile Peregrine Falcons with Implications for Harvest Levels in North America

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I used banding data to generate an annualized estimate of the size of the Hatch Year (HY) population of Peregrine Falcons (*Falco peregrinus*) based on mark and recapture data (Lincoln-Petersen model) from northern North America (including Greenland) from 1970 through 2010. This analysis supported a previous finding that migratory populations in western and eastern North America tend to remain separate, and are best analyzed as two distinct populations. The annualized migratory population estimate in western North America was approximately 12,500 HY falcons, and approximately 3,500 HY falcons for the migratory population in eastern North America. When accounting for mortality (10.4%) from the time that nestlings were marked and the arrival of HY falcons at trapping stations in the U.S., this analysis indicated that the annualized HY population was estimated to be greater than 13,800 migrant Peregrines in the eastern and western United States by the turn of the century. This estimate excludes some unknown proportion of the population that migrates through the central U.S., and the west coast of the U.S. and Canada. The Peregrine Falcon is no longer threatened or endangered in Canada or the U.S., and legal harvest of wild-caught migratory Peregrine Falcons for the practice of falconry is permitted. Using the US Fish and Wildlife harvest guideline (i.e., 5% of annual production), and the annualized estimate of HY falcons reported here (after mortality), it appears that the combined annual harvest limit in Canada, the U.S., and Mexico could be conservatively set at approximately 700 falcons without negative impact to the breeding population.

Geographic Variation in Isotopic (δD, δ13C, δ15N) Composition of Feathers from Falconer-Harvested Peregrine Falcons

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Wild-caught migratory Peregrine Falcons (*Falco peregrinus*) were used regularly for the practice of falconry from 1938 until 1970, when rarity lead to conservation action. The Peregrine Falcon is no longer threatened or endangered in the U.S. or Canada, and support for resumption of a harvest was established in 1998. Prior to resuming harvest, agencies in the eastern U.S. and southeastern Canada sought assurances that local populations would be protected from take. The US Fish and Wildlife Service completed an environmental assessment for take of Peregrine Falcons in the U.S. in 2008, and committed to isotopic analyses of feathers collected from falconer-harvested passage birds to estimate the latitudinal origin of passage Peregrine Falcons taken for falconry. Legal harvest of passage falcons was re-instated in 2009 and allows an annual take of up to 36 first-year migrants. The expected make-up of passage falcons harvested from northern Canada and Greenland, Alaska, eastern North America, western Canada, and the western U.S. was approximately 15, 8, 7, 1, and 6 birds, respectively. We used deuterium in feathers (δDf) sampled from nestlings originating from known locations, and the known geographic gradient associated with deuterium in precipitation (δDp) to link falconer-harvested passage Peregrines to natal origin. We used multivariate Analysis of Variance (MANOVA) and Tukey's post hoc test to identify jurisdictions that differed in isotopic composition of deuterium, carbon and nitrogen. We used discriminant function analysis (DFA) to assign samples to predefined jurisdictions. Our results indicated a strong correlation between δDf and δDp, and that δDf in passage falcons was consistent with northern latitudes. Leave-one-out cross validation indicated relatively high rates of misclassification between falcons originating from eastern and western population, but northern birds were rarely misclassified.

Population Estimates and Habitat Relationships of the Caribbean Red-tailed Hawk (*Buteo jamaicensis jamaicensis*) in Eastern Puerto Rico

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Organisms of oceanic islands exploit resources through niche expansion or shifts mostly by release from interspecific competition. The Red-tailed Hawk is a continental species with resident populations in North America, Central America and Caribbean islands. Red-tailed Hawks have been well studied in North America but information from neotropical environments, including insular forms, is lacking. In Puerto Rico, the Red-tailed Hawk exhibits high abundance compared to mainland conspecifics. Our objectives were to derive population estimates and identify habitat characteristics and vegetation associated with Red-tailed Hawks in eastern Puerto Rico. We conducted point transects along primary and secondary roads in the Luquillo Mountains and surrounding lowlands. We surveyed 127 points along 19 routes visited eight times from November 2012 - July 2013. We recorded 953 sightings of soaring adult Red-tailed Hawks, 635 during the breeding season (December-April) and 318 during the non-breeding season (November, May-July). We used distance sampling to estimate density and detection probability. We derived estimates for the breeding season (0.0159 individuals/ha, 95% CI = 0.0124-0.0206, CV = 130.03, P = 0.3) and non-breeding season (0.2051 individuals/ha, 95% CI = 0.0175-0.0241, CV = 8.19, P = 0.36). We used generalized linear mixed models to describe habitat associations with route as a fixed effect and visit as random effect. Best models (Δ AIC < 2) indicated Red-tailed Hawk density was negatively related to upland mature forest and positively related to temperature, mean slope, early successional vegetation and breeding season. Density of soaring adult Red-tailed Hawks was positively associated with temperature and slope, related to favorable thermal and updraft conditions, respectively. Our results indicate the Red-tailed Hawk of the Luquillo Mountains represent the highest known densities for the species across its range and in eastern Puerto Rico.

Assessing the Health of a Scarce and Threatened Raptor Endemic to Southern Africa, the Black Harrier (*Circus maurus*)

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The Black Harrier is a scarce and endemic raptor of South-western Africa. Considered regionally endangered by the IUCN, the total Black Harrier population has been estimated at < 1,000 breeding birds, but the reasons for scarcity of this ground-nesting species are poorly understood. In this context, it is important to evaluate potential threats, such as pollutants, to the population. Organochlorine pesticides (PCBs and DDTs) are known to be responsible for population declines of several species of birds of prey around the world. Despite widespread prohibition, the use of DDT persists in some countries, such as in South Africa, for controlling mosquitoes that spread malaria. In 2012-2014 we collected blood samples from breeding Black Harriers (n = 32) and their chicks (n = 170) in two areas, one coastal where natural vegetation predominates, and the other inland and more fragmented by agriculture. We found several PCBs (PCBs #52, #101, #153, #138, and #180) in the plasma of sampled birds. PCB levels were significantly greater in the coastal (3.41±0.37 pg/µL) than inland areas (2.15±0.50 pg/µL). DDT (*o,p'*DDE, *p,p'*DDE and *p,p'*DDT) levels were significantly higher in adult males than in adult females and chicks (3.10±0.57 pg/µL; 1.70±0.46 pg/µL; 1.68±1.20 pg/µL, respectively). In chicks, DDT levels were higher than DDE levels, suggesting current use of DDT and ingestion through diet. Total levels of DDTs increased when the diet (assessed through pellets and video footage) included proportionally more small-mammals. DDTs/PCBs ratio was higher in inland areas, suggesting that farmland pollution was stronger than industrial pollution there. We also assessed whether detected pollutant levels were related to estimates of healthiness of our sampled individuals, in particular body condition (weight/size) and amount of parasites. We discuss the most likely contaminating pathways (diet, maternal transfer) and the implications for the conservation of the species.

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Ornithogenic Fire: Raptors as Propagators of Fire in the Australian Savanna

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Birds have long been regarded as key taxa for the study of the impact of fire in the Australian savanna woodlands, with most studies concentrating on the effect of fire upon bird populations and their habitats. Fire in Australian savanna woodlands and the rest of the Australian continent has two commonly accepted sources, anthropogenic and lightning. Here we examine the as yet elusive but compelling evidence that two common Australian raptors, the Brown Falcon (*Falco berigora*) and the Black Kite (*Milvus migrans*), are responsible for intentional fire propagation in Australian savanna woodlands. Australian Aboriginal traditional knowledge and management of the Australian environment, long derided as having no scientific validity, is increasingly being accepted as a key element in contemporary land management. Our analysis of the anthropological, linguistic and first-person accounts of birds as propagators of fire in the Australian landscape provides evidence of the previously unrealized role of these raptors as regional and local-scale manipulators of landscape. The importance of the role of birds and fire in many traditional Aboriginal ceremonies and legend supports this conclusion and we discuss the significance of this knowledge to local Aboriginal people, the role of the birds-and-fire nexus as an example of ornithogenic service provision and the potential implications of this research for fire management in Australian savanna woodlands and beyond.

Can Operations Staff Effectively Monitor for Eagle Fatalities at a Wind Energy Facility?

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Fatality monitoring has long been a primary component of post-construction surveys aimed at determining a wind energy facility's direct impacts on wildlife. Recently, additional emphasis has been placed on identifying impacts on eagle populations specifically, and mitigating those impacts when they occur. As eagle programmatic take permits are issued, permit holders will be required to conduct fatality monitoring to ensure compliance with regulatory requirements. In most cases, two years of fatality monitoring may be needed. Survey duration may be longer in specific cases to assess the efficacy of additional conservation measures when implemented. Our objective was to develop a cost-effective yet viable eagle fatality monitoring protocol using operations personnel at two wind facilities in Washington and one in California. This study focused on decoy detection rates by operations personnel while conducting modified Spill Prevention, Control, and Countermeasure (SPCC) checks; these checks are typically conducted monthly as routine maintenance. Our "modified SPCC checks" required operations personnel to scan along roadways whenever within 200 m of turbine bases, and exit the vehicle at each turbine base to scan the surrounding terrain. Decoys were placed out to 150 m from turbine bases to provide coverage of the anticipated carcass distribution area. Operations personnel had encouraging detection rates: > 0.95 and > 0.68 within 150 meters (m) of turbine bases in easy and moderate visibility habitats, respectively. We feel that these rates merited continued testing and development of survey protocols, and may lead to a viable monitoring method for the facilities' Eagle Conservation Plans. Currently, decoy detection trials are being conducted within difficult visibility and unviewable areas. If a reasonably precise estimate of the mean annual eagle fatality rate can be obtained using on-site personnel incorporating fatality monitoring into their operations routine, the need for costly 3rd party eagle fatality monitoring may be eliminated.

Use of Passive Acoustic Recordings to Examine Interactions of Northern Spotted Owls (*Strix occidentalis*) and Barred Owls (*Strix varia*)

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Contemporary Northern Spotted Owl surveys are conducted by inducing territorial responses to a recorded call. Northern Spotted Owl response rates during these surveys have been declining, in part due to interference by an exotic congener, the Barred Owl. In an attempt to quantify Northern Spotted Owl calling behavior, I have deployed automated recording devices (SM2+ Recorder by Wildlife Acoustics) at five active Northern Spotted Owl sites with a range of Barred Owl activity. Recordings are made at sunrise and sunset. Call recognizers are being built using the Song Scope Recognizer (Wildlife Acoustics). Calling rates of Northern Spotted Owls with Barred Owls absent and present will be calculated and compared to the results obtained from contemporary surveys.

Observations of Golden Eagles Breeding on a Managed Forest Landscape in Western Washington, U.S.A.

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Golden Eagle (*Aquila chrysaetos*) life history is well studied throughout much of their breeding range in western North America. Few studies, however, have focused on Golden Eagles breeding in coniferous forests west of the Cascade Mountains where dense canopy cover limits foraging habitat. Long-term

monitoring of four Golden Eagle nesting territories occurring on 22,000 ha of industrial timberland in western Washington provides an opportunity to investigate nest site characteristics and productivity in this region. Seventeen nests were located in the study area (nine cliff nests and eight tree nests). Occupancy and productivity at each territory has been monitored annually for 12 to 19 yr. Annual productivity ranged from zero to one fledgling per pair, with a 19 yr average of 0.36 fledglings per pair (63 nesting attempts). Egg-laying occurred between 26 February to 11 April, and young hatched between 20 June and 3 August. Preliminary results from observations of prey deliveries to occupied nests and collection of prey remains beneath nests suggest that Golden Eagles in this region predate mainly small mammals, particularly mountain beaver (*Aplodontia rufa*), which constituted nearly 80% of all confirmed prey items delivered to nests. Future studies will continue to inform our knowledge of prey habits, as well as shed light on habitat characteristics of breeding territories in this region.

Do Invasive Aquatic Plant Infestations Create Ecological Traps for Bald Eagles (*Haliaeetus leucocephalus*) and Waterbirds by Promoting Avian Vacuolar Myelinopathy Disease?

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Invasive aquatic vegetation such as hydrilla (*Hydrilla verticillata*) may create ecological traps for Bald Eagles and waterbirds. Non-native hydrilla has spread across the U.S. since its anthropogenic introduction in the 1950s. Avian vacuolar myelinopathy (AVM) is a deadly neurologic disease caused by a toxin-producing cyanobacterium (*Aetokthonos hydrillicola*) colonizing hydrilla. AVM toxin is transferred trophically from herbivorous waterbirds to raptors. We investigated effects of hydrilla on avian distribution, the species' susceptibility range for AVM, and the Bald Eagle population sink on a southeastern U.S. reservoir. Over 75 AVM Bald Eagles have been documented at J. Strom Thurmond Lake (JSTL), a large reservoir on the Georgia-South Carolina border, since hydrilla's appearance in 1995. In 2012-2015, we observed significantly higher densities of waterfowl and Bald Eagles at hydrilla sites versus non-hydrilla sites, and a lake-wide decline in Bald Eagles from October-March (AVM season). Since 1998, JSTL has had significantly more Bald Eagle mortalities, fewer productive territories and lower productivity compared to a nearby, hydrilla-free reservoir with less shoreline habitat. JSTL has not seen a significant increase in Bald Eagle production or productive territories, contrary to the statewide population increase. We documented various avian and mammalian scavengers on American Coot (*Fulica americana*) carcasses along JSTL's shoreline, as well as Red-Tailed Hawks (*Buteo jamaicensis*) and Peregrine Falcons (*Falco peregrinus*) hunting coots at hydrilla sites, suggesting the list of species at risk to AVM is incomplete. To investigate the fate of Bald Eagles fledged from JSTL, we harnessed three nestlings with GPS-PTT transmitters. Transmittered eagles a will provide information on roost and hunting locations, time spent at hydrilla sites, and AVM susceptibility. Recent and historical data support the hypothesis that the hydrilla infestation on JSTL is creating an ecological trap for Bald Eagles and waterbirds that migrate to and breed at the reservoir.

The Nature Conservancy's Development by Design Strategy: Lessons for Golden Eagle Conservation

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The Nature Conservancy (TNC) has been a leader in using decision theory and scientific data on the distribution of biodiversity and human impacts to prioritize the best places and strategies for maximizing conservation returns and taking action at site, landscape, national, and global scales. In recent years, TNC has focused on bringing government, industry, and community decision-makers together around energy development policy and practice in a strategy termed "Development by Design." This strategy uses a landscape-level, big picture focus on collaborative decision-making and credible biodiversity and ecosystem service data and modeling to avoid, minimize, or offset the worst impacts of energy development to people and nature–while also generating significant new financing for proactive conservation. Results and lessons learned from several on-going projects in the Western U.S. will be used to highlight possible application to Golden Eagle (*Aquila chrysaetos*) conservation.

Short Distance Seasonal Movements of Striated Caracaras (*Phalcoboenus australis*) in the Falkland Islands

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The Striated Caracara is a near-threatened endemic raptor with a limited range in the extreme south of Argentina, Chile, and the Falkland Islands (Malvinas). Global population estimates range from 2,500-4,000. Little is known about the basic biology and movement ecology of the species. We are now undertaking a saturation banding effort in the Falkland Islands and have banded more than 1,000 individuals on four islands within the archipelago. Using five years of resighting data, we examined patterns of seasonal movements on 150 square km Saunders Island. Saunders is a nursery island for Striated Caracaras, with no breeding pairs, and with about 150 juveniles and sub-adults, and 10-20 adults. Of the 176 banded birds resighted 20 or more

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times on Saunders between December 2010 and May 2015, we detected substantial seasonal movement between two study sites separated by 16 km: the "Neck," which during austral summer provides a marine nutritional subsidy in the form of seabirds at seabird colonies, and the "Settlement," which during austral winter provides a human nutritional subsidy in the form of farm surplus and waste. During austral summers, 67% of resighted birds spent at least 80% of their time at the Neck, whereas only 4% spent most of their time at the Settlement. The pattern reversed during austral winters, when seabirds migrated, leaving only 1% of caracaras at the Neck versus the 81% who began spending the majority of their time at the Settlement. These results have important implications both for the species' spatial ecology and for their conservation, as farm settlements appear to play a critical role in providing an essential nutritional subsidy at a time of nutritional stress.

Mange Caused by a Novel Micnemidocoptes Mite in Free-ranging Golden Eagles (*Aquila chrysaetos*)

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A second-year, female Golden Eagle was live trapped in Northern California because of severe feather loss and crusting of the skin on the head and legs. On physical examination, the bird was lethargic, dehydrated, and thin, with severe feather loss and diffuse crusting on the head, ventral wings, ventrum, dorsum, and pelvic limbs. Mites morphologically similar to *Micnemidocoptes derooi* were identified with scanning electron microscopy. The eagle was treated and released after 9 months in captivity, but unfortunately was found dead near a wind turbine several months later. Two additional Golden Eagles found in the same region and also affected with this mite died soon after presentation to the hospital. Several other Golden Eagles have been reported by biologists in CA and NV since that time, but have not been live trapped and brought into captivity. Morphological characteristics of this mite strongly suggest a novel species of Micnemidocoptes mite. It is currently unclear as to the extent of this mite infestation in the Golden Eagle population in Northern CA.

Conservation of the Critically Endangered Ridgway's Hawk (*Buteo ridgwayi*)

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The Ridgway's Hawk is one of only three island-endemic buteos found worldwide and one of 11 diurnal raptors listed as critically endangered by the IUCN. Once found throughout the island of Hispaniola, the species has declined to approximately 300 individuals isolated to a small "paper-park" in the Dominican Republic called Los Haitises National Park (LHNP). Known threats to the species are habitat loss and human persecution. More recently we have determined nests falling and infestations by parasitic bot flies (*Philornis* species) are causing significant nest failure. In 2015 we conducted an observational study to measure reproductive success in control nests and nests managed for bot flies and nests falling. Results showed that only 26.1% (n = 23) of first attempts in control nests were successful and productivity was 0.4 (10/23) fledglings per nesting attempt. In managed nests, success of first nesting attempts was 70.4% (n = 54) and productivity was 1.1 (60/54) fledglings per nesting attempt. The translocation of nestlings from LHNP to protected habitats is proving successful in the formation of a new breeding population outside of LHNP. Since 2009, 79 young Ridgway's Hawks have been released in Punta Cana with 29 and 31 released in 2014 and 2015, respectively. Eight known pairs of Ridgway's Hawks have formed with the majority coming from the 2014 releases. Four of these pairs attempted nesting in 2015. Since 2013, when we discovered the first nesting pair in Punta Cana, four young have successfully fledged.

The Benefits of Staying: How Warming Winters, Migration Strategies, and Seasonal Declines in Fecundity Drive Earlier Nesting in a Partial Migrant

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Associations between climate change and advanced breeding phenology have been documented for several taxa, but aside from the prey tracking hypothesis, there are few hypotheses to explain why animals are breeding earlier. We propose that warming winters could result in earlier nesting by temperate-breeding short-distance migrants because of carry-over effects from remaining near or on breeding grounds in the winter, and because of reduced constraints to early nesting that allow seasonal declines in fecundity to

drive directional selection for earlier nesting. We studied the consequences of remaining resident on the breeding grounds in a partial migrant population of American Kestrels (*Falco sparverius*), and using extensive empirical data from this population, we developed an individual-based model to examine how changes in migration and seasonal declines in local fitness may drive shifts in nesting phenology. We found resident kestrels spend the winter within 1 km of their subsequent nest site and nest earlier than nonresident kestrels. Our simulation experiments suggest that population level shifts in nesting phenology can be explained by the additive effects of both shorter migration distances and the fitness benefits conferred by early season nesting. These results provide evidence for mechanisms for earlier breeding in animals and illustrate the complex and cascading effects of climate change on annual cycles.

Weather, Food, and Nestling Survival among Peregrine Falcons (*Falco peregrinus*) Breeding in the Canadian Arctic

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A long term project being conducted on a population of Peregrine Falcons breeding in Nunavut, Canada, has chronicled a steady decline in breeding productivity over 30 years. By documenting the direct effects of summer rainfall on nestling mortality, a recent study on this population suggests that increasing storm frequency may partially explain the observed declines. If the lower trophic communities that falcons rely on as prey are also affected by rainfall, a lack of food may be further limiting breeding success of Peregrine Falcons. Such reduced food availability would likely result in higher vulnerability to environmental pressures among Peregrine nestlings, and further decreases in survival. To investigate the food-related effects of severe weather, we implemented a food supplementation experiment over two breeding seasons. After nestlings hatched each year, we provided randomly selected nests an amount of commercially produced Common Quail (*Coturnix coturnix*) that correlated to 50% of the nestling's age-specific energetic demand. The two breeding seasons in which data were collected (summers of 2013 and 2014) were uncharacteristically dry and lacked heavy rainfall. Despite this, nestlings receiving supplemental food showed an increase in survival across all variables. Our results suggest that Peregrines in this area are food limited during the brood rearing period even in the absence of severe weather, and here we present how such limitation affects nestling survival across variables such as within brood hatch order, between brood hatch order, and hatching asynchrony.

Restoring Key Grassland Processes for Western Burrowing Owls (*Athene cunicularia hypugaea*) Using Ecosystem Engineers and Vegetation Management

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In response to population declines, the Western Burrowing Owl has been listed as a species of conservation concern at both state and federal levels. The factors most likely driving Burrowing Owl population decline in southern California are reduced habitat area, changes in habitat composition and structure from exotic annual grass species, and reductions in the distribution and abundance of an ecosystem engineer, California ground squirrels (*Otospermophilus beecheyi*). Squirrels create burrows and maintain open vegetation structure beneficial to owls, but continuing eradication efforts keep ground squirrels at 10-20% of historic population levels. We developed a new approach to provide conservation managers with a cost-effective tool for restoring degraded habitats to improve suitability for the Burrowing Owl. Our objective was to implement short-term vegetation management and squirrel translocations in order to re-establish key ecological processes. The success criteria were self-sustaining squirrel populations, creation of burrow complexes, and persistent change in vegetation structure. Nearly all burrows were concentrated in plots that received squirrel translocations. Within plots receiving translocations, most burrows were observed in mowed subplots (84±2%) compared to un-mowed controls. Our results indicate that the best management approach will often require both vegetation management and squirrel translocation, as the combination supports higher levels of squirrel activity than the use of either strategy alone ($p < 0.01$). More than 1,000 burrow entrances remained through the third year, indicating noteworthy and persistent engineering effects were achieved through squirrel activity. We found that a realistic restoration target would consist of dominant exotic grass cover, active human management of grass structure, burrowing activity by squirrels, and breeding owls. We anticipate that the primary usage of this management protocol will be the creation of nesting habitat for burrowing owls on targeted protected sites.

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Lead Exposure and Effects in Golden Eagles in the Pacific Northwest: Implications for Western Golden Eagle Population Management

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Lead (Pb) exposure is a major threat to raptor conservation in the western U.S. Pb is a particular threat to raptors such as Golden Eagles (*Aquila chrysaetos*) that scavenge on hunter-killed remains (offal) and un-retrieved game and varmint carcasses. Evidence indicates that juvenile and adult Golden Eagles in the Pacific Northwest may be continually exposed to Pb throughout the year. However, little is known about Pb exposure during the nestling stage, when both rapid growth and neurological development are occurring; both of which can be impaired by Pb exposure. To quantify the risk of Pb exposure to nestling Golden Eagles, we sampled nestlings in California, Idaho, and Oregon during 2013 – 2015. Our goals were to ascertain whether Golden Eagle Pb concentrations were diagnostic of sublethal or lethal poisoning, correlate Pb concentrations with heme biochemistry (delta-aminolevulinic acid dehydratase) to determine if nestlings were undergoing a toxicological response, and identify potential spatial or temporal patterns in Pb exposure that may be identifiable with Pb sources. Preliminary data suggested that there were significant regional differences in Pb exposure; concentrations were highest in California, but similar between Idaho and Oregon. Pb exposure did not change with age of nestlings, suggesting Pb was equally available across the breeding nestling stage. Overall preliminary data suggested that 23% and 11% of nestlings exceeded a background concentration of 5 or 10 µg/dL respectively.

The Urban Incubator: Minneapolis' Peregrine Falcons and the Creation of the Natural

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The disappearance and subsequent reintroduction of Peregrine Falcons (*Falco peregrinus*) within the eastern U.S. highlights both human ignorance and our capacity to heal fractured ecologies. For contemporary conservationists the story of the eastern Peregrine suggests numerous lessons indicative of changing human-natural relationships. This historical work examines how scientists, breeders, and falconers came together to rehabilitate the regional population. Focusing particularly between 1965 and 1985, the success of captive breeding and reintroduction is seen to rely on the careful control and close monitoring that defined breeding and release programs. Two methodological transformations were crucial to these successful efforts. First, was the development of captive breeding techniques through the Raptor Research Foundation's Breeding Program Internal Exchange (BPIE). These communications allowed different breeders and scientists to develop a shared knowledge base of techniques. These communications trace how successful breeding methods demanded a balance of human control with the biological needs of Peregrines. Second, releases at artificial structures and within urban areas allowed researchers to extend their control of fledglings beyond the breeding facility. As researchers were able to develop release techniques within artificial environments, the success of Peregrine reintroductions increased dramatically. Urban sites provided a type of incubator, where fledglings could be largely protected from non-human threats. Specifically the first urban releases in Minneapolis, Minnesota provide the key example. Through captive-breeding and release techniques the careful interference of breeders and researchers allowed for Peregrines to once again become natural. The character of the relationship between the domestic and the wild, the human and the natural, is examined within this history. Conservationists, policy-makers, scientists, and consumers continue to be confronted with choices which pivot upon their conceptions of human-natural relationships. This conservation success story suggests that the categories of human and natural remain heuristically useful, though practically inseparable.

Habitat Use of Barn Owls (*Tyto alba*) across a Rural to Urban Habitat Continuum and the Associated Risk of Rodenticide Exposure

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Anticoagulant rodenticides (ARs) are widely used to suppress rodent populations in human-intensive environments. However, accruing toxicity data are showing that these poisons are causing negative impacts on non-target wildlife, including secondary poisoning of raptors, particularly owls. To better understand the risk of Barn Owls consuming AR-poisoned prey, we conducted a 3-year radio-telemetry and pellet study assessing habitat choice and diet in Barn Owls across a rural-urban landscape continuum in the Lower Mainland, British Columbia. We found that Barn Owls persist in urban landscapes, albeit at lower densities, using industrial structures and bridges as nest sites, and hunting in the remaining patches grass habitats. Within home-ranges, the majority of condominiums, industrial, and commercial buildings had permanent placement of the second generation AR (SGAR) bromadiolone around their perimeters, as did most structures in agricultural landscapes. The relative risk of consuming AR-

poisoned prey, which was a product of the particular habitats' distance to AR bait and the owls' proportional use of this type of habitat, ranged from 0 – 40 %. Urban Barn Owls were on average closest to bait stations containing bromadiolone when hunting parcels of grass slated for urban development. Conversely, in agricultural landscapes, blueberry fields, which are often baited with first generation ARs to reduce vole abundance, were not a preferred hunting habitat for Barn Owls. However, Barn Owls were often observed hunting field margins or roadside verges bordering blueberry fields. Field voles were also the main prey item for all Barn Owls. Hence, given the increased amount of blueberry production in the region and corresponding AR usage we need to understand the role of field voles as vectors of ARs to Barn Owls and other raptors in agricultural landscapes. The justification for permanent placement of AR bait should also be evaluated further.

Estimating Key Parameters of Eagle Populations from Shed Feathers

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Understanding the population dynamics of threatened raptor species is important for setting conservation priorities. The correct estimation of some key parameters for population modelling, such as adult survival rate, natal, and breeding dispersal is difficult, especially for rare and sensitive species. The Eastern Imperial Eagle (*Aquila heliaca*) is a globally threatened large eagle, which has a small isolated population within the European Union in Hungary and surrounding countries. This population currently consists of 220 breeding pairs and has been monitored for over 30 years. The extensive field surveys covered at least 90% of the breeding population annually in order to record the number of breeding pairs and breeding success. The lack of data on survival and dispersal has hampered effective population modelling. Moreover, in the last decade illegal poisoning was identified as the main cause of eagle mortality in the study area, but it was not possible to assess the real extent of such crimes with traditional methods. To overcome these problems an intensive collection and genetic analyses of shed feathers from breeding adults and plucked feathers from chicks began in 2000. We built a DNA fingerprint database including more than 500 identified individuals, which enabled us to conduct genetic tracking. The average distance of natal dispersal (i.e. when the specimens identified as chicks were later found as breeding birds) was 111 km (n = 45). We found annual turnover of breeding birds was 12% (n = 249); significantly higher than would be expected for such a long-lived species. We recorded only six cases of breeding dispersal (i.e. switch between defined territories). Thus, territory fidelity was very high, so high annual turnover was probably due to non-natural mortality, like poisoning, not dispersal.

Golden Eagle Demography at Altamont Pass: An Update

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We began studying the resident population of tree-nesting Golden Eagles (*Aquila chrysaetos*) in the vicinity of Altamont Pass windfarm in west-central California in 1994. During the first 7 years, we estimated survival rates with radio-telemetry and monitored annual reproduction of 59-69 territorial pairs within 30-km of the windfarm. Wind-turbine blade strikes were the most frequent cause of recorded death for radio-marked eagles, particularly subadults. Demographic analyses suggested that the eagle population surrounding the windfarm was neither increasing nor declining, but that it lacked a locally-derived floater population that might buffer it against any further reduction in vital rates. We continued monitoring territory occupancy as a direct test of stability and found that all 58 territories occupied by territorial pairs in 2000 were still occupied by pairs in 2005, and all but two in 2013. We use these data to estimate the number of territorial pairs necessary to sustain various estimates of blade-strike mortality and the geographic extent of its influence.

Providing Evidence of Compliance with Incidental Take Permits

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The US Fish and Wildlife Service has begun issuing 20- and 30-year permits to wind power developers for take under the Endangered Species Act and the Bald and Golden Eagle Protection Act, e.g., Indiana Bat (*Myotis sodalist*), Newell's Shearwater (*Puffinus newelli*), Golden Eagle (*Aquila chrysaetos*). Once a take limit is set and minimization and mitigation approaches agreed upon, additional actions may be necessary if the permitted take limit is exceeded. Accurately collecting and interpreting data to determine that take is difficult. To date, monitoring has been mostly carried out by the industry with the objective of estimating general fatality rates, not to address compliance with take limits for individual species. Current statistical approaches can usually provide adequate estimates when observed counts are fairly large, even when detection probability is very low. But when the target population is small, as might be expected for endangered species or species with low population densities, the likelihood of finding

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no carcasses may be high, yet observing no carcasses cannot necessarily be interpreted to mean zero or even low numbers of fatalities. We present an approach based on Bayes' theorem that uses information about the search process and estimated detection probabilities to provide posterior probabilities of the actual fatality. We review the basic functionality of the Evidence of Absence software developed to carry out its complex calculations. The ultimate purpose of this software is to give managers tools for designing monitoring programs to provide evidence of industry compliance with Incidental Take Permits. We describe modules currently under development that will help define decision points where evidence of compliance is insufficient or where adaptive management actions should be considered to reduce excessive take. These products will be useful for any species of concern in any region, from Golden Eagles to Black-capped Vireos.

Diet Composition and Provisioning Rates of Swainson's Hawk Nestlings in the Northern Great Plains

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During the 2013–2014 breeding seasons, we monitored 18 Swainson's Hawk (*Buteo swainsoni*) nests using time-lapse video cameras to document diet composition and provisioning rates. We recorded 5,091.4 total hr ($\bar{x}$ = 282.8 ± 47.8 hrs/nest) of daylight video footage and documented 2,221 prey deliveries, identifying 2,017 (93.9%) of delivered prey items to species, genus, family, or class. Overall biomass consumed during the study was 189.2 ± 3.0 kg. The five most delivered prey items accounted for 74.7% of all deliveries and consisted of small mammals and reptiles. Small mammals accounted for 61.7% of total biomass, however reptiles (e.g., common garter snake [*Thamnophis sirtalis*]) accounted for a considerable proportion of biomass (19.2%). We documented a significant effect of brood size on the frequency of prey delivered to nests. Prey deliveries per nestling decreased as brood size increased ($F_{2,17} = 3.75$, $P = 0.04$); however, biomass did not differ ($F_{2,17} = 0.18$, $P = 0.84$) in relation to brood size. Provisioning rates during our study differed in biomass over 5-day interval periods from ~10 days old until fledging (~43 days old; grams/nestling/day; $F_{6,70} = 2.12$, $P = 0.06$). We observed an increase in biomass delivered per nestling per day to nest sites at early age stages of nestling growth; delivery peaked at 25 – 30 days of age and then declined thereafter. Overall, Swainson's Hawks exhibited a generalist approach to foraging by providing a wide variety of prey species. Trends in provisioning rates appeared to correlate with critical growth stages (e.g., flight feather development) in Swainson's Hawk nestlings. Our results suggest that Swainson's Hawks in our study were killing smaller prey more frequently than other Swainson's Hawk populations studied in the Northern Great Plains; prey species selected varies spatially and temporally among Swainson's Hawk populations.

Does Urbanization Have the Potential to Create an Ecological Trap for Powerful Owls (*Ninox strenua*)?

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Landscape transformation associated with urbanization is one of the most damaging and pervasive impacts on natural ecosystems. The response of species to increasing urbanization has become a major focus of research globally. Powerful Owls are a top-order predator capable of residing in urban environments, but increasing urbanization has been demonstrated to reduce available habitat. Powerful Owls only use tree cavities for nesting, so the cue for settlement is associated with the presence of habitat and food, meaning breeding requirements may be disconnected from settlement requirements. Our results demonstrate that the incorporation of a general prey resource as a cue for settlement does not reduce the amount of available habitat for Powerful Owls substantially across the gradient. Further constraining the model with a tree cavity resource, leads to a substantial reduction in Powerful Owl habitat in the urban and urban fringe environments. If a diverse prey resource is used as the cue for settlement, a substantial reduction in available habitat occurs in urban environments. Incorporation of tree cavities into this model does not reduce the available habitat for Powerful Owls substantially. We propose that Powerful Owls do not need a diverse prey base for survival, and that breeding resources are unlikely to be a cue for settlement. As such, we believe that increasing urbanization has the potential to create an ecological trap for Powerful Owls as there is a significant difference between habitat capable of supporting Powerful Owls, and habitat in which owls can breed. Management of Powerful Owls in urban environments will be difficult, but this research highlights the potential for the use of nest boxes to enhance the breeding activities in increasingly urbanized environments. Replacement of this critical resource may be able to reverse any potential ecological trap that is occurring.

Golden Eagles (*Aquila chrysaetos*) Nesting in Oregon, 2011–2014

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Historical (pre-2011) Golden Eagle nest locations were compiled for Oregon and used to guide statewide nest survey, search, and monitoring efforts during 2011–2014. We identified 1,042 potential breeding areas (PBAs) through 2014, including 902 (87%) that we surveyed at least once. Fifty-six percent of surveyed PBAs (n = 2,390) were occupied, and nesting success was 58% of PBAs with known outcome (n = 1,125). Productivity and brood size were 0.81 young per occupied breeding area with known outcome (n = 1,125) and 1.40 young per successful breeding pair (n = 651). Nests were built on cliffs (75%), in trees (23%) and on electricity pylons (2%, n = 777 breeding areas). Egg-laying and initiation of incubation began during the week of 29 Jan–4 Feb, peaked during 26 Feb–3 Mar and ended the week of 1–7 Apr (n = 478 estimated nesting chronologies). These data represent preliminary results for the first four years of a five-year study and provide important baseline information on the population of nesting Golden Eagles in Oregon. Historical and recent survey and monitoring results will be discussed in the context of our attempt to determine the size, distribution and productivity of the population of Golden Eagles nesting in Oregon.

High Prevalence of Leucocytozoon Parasites in Nestling Northern Goshawks (*Accipiter gentilis*) in the Northern Great Basin, U.S.A.

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The Northern Goshawk (*Accipiter gentilis*) is currently listed as a sensitive species by the U.S.D.A. Forest Service. Previous research in our study area, the South Hills of the Minidoka Ranger District of the Sawtooth National Forest, Idaho, identified possible signs of parasite infections among banded adult and nestling goshawks, which could influence their survival and breeding success. Therefore, we sought to quantify the prevalence and intensity of Leucocytozoon parasites among a sample of nestling goshawks in the South Hills during the 2012 breeding season. We sampled 27 nestlings from 12 nests for Leucocytozoon parasites by examining blood smears. All sampled nestlings were infected with Leucocytozoon parasites. The infection intensity ranged from 0.82 – 10.05 Leucocytozoon parasites per 1,000 erythrocytes ($\bar{x}$ ± SE = 4.35 ± 0.54). Using site elevation, distance-to-water, nestling age, nestling sex, and nest tree species as predictor variables for infection intensity by Leucocytozoon parasites, we employed an information theoretic approach to select a top model to determine the presence of an effect. The top model included nest tree species as the sole predictor for infection intensity. Specifically, higher Leucocytozoon parasite intensity was associated with quaking aspen (*Populus tremuloides*) nest substrate, as compared to lodgepole pine (*Pinus contorta*). Further research will help identify management implications for this species of concern in this high altitude forest surrounded by a shrub-steppe ecosystem.

Raptor "Take" From a Law Enforcement Prospective: The Unlawful Killing, Sales and Possession of Raptors and Their Parts by the Public

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Captain Jeter has over 24 yrs of experience in patrol, as a member of our covert operations team, and now management. He works closely with several leading authorities in the raptor management community, enforcing wildlife laws and regulations pertaining to unlawful "Take" of raptors. Take as defined by the California Fish and Game Code means to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, capture, or kill. He is recognized by the department as the lead enforcement officer dealing with raptor issues. He has investigated and successfully prosecuted several raptor cases, and has developed plans and enforcement details in an attempt to halt or curtail unlawful activity. He is a member of the California and Nevada Golden Eagle working group and has recently worked on the Gyrfalcon Conservation Project with the Peregrine Fund. Captain Jeter will present and discuss several issues other than the current and popular anthropogenic issues facing raptor ecology and management (e.g. wind farms, electrocutions and the continued poisoning of raptors throughout the west). Few are aware of the everyday unlawful interactions and adverse effect people have on raptors. These issues include trapping by pigeon hobbyists, unlawful sale and possession of raptor parts, take with firearms and traps, possession as pets, nest robbing, eagle feathers, falconry, falcon trade, and sales to the Middle East. These often unknown and veiled aspects of raptor take are widespread and far reaching.

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Prey Availability, Diet Selection and Nesting Success of Golden Eagles (*Aquila chrysaetos*) in the Mojave Desert

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Within the Mojave Desert, rapid large-scale development of solar energy facilities has the potential to impact Golden Eagle demographics through loss of foraging habitat and prey base. Knowledge of how eagle productivity is influenced by variability in prey abundance and distribution is critical for understanding the effects of solar energy development. Unfortunately, such information is largely unavailable for the region. In this study we investigate prey availability, diet selection, and nesting success of Golden Eagles in the Mojave Desert during two nesting seasons (2014 and 2015). To examine prey availability, we conducted nocturnal spotlight surveys along 140 5-km transects. We documented diet selection using motion-activated trail cameras and by collecting prey remains at 20 active nests. We determined nest success by conducting occupancy and reproductive assessment surveys within 50 historic breeding areas and by evaluating nest camera data at active nests. Preliminary results indicate high spatial variability in prey species abundance and selection. Overall percent composition of available prey was highest for black-tailed jackrabbits (54%), followed by kangaroo rats (15%), birds (12%), other rodents (7%), desert cottontails (5%), carnivores (5%), reptiles (1%) and large mammals (1%). Percent composition of selected prey species from nest cameras was highest for black-tailed jackrabbits (47%), followed by desert cottontails (11%), rock squirrels (10%), small mammals (10%), reptiles (10%), birds (8%), and mesocarnivores (4%). Overall nest success was 47%. Productivity was 0.67 young per occupied breeding area, and mean brood size was 1.4 young per successful nest. We found no evidence that camera installation caused nest failures or influenced eagle behavior for any sites. Results from this project provide important baseline information that may be used to construct predictive models linking prey availability and abundance to Golden Eagle productivity across a changing Mojave Desert landscape.

Migrating Golden Eagles at a Mountain Top Wind Farm: Conclusions on Collision Risk from Pre- and Post-Construction Monitoring

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Wind energy development in the eastern Rocky Mountain foothills of British Columbia, Canada, overlaps a fall Golden Eagle (*Aquila chrysaetos*) migration corridor. Using a before-after-control-impact design, we visually tracked Golden Eagle flights over 3 fall migration seasons (2009-2011) to document eagle flight behavior in response to wind turbines at the Dokie Wind Energy Project; one season pre-construction and two post-construction. We estimated 3-dimensional positions in space of the eagles as they migrated through our study site. These positions were incorporated into a Geographic Information System to ascertain flight altitudes for eagles that flew over the ridge-top area, or turbine string. We found the proportion of Golden Eagle heights (m above ground) were higher post-compared to pre-construction, and the likelihood of an eagle crossing the ridge-top at turbine height was 6-times greater during pre- compared to post-construction, 2.5 times greater under head winds vs western crosswinds, and 13 percent less likely with each km increase in wind speed. No changes in the number of eagles that used the site were detected, suggesting that Golden Eagles see the turbines and increase their altitude to avoid the structures during migration. Careful site planning, particularly in relation to the type of site-use by migrating raptors, remains a critical mitigation for minimizing collision risk.

Genomic Resources for the Management and Development of Conservation Units for Bald Eagles (*Haliaeetus leucocephalus*)

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Bald Eagles (*Haliaeetus leucocephalus*) are currently facing many anthropogenic stressors, such as electrocutions, lead poisoning, and habitat loss. To help combat the losses caused by these stressors, management plans should take genetic variation into account. Considering genetic variation is especially important in species such as Bald Eagles that have suffered from extreme population declines, which could have contributed to the loss of genetic variation, and reintroduction programs that may have inadvertently moved the natural genetic variation among groups. Furthermore, by having a robust genomic data set, individuals that have been killed by these stressors can be genotyped, thereby allowing their natal conservation unit to be determined. Here we present a genomic study of variation in 200 Bald Eagles from throughout North America that were sequenced using RAD-tag sequencing. Genomic sequencing was conducted using Illumina Sequence by Synthesis technology on the HiSeq and NextSeq platforms. Sequencing produced a total of 26.1 GB of sequence data, 293,661,880 reads total (an average 1,468,309 reads/sample). All read data generated from the samples were de-multiplexed, processed into loci, and analyzed for polymorphic regions using the Stacks software package. Stacks processing yielded 26,301 single nucleotide polymorphisms (SNPs) with an average SNP

allele frequency of 83.5% and 20.4 present per sample. This analysis of genomic variation in Bald Eagles has yielded quality information on the presence and location of variation within the Bald Eagle genome and will allow the study of geographic specific Bald Eagle genomic markers. These results assist in the creation of geographic specific conservation units to be used in Bald Eagle management plans.

Reducing Carbon Emissions by Using a Small Rotary-Winged Unmanned Aerial Vehicle (UAV) or "Drone" to Survey Nest Contents in Raptorial Birds

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We conducted 113 UAV flight surveys of the nest contents of four raptor species: Osprey (*Pandion haliaetus*) in Montana, U.S.A in 2013, and Bald Eagle (*Haliaeetus leucocephalus*), Ferruginous Hawk (*Buteo regalis*), and Red-tailed Hawk (*Buteo jamaicensis*) in Saskatchewan, Canada in 2014. With a success rate of over 90%, this technique is applicable and useful in a variety of nesting situations. Each survey was conducted using a GoPro camera attached to a sub-3 kg rotary-winged Draganflyer X4 Drone. In the majority of trials, high quality images of the nest allowed for accurate counts of contents, including estimates of the nestling age. Flight times were less than five minutes with the majority less than two minutes and times decreasing as pilot skill increased. We measured parental response at each nest, recording key behaviors of initial flush distances, call rates, flight behavior, and dives. We observed large variation in parental nest defense response between species. In general, Osprey were the most aggressive, the two buteos were less aggressive, and Bald Eagles moderately aggressive. We measured variation within the nesting cycle by conducting 86 UAV nest surveys of Osprey and comparing parental nest defense response between egg stage and nestling stage. Finally we approached active nests on foot without flying the aircraft, but still recording parental behavior. This allowed us to determine the amount of disturbance caused specifically by the drone versus any human presence at the nest site. We demonstrated that drone aircraft are valuable for monitoring raptor nests by allowing a flexible schedule of quick checks and causing less disturbance than current methods. Equally important, drones offer a much more "green" alternative to manned aircraft in terms of carbon emissions and ultimately, a significant way for raptor researchers to help reduce climate change.

Origins of Golden Eagles Killed at Altamont Pass Wind Resource Area: Continental-Scale Environmental Consequences of Local-Scale Renewable Energy Development

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Renewable energy is rapidly growing in prominence, largely because its use produces few greenhouse emissions and it is seen as environmentally friendly. Nevertheless, renewables have environmental effects of unknown scope for wildlife and habitats. To understand those effects, we used a combination of genetic and stable hydrogen isotope (δ2H) data, in conjunction with known-origin reference samples, to test hypotheses about the geographic extent and demographic consequence of mortality of Golden Eagles killed at a renewable energy facility in California, U.S.A. Genetic (microsatellite and SNP) data suggested that the eagles killed at the Altamont Pass Wind Resource Area (APWRA) near Livermore, CA were from a single, panmictic population, whereas geospatial analyses of δ2H values obtained from feathers suggested that ≥25% of these birds were immigrants to the population. The age structure of killed immigrant eagles was not random. Because the majority were young (2-year old birds), it suggests that some of the older eagles killed may have immigrated to the region when they were younger. Incorporation of these results into a demographic model indicates that Golden Eagle mortality at the APWRA is not compensatory, implying that populations at this renewable energy facility are sustained by long-distance continental-scale migration. These results indicate that management decisions concerning the impacts of renewable energy development may need to take into account the continental-scale impacts of local-scale activities.

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Mercury Levels in Birds of Prey Captured at Hawk Ridge, Minnesota

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The goal of this study was to create a baseline dataset of mercury levels in raptors. While mercury levels have been widely studied in birds in general, little is known of mercury levels in wild birds of prey in particular. To address this knowledge gap, we analyzed breast feathers from eight species of raptors banded at Hawk Ridge, Minnesota to evaluate mercury levels. Sharp-shinned Hawks (*Accipiter striatus*) averaged 3.26 ppm (n = 392), Merlins (*Falco columbarius*) 2.15 ppm (n = 137), Northern Harrier (*Circus cyaneus*) 1.48 ppm (n = 30), Peregrine Falcons (*Falco peregrinus*) 1.44 ppm (n = 8), Northern Goshawks (*Accipiter gentilis*) 1.24 ppm (n = 222), Cooper's Hawk (*Accipiter cooperii*) 1.11 ppm (n = 11), Long-eared Owl (*Asio otus*) 0.68 ppm (n = 88), and American Kestrel (*Falco sparverius*) 0.61 ppm (n = 71). Analysis of variance results show that after-hatch-year birds had significantly higher Hg levels ($P < 0.05$) than hatch-year birds for all species except for Cooper's Hawk, Long-eared Owl and Peregrine Falcon. Based on known effects of mercury levels on American Kestrels, these results suggest that some individuals migrating through central flyways may be at risk to detrimental effects of mercury.

Effects of Drought and Wildland Fires on Breeding Raptors at Naval Weapons Station Seal Beach Detachment Fallbrook: A 20 Year Case Study 1994-2015

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During 1994 and 1995, Navy Facilities Engineering Command (NAVFAC) Southwest funded a breeding season census of large raptors nesting on Naval Weapons Station Seal Beach Detachment Fallbrook, San Diego County, California. The breeding population has been monitored annually since, to varying degrees, through nest searches and mark-recapture studies. During 2015, NAVFAC funded a 20-year follow-up census to report on the territory occupancy and nest success following record drought years and wildland fires in October 2013 and May 2014 that burned 59% of the installation. To document cumulative effects of the drought and wildfires on breeding raptors, we re-surveyed all previously documented territories during spring 2015. Survey methodology was consistent between both 1994/95 and 2015 efforts. During 2015 we noted an absence of breeding attempts from six species, including Barn Owls (*Tyto alba*), Great Horned Owls (*Bubo virginianus*), Long-eared Owls (*Asio otus*), White-tailed Kites (*Elanus leucurus*), Northern Harriers (*Circus cyaneus*) and Red-shouldered Hawk (*Buteo lineatus*). Only eight of 34 (23.5%) Red-tailed Hawk (*Buteo jamaicensis*) and one of 13 (7.7%) Cooper's Hawk (*Accipiter cooperii*) territories successfully fledged young. In total we surveyed 78 large raptor breeding territories and documented only nine (11.5%) that successfully fledged young. We conclude declining breeding populations on Detachment Fallbrook are primarily linked to drought and wildland fires, however other secondary and off-site factors may include rodenticide poisoning, West Nile Virus, and habitat conversion. Declines observed in breeding raptors are not unique to the installation and seem to be wide spread throughout similar habitats in this region. Future studies can reveal the long-term effects of drought, fire, and other environmental stressors. Insights gained regarding the relative resiliency of raptors will have implications for climate change adaptation and management under future climate scenarios.

Spring and Fall Migration, Summer Range Fidelity, and Route Fidelity of Adult Rough-legged Hawks (*Buteo lagopus*) Captured While Wintering in California and Nevada

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During 2014 and 2015, we deployed 18 GPS transmitters (14 PTTs and 4 GSMs) on Rough-legged Hawks overwintering in California (n = 9) and Nevada (n = 8) and while on spring migration in Alberta, Canada (n = 1). With data for spring 2014 and 2015 combined (n = 16 tracks for 12 birds), departure dates ranged from 14 March to 27 April ($\bar{x}$ = 2 April ± 11.6 d [SD]), travel times from 22 to 57 d ($\bar{x}$ = 35 ± 10 d), travel distances from 3,816 to 5,491 km ($\bar{x}$ = 4,665 ± 553 km), and travel paces from 67 to 232 km/d ($\bar{x}$ = 141 ± 44 km/d). Hawks used several different spring migration routes through and on both sides of the Rocky Mountains to reach summer ranges spread out from the Kenai Peninsula to the north slope of Alaska and northwestern Nunavut in Canada. We tracked 3 birds on spring migration twice; two exhibited route fidelity while the other did not, whereas all three showed strong summer range fidelity. Fall departure dates in 2014 for 6 birds ranged from 8 September to 29 September ($\bar{x}$ = 20 September ± 8.1 d), travel times from 43 to 66 d ($\bar{x}$ = 54 ± 9 d), travel distances from 2,559 to 5,110 km ($\bar{x}$ = 4,014 ± 1,054 km), and travel paces from 39 to 119 km/d ($\bar{x}$ = 78 ± 31 km/d). Five birds arrived on their winter ranges from 9 November to 20

December ($\bar{x}$ = 26 November ± 19 d). With data combined for 2014 and 2015, males and females traveled similar distances and at similar paces in spring, but males generally departed earlier and arrived on their summer ranges earlier than females. Males also tended to depart earlier in fall and arrive on their winter ranges earlier than females.

Golden Eagle Dietary Responses to Habitat Alteration in the Morley Nelson Snake River Birds of Prey National Conservation Area, Idaho

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Wildfires have caused massive habitat alteration from shrubsteppe to grasslands in the Morley Nelson Snake River Birds of Prey National Conservation Area (NCA) since the early 1980s. Contrary to predictions, extensively burned Golden Eagle (*Aquila chrysaetos*) territories continue to be productive, suggesting a dietary shift away from shrub-reliant species like black-tailed jackrabbits (*Lepus californicus*). We collected prey remains from eagle nests in 1970s and 1980s (pre-burn years) and again in 2014 and 2015 (post-fire years) to 1) assess changes in Golden Eagle diet composition and diversity and 2) determine if diet changes were related to fire extent. We computed the frequency of individual prey items by species, calculated indices for diet diversity, and compared results with data collected on the same territories in the pre-burn years. Preliminary results show significant shifts in the composition of eagle diets. Post-burn diets included a higher proportion of American Coots (*Fulica americana*), Mallards (*Anas platyrhynchos*), Piute ground squirrels (*Urocitellus mollis*), and Rock Pigeons (*Columba livia*) compared to pre-burn years. Post-burn diets also contained significantly lower proportions of black-tailed jackrabbits and mountain cottontails (*Sylvilagus nuttallii*). Shifts in diet composition were related to the proportion of area burned within a 3-km radius area around the nesting centroids of territories. Territories with moderate to extensive burn areas (> 11% burned) showed a decline in the proportion of rabbits in the diet and an increase in ground squirrels. Territories that had less area burned (< 10%) showed no change in rabbits or ground squirrels over time. In addition to shifts in diet composition, we found that diet diversity at all territories increased significantly compared to pre-burn years. These results suggest access to waterfowl and Piute ground squirrels facilitate a dietary shifts that have allowed for continued productivity of Golden Eagles.

Factors Influencing Wind Turbine Collisions and Indirect Effects of Wind Energy Development on Non-Eagle Raptor Species

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As the production of wind energy increases worldwide to address concerns regarding climate change, adverse effects of turbines and development activities have been documented for many avian groups, especially raptors. The response of different species to wind energy development, however, has been shown to be highly variable and dependent upon a number of factors. The risk of collisions with turbines is influenced by characteristics of the wind energy project area and often varies by age- and life-history stage. While some commonly occurring species in a given area are more frequently found as collision fatalities, the risk of collisions is influenced by more than abundance alone, such as by species-specific flight and hunting behaviors. Indirect effects on raptor species may also occur when birds are displaced from foraging and nesting habitats due to avoidance of turbines or disturbance associated with operations and maintenance of the wind energy facility and associated infrastructure. This presentation will provide a broad overview of the ways in which wind energy development can impact non-eagle raptor populations and will discuss the factors that contribute to these effects.

Win-Win Conservation: A Case-Study of New Zealand Falcon Conservation

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The New Zealand Falcon (*Falco novaeseelandiae*) is a nationally threatened species, and is the country's only remaining endemic bird of prey. Due to their long evolutionary isolation, New Zealand Falcons display unique behaviors, including nesting on the ground, which contribute to their ongoing declines. Recently though, community-driven conservation projects have sought to reverse population declines, mainly through reintroductions of falcons from the last remaining population strongholds in the mountains to the low-lying regions in which they were once found. One reintroduction project in the vineyard-dominated region of Marlborough aimed to create a form of win-win conservation whereby falcons would benefit by expanding their range and vineyards would benefit by receiving a form of natural pest control for protecting their grapes from pest birds. We found that reintroduced falcons nesting in vineyards spent more time brooding their chicks, fed their chicks more, hunted for the same

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prey species, and had access to more abundant prey compared to their counterparts in the mountains. Falcon presence in the vineyards significantly reduced grape damage and increased yield at a value of over $230/ha. This research suggests that the goals of agriculture and predator conservation can converge, and that island raptor populations can benefit from concerted, community-driven conservation efforts.

Looking Beyond Mortalities: Lead Exposure and Stress in the California Condor (*Gymnogyps californianus*)

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Lead poisoning is the leading mortality factor for the critically endangered California Condor. Nonetheless, sub-lethal effects from the repeated lead exposures they experience are not well understood. Generally, lead exposure impairs the vertebrate stress response, and elevated stress can reduce avian reproduction and survival. Accurately evaluating changes in stress hormone release via blood sampling in wild birds is challenging, but measuring stress hormones in fecal and feather samples as a proxy for stress has shown promise as a non-invasive approach in some species. However, since the stress hormone response and hormone metabolism can differ widely among species, methods to assess the stress hormone response must be validated on a species-by-species basis. Here we report development and validation of methods to assess condor-specific stress hormone response and metabolism, including hormone metabolite stability, using enzyme-linked immunoassay (ELISA) and radioimmunoassay (RIA). Preliminary data on condor stress responses indicate a high degree of variation within the wild population. Serially collected condor urates show an elevation in circulating stress hormone that increased 2 to 65-fold within 2 hours following a defined stressor (i.e., trapping and handling). Additionally the ELISA used appears to be more susceptible to sample matrix interferences than the RIA. We will build on these findings to investigate lead-induced alterations in the condor stress response and potential impacts to California Condor recovery.

Chick Survival in Two Critically-Endangered *Gyps* Vultures in Assam, India

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Three species of *Gyps* vultures (Slender-billed Vulture [*Gyps tenuirostris*], White-rumped Vulture [*G. bengalensis*] and Long-billed Vulture [*G. indicus*]) have become critically endangered and are facing extinction in South Asia because of contamination of mammal carcasses with the veterinary drug diclofenac and possibly other NSAIDs with similar properties. Recovery efforts of these three species are diverse across their range countries. In 2003, we started and thereafter continued a program in Assam, India, to monitor the status of Slender-billed and White-rumped Vultures and to identify factors that are affecting their survival and that are expected to affect their recovery. From 2003 to 2013, we used nest monitoring data and recovery data from dead birds to evaluate the causes of chick mortality at breeding and foraging sites. We found that although chick survival and annual breeding success are high, nesting pairs have a declining trend. Thus, chick mortality is not at the heart of the population decline. An effective monitoring program strategy is required to measure the decline of nesting pairs and a conservation strategy is required to stop the extinction of these species in Assam, India.

Linking Pre-Laying Energetic Allocation and Timing of Breeding in a Migrating Arctic Raptor

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For migratory species, acquisition and optimal allocation of energetic resources after arrival on breeding grounds strongly influences individual variation in reproductive decisions, such as breeding phenology, and ultimately affect breeding success. However, given the challenges associated with capture of pre-laying migratory birds, relatively few studies have investigated the underlying physiological mechanisms driving individual variation in these crucial fitness-related traits. Here we characterize the dynamics of physiological parameters predicted to influence and reflect energetic allocation in pre-laying arctic-nesting female Peregrine Falcons (*Falco peregrinus tundrius*), and link physiological state to individual timing of breeding. Females from two populations were captured 2 to 20 days before egg-laying to assess plasma concentration of beta-hydroxybutyric acid (BUTY) and triglyceride (TRIG), two energetic metabolites known to reflect energetic allocation and short term changes in physiological fasting and fattening rate. We also assessed plasma concentrations of baseline corticosterone (CORTb), a hormone that mediates energetic allocation through adjustment of behavior and physiology. Plasma BUTY was higher during the pre-recruiting period than the estimated period of rapid follicular growth, indicating females improved their physiological state (reduction in catabolism of lipid reserves) before investing in rapid follicle development. Conversely, TRIG levels increased in pre-

recruiting females, and best predicted individual variation in both pre-laying interval and lay date. A marked increase in CORTb occurred approximately one day prior to the estimated period of rapid follicle growth and remained elevated thereafter. These results suggest that lower pre-laying fattening rate and lower rate of lipoprotein mobilization to the ovarian follicles delays the start of breeding, and that an elevation in pre-laying CORTb may be required to compensate for, or a result of, the high energetic costs of egg production. Our results illustrate dynamics of physiological management in pre-laying migrants and the manner that allocation of energy can influence individual reproductive decisions.

A Tour through the History of a Single Golden Eagle (*Aquila chrysaetos*) Nest: 27 years of Adaptive Management

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Since 1989, we have monitored a single Golden Eagle breeding area in conjunction with the planning and construction of a large urban development project in Dublin, California. Historical evidence suggests that eagles have nested at this site since at least the 1950s. Due to the potential for significant development-related impacts to nesting Golden Eagles, the final Eastern Dublin Specific Plan dictated a "line-of-site" buffer zone around the nest. Planning for the Dublin Ranch project excluded most development within that line-of-site buffer while possible disturbance from construction for certain facilities, and restoration work have been avoided within the eagle's view shed during the breeding season (1 January - 1 July). The eagles have successfully fledged young under this scenario. The estimated overall fledging rate over 27 years of monitoring is 1.2 fledglings/yr. During the last fifteen years of active management of the breeding area within a designated Conservation Area, the fledging rate has increased to 1.6 fledglings/yr. As part of our tour, we will explore adaptive management techniques instituted to preserve nesting success, such as providing alternate tree and pole platforms as nest sites, enhancing the prey base, installing fledgling safe fencing, and monitoring human disturbance through video surveillance. Despite past success the general urbanization of the area and the recent loss of the primary female to knemidocoptic mange are concerning. We will discuss what we have learned from long-term management of this Golden Eagle nest located in a rapidly urbanizing area with specific lessons learned regarding disturbance thresholds, and coordination of local stewardship for raptor conservation.

Climate Stability, Can We/Raptors Afford To Lose It?

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Many scientists agree that climate change is now the lens through which future conservation, mitigation, adaptive management, and species adaptation must be viewed. Terrestrial ecosystems are particularly vulnerable to changes in global climate, including increased temperatures and changing precipitation regimes, and other anthropogenic influences, especially along North America's west coast. Greenhouse gas accumulation in the atmosphere is causing a long-term change to climatic conditions that have been remarkably stable over the last 12,000 years. Atmospheric carbon dioxide (CO^2) during the past 600,000 years is well-documented; and today's CO^2 level exceeds those previous levels and is increasing quickly. Scientists have concluded that exceeding a 2°C average increase in the world's temperature would be ecologically dangerous. The world's current rate of CO^2 release into the atmosphere is projected to continue, pushing average temperatures beyond that critical 2°C. The resultant ecological changes will be numerous, with high loss of biodiversity (extinctions and extirpations) and changes to the remaining community composition that will reverberate throughout most food webs. We illustrate some species-specific changes that are already documented. Raptors are known to be valuable environmental sentinels because they are at the tops of food webs and are highly-dependent on food web integrity to persist, which in turn, depends on reasonably stable environmental conditions. As climbing heat and changing precipitation patterns continue to exert increasing pressure on ecological stability, food web integrity will be changed and, likely, degraded. The raptor scientific community should be 1) alarmed at evidence that some species may already be passing population tipping points and 2) aware of significant habitat changes, which are modeled to be at our doorstep. These developments should prompt raptor scientists to focus quickly on these climate-related challenges before raptor populations are negatively affected and scientists and habitat managers run out of time to formulate species-specific solutions.

Routes, Timing, and Wintering Areas of Migratory Flammulated Owls (*Psiloscops flammeolus*)

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Determining patterns in annual movements of animals is an important component of studies in population ecology, particularly for migratory birds, where migration timing and routes, and wintering habitats have key bearing on population dynamics. We used light-level geolocators to provide the first documentation of migratory movements in Flammulated Owls from 2009-present. Four males departed Colorado breeding areas

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for autumn migration from 5 to 21 October, arrived on wintering areas in Mexico between 11 October and 3 November, departed wintering areas from 6 to 21 April, and returned to Colorado from 15 to 21 May. Kernel density estimates indicated core wintering areas for three males were in central Mexico, where they were primarily associated with the Trans-Mexican Volcanic Belt in Jalisco, Michoacán, and Puebla, while the core area for one male was associated with the northern Sierra Madre Oriental Mountains in Tamaulipas. Mean distance from breeding to wintering areas was 2,057 + 128 km. Fall migrations were characterized by two flight pathways, as two males took a southeastern path to eastern Mexico and two males took a southern path to central Mexico, while spring migrations were characterized by a singular pathway, as all males traveled north from Mexico along the Sierra Madre Oriental Mountains to the Rio Grande River, and north through central New Mexico. The most prolonged stopovers by all males during both migrations occurred in New Mexico, 300 km from breeding areas. In the spring, this final stopover may have functioned in adjusting timing of return to high elevation breeding areas, where late snowstorms are common. One male tracked over two years showed similar patterns in migration routes and timing, and wintering areas, between years. Vegetation within core wintering areas, and at many stopovers, were associated with evergreen forests, suggesting important habitats throughout the owl's annual cycle.

Natal Dispersal of Wild Aplomado Falcons in Chihuahua, Mexico

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The Northern Aplomado Falcon (*Falco femoralis septentrionalis*) is classified as endangered in both Mexico and the U.S. The Northern Aplomado Falcon currently has a disjunct distribution, divided into two main regions: 1) Chihuahuan Desert and 2) coastal region of the Gulf of Mexico and Central America. The Chihuahuan Desert population is currently threatened by the extensive conversion of the species' breeding habitat from open desert grasslands to irrigated farmland. However, why the species has not been able to occupy apparently-available breeding habitat in the Chihuahuan Desert of Mexico and southwestern U.S. remains a mystery. The study of natal dispersal of Aplomado Falcons may reveal mechanisms of habitat selection and help to identify breeding habitat suitable for protection. To evaluate this, we are using Argos 5g-PTT satellite transmitters deployed on three fledglings from different nests (two males and one female) in Chihuahua (Mexico) in May 2015. One transmitter failed 7 days (male 40 days old) after being deployed, apparently related to a predation event. As of 25 June 2015, the other two transmitters continue to transmit (female 64 days old; male 71 days old), showing exploratory movements of young Aplomado Falcons around their respective nest sites.

Ecological Separation in Serpent Eagles (*Spilornis*) of the Andaman Islands, India

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The two serpent eagle (*Spilornis*) species in the Andaman Islands are believed to be ecologically separated with respect to habitats and distribution. The Andaman Serpent Eagle (*Spilornis elgini*) is endemic to the Andaman Islands, and is believed to be widely distributed in a majority of inland forests. The Crested Serpent Eagle (*Spilornis cheela*) is believed to be restricted to coastal forests. When this hypothesis was examined through occupancy surveys we found interesting results. The Andaman Serpent Eagle with its detection probability (0.116 ± 0.002) was found to be more abundant (encounter rate: 0.283) compared to the Crested Serpent Eagle (detection probability: 0.033±0.001; encounter rate: 0.106). Andaman Serpent Eagles were found to be more common in deciduous forests (37% of total sightings) and were never encountered in plantations. Whereas Crested Serpent Eagles were encountered in all the identified habitats but were more common in mangroves (32% of total sightings). Of the 13 cells (25 km2 each) surveyed, both species were encountered in more than 61%. In one cell neither of the species were encountered. On mapping the sightings of both species, we found that these sympatric species have significant overlap in their distribution and habitat. Based upon the co-existence of Andaman Serpent Eagles and Crested Serpent Eagles, we reject the null hypothesis of the ecological separation among these two *Spilornis* species.

Conserving Broad-winged Hawks (*Buteo platypterus*) Throughout Their Life Cycle: Migration Behavior and Habitat Use

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Broad-winged Hawks are the most numerous migrating raptor in eastern North America, yet little is known about their behavior and habitat during this critical period. Although relatively common, the range of Broad-winged Hawks in Pennsylvania declined by 16% over the last 20 yr. As part of a comprehensive study of breeding, migrating, and wintering ecology we attached 9.5 g, solar-powered satellite transmitters to four Pennsylvania birds in 2014 and four in 2015 to better understand their migration

behavior and habitat use. Preliminary results from 2014 (on three juveniles and one adult) show dates of departure from the nesting territory differ between adult and juveniles, and that daily distance traveled during fall migration of the adult was greater than that of the juveniles. All four birds initiated migration between 27 and 29 August, left Pennsylvania between 29 August and 8 September, and were south of Texas by the 1 October. Routes of migration varied south of Texas with a juvenile and an adult traveling along the Gulf of Mexico, while a second juvenile flew along the Pacific coast. Transmission from the telemetry unit was lost for one juvenile on 18 September 2014 and for the other two juveniles between 9 and 22 November. The adult arrived at the wintering area on 22 November in Brazil, spending a total of 94 d migrating. Only the adult returned in the spring, taking a similar route used during fall migration. Habitat of 2014 stopover roost locations in North America was primarily large forests. In 2015, four adult birds are being tracked from Pennsylvania nesting territories. We intend to compare autumn migration behavior and habitat for 2014 and 2015 birds.

Demography of the American Kestrel Lends Insight into Potential Causes of Population Declines and Suggests Future Research Needs

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Population declines are emergent properties of demographic processes, but not all processes affect the growth (or decline) of a population equally. Demographic models often are used to identify the processes that most affect the growth rate of a population and may identify processes that should be targeted for management or further research. Raptors are typically long-lived species and are generally considered "survivor" species because changes in survival rates tend to affect population sizes more strongly than changes in reproduction. Many populations of American Kestrels (*Falco sparverius*) have declined steadily over the past several decades, but the underlying causes remain unknown. Although there are a myriad of hypothesized drivers of kestrel declines, the hypotheses tested to date have been related to reproduction or threats on the breeding grounds. Here, we use data from thousands of banded kestrels as part of nest-box programs in Florida and Idaho to examine American Kestrel demography and test the hypothesis that, like other raptors, the growth rate of a typical population is more sensitive to changes in survival than to changes in fecundity. Our results support this hypothesis and suggest that future research should examine threats to American Kestrels during the post-fledging, migratory, and wintering periods.

Striking Gold in the Mentasta Mountains: Insights about Population Size and Migration Monitoring Based on Observations of Migrating Golden Eagles (*Aquila chrysaetos*) in Alaska

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Migratory Golden Eagles (*Aquila chrysaetos*) from Alaska winter across a vast region of western North America, much of which is undergoing rapid change from a diversity of anthropogenic activities. We are studying the year round movements of migratory Golden Eagles from interior and northern Alaska to identify and evaluate potential risks to their survival. In 2014, we conducted preliminary field investigations to locate concentrations of migrating Golden Eagles and potential Golden Eagle capture sites in eastern interior Alaska. These investigations included conducting a series of standardized counts during spring and autumn migration in the eastern Alaska Range. Our observation of 1,364 migratory Golden Eagles in October 2014 is among the highest counts of that species recorded at a raptor migration monitoring site in North America, and suggests that the only population estimate available for this species in Alaska is low. Further research is needed to document population size and to assess the potential of using migration monitoring as a tool for estimating population size and trends of Alaska's migratory Golden Eagles.

Describing Landscape-level Movement Patterns of Golden Eagles in North America using ARGOS and GPS Tracking Data

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Conserving wide-ranging animals requires knowledge about their year-round movements and resource use. Golden Eagles (*Aquila chrysaetos*) exhibit a wide-range of movement patterns across North America. We combined tracking data of > 540 Golden Eagles from multiple independent satellite-telemetry projects across North America to provide the first comprehensive look at the magnitude and extent of these movements on a continental scale. In the first stage of this project, we described the broad-scale geographic movement patterns of Golden Eagles. On a per-eagle basis, we subsampled location data to a maximum temporal frequency of one location per hour, and a spatial precision of 3 km. We then summed the total number of locations observed within each subunit of several schemes from continent-wide geographic units, such as the US Fish and Wildlife Service administrative Flyways, Bird Conservation Regions and CEC/EPA Ecoregions. For preliminary analyses, we assessed patterns of use of these geographic units through both cluster analyses and multinomial models. Both types of analyses suggested that eagles initially captured in eastern North America used geographic space differently than those captured in western North America. Other groups of eagles that exhibited distinct patterns in geographic space use included long-distance migrants from northern latitudes, and southwestern and Californian desert residents; there were also several groupings of inter-mountain western eagles. Our collaborative approach will allow us to identify large-scale movement patterns that may have not been possible with individual studies. These results will be useful for developing landscape-scale conservation strategies for Golden Eagles across North America.

Shifting Habitat Preferences and Migratory Strategies in a California Population of Swainson's Hawks (*Buteo swainsoni*)

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Migratory movements provide access to resources which lead to increases in survivorship and fecundity. Shifts in migratory strategy have been observed as anthropogenic landscapes have altered resource availability and stressors for numerous species, including Sharp-shinned Hawks (*Accipiter striatus*), Merlins (*Falco columbarius*), and Red Kites (*Milvus milvus*). Using historical and current literature, citizen science, and satellite telemetry data, we describe changing habitat associations and migratory strategies of California's Central Valley population of Swainson's Hawks. Historically the California population nested in dry open foothill grasslands within the upper Sonoran life zone, moving upslope through the transitional and Canadian zones after breeding. More recent studies demonstrate local shifts in breeding range, post breeding movements, and a strong dependence on cropland with differential use of crop types and cultivation regimes. As of 1943, no winter records existed within California, however, instances of partial migration have been documented from 1955-present within the Sacramento-San Joaquin Delta. Satellite telemetry data from 18 females breeding in the Central Valley from 1998–2002 indicate both partial migration (n = 1) and short-stopping (n = 9) at sites converted to cropland in western Mexico. The migratory route of all individuals which departed California differed from those described in other studies, recorded as traveling west of the Sierra Madre Occidental. All migrating birds used agricultural stopover sites in western coastal Mexico. Several wintering birds traveled long distances (approximately 200-1,000 km) between overwinter sites. Central Valley birds appeared to arrive and depart from the breeding grounds earlier than other continental populations. From a conservation perspective, these results suggest that the California population is exploiting novel habitats and may experience different migration costs compared to other populations in North America. Our results also contribute to our understanding of the emergence of facultative migration within the avian taxa.

In-Flight Winter Habitat Use and Selection of Golden Eagles (*Aquila chrysaetos*) in Eastern North America

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Identifying resources that are important to animals is critical for conservation and management of species, especially for rare and cryptic species. Birds use landscapes differently depending on the activity in which they are engaged, and consequently may be exposed to different risks based on their behavior. For example, electrocution is more likely when perched, collision with wind turbines more likely when flying. To identify important resources important for flying eagles, we measured habitat at GPS-telemetry locations of flying Golden Eagles wintering in eastern North America. We used generalized estimating equations to model population level resource selection with a used vs. available design. From 2006–2015, we tracked 29 female and 40 male eagles with

GSM-GPS telemetry that collected a location every 15 min. We collected a total of 249,662 locations of which 40,654 locations were in flight. We found that flying eagles mainly used and selected forested areas, higher elevations, side slopes, cliffs, and ridge tops. Eagles avoided agricultural, developed, and disturbed areas. They also avoided both wet and dry flats and valleys. Importantly, many of these same types of undeveloped, high elevation forests are candidates for extensive energy development including natural gas and wind power. Our results show that eagles may be affected by development of remote areas in eastern North America. Our data also provide relevant information that can be used by managers to conserve wintering habitat of Golden Eagles.

Short-eared Owl (*Asio flammeus*) Surveys in the North American Intermountain West: An Innovative Approach using Citizen Science to Conduct Long-term Monitoring

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The most significant threat to Short-eared Owls in North America is the loss or alteration of native grasslands, shrublands, and wetlands across the species' range. Despite evidence that Short-eared Owl populations are experiencing long-term, range-wide, substantial declines in North America, very little population monitoring has been dedicated to this species. Through creative partnerships we launched a broad survey of Short-eared Owls across Idaho and northern Utah. We recruited citizen-scientists and volunteer professional biologists to perform the surveys, engaging over 130 individuals in the effort. We used multi-scale occupancy models to evaluate habitat associations and multi-scale abundance models to produce the first broad-scale estimate of the Short-eared Owl population size within the region. In the coming years, we expect to scale our successful citizen-science model to encompass the range of Short-eared Owls in western North America.

Variable Impacts of Within-Year Weather Conditions and Among-Year Shifts in the Post-Breeding Migration Phenology of Soaring Birds at the Strait of Gibraltar

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While alteration of the migratory habit of birds is widely regarded as one of the most evident ecological effects of climate change, studies reporting shifts in migration phenology for long-lived, long-distance migrants have been few. We set forth to analyze the effects of local and regional weather conditions on migration counts and evaluate the magnitude and direction of phenological shifts for six common species of soaring birds at the Strait of Gibraltar during post-breeding migration. We used an information theoretic approach to analyze the influence of local visibility, cloud cover, local weather, and regional weather in northern Spain on migration counts, and time series of count data to evaluate the phenological shifts. We found that migration counts were higher on days with local westerly winds, often following a day of easterly winds; on days with local high pressure systems, often following a day of lower pressure; and when tailwind conditions occurred in northern Spain three days prior. Cross-correlation analysis allowed us to compare recent data on the timing of migration from 1999–2011 to a historic data set collected during 1976 and 1977. The direction of phenological shifts for autumn migration were species-specific: White Storks (*Ciconia ciconia*) and Black Kites (*Milvus migrans*) appeared to delay passage; Black Storks (*Ciconia nigra*), Short-toed Eagles (*Circaetus gallicus*), and European Honey Buzzards (*Pernis apivorus*) advanced their migratory timing; and we found no clear phenological change for Booted Eagles (*Hieraaetus pennata*).

The Devil in the Details: Conservation of Eagles under the Eagle Non-Purposeful Take Rule

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Bald (*Haliaeetus leucocephalus*) and Golden (*Aquila chrysaetos*) Eagles are protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). The BGEPA is generally the more restrictive and specific statute, therefore BGEPA regulations have the most direct impact on eagle conservation. In 2009, the US Fish and Wildlife Service (Service) adopted regulations under the BGEPA that allowed for issuance of permits to take eagles incidental to otherwise lawful activities. Provisions in the BGEPA require the Service to ensure the activities it permits are consistent with the preservation of Bald and Golden Eagles. There is a great deal of uncertainty about population-level effects of activities that incidentally kill or injure eagles, and understanding these relationships is crucial to ensuring compliance with Service regulations and the preservation

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standard. The Service is presently considering revisions to the 2009 non-purposeful take regulations to incorporate updated and new information on eagles and the activities that might incidentally take them. Elements of the regulation of particular interest include: 1) the appropriate geographic management unit for both eagle species, 2) new or updated information about population status and dynamics, 3) improved understanding of causes and levels of mortality, 4) facilitating mitigation, and 5) improving work-flow for permit applications. In this presentation we will provide an update on the status of the rule revision process and some of the complexities that must be addressed.

Causes of Mortality of Golden Eagles in the U.S.

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Analysis of band recovery data suggest that annual survival rates of Golden Eagles (*Aquila chrysaetos*) in North America increases annually with age to at least three years, with juvenile survival about 70%, and after-third-year survival averaging about 87% per year. Across all age-classes annual survival averages 80%, which means about 20% of all Golden Eagles die each year. A 20% mortality rate is higher than what has often been assumed in recent studies in the literature. To determine what factors account for this mortality, a group of collaborators from across North America pooled data from nearly 400 Golden Eagles equipped with satellite-tags. Satellite-tags provide a relatively unbiased picture of causes of mortality, unlike band recoveries or opportunistically found carcasses. Based on a preliminary assessment of 97 tagged eagles that died and for which the cause of death could be determined, 56% of deaths were from anthropogenic causes. Shooting, electrocution, and poisoning (32% of all deaths) were the leading causes of anthropogenic death. Starvation and related disease was the leading cause of death overall (40% of all deaths). The importance of anthropogenic mortality increased with Golden Eagle age, accounting for 34% of juvenile mortality, 58% of subadult mortality, and 65% of adult mortality. Overall survival rates excluding human-caused mortality are consistent with presumed survival rates for large raptors. The comparatively high rate of human-caused mortality, particularly among adults, is likely limiting Golden Eagle population size.

Consequences of Changes in Human Attitude: Expanding Nest Site Opportunities for the Spanish Imperial Eagle (*Aquila adalberti*)

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Over a period of 14 years we studied expansion of the Spanish Imperial Eagle population in the Andalusia region of southern Spain. During the 20th century, the Spanish Imperial Eagle experienced declines and reductions in distribution, mainly due to human persecution. Territories present before the expansion process were relegated to areas that were inaccessibility and away from human activities, such as towns, roads, and agriculture. Today however, the species is experiencing growth in the number of individuals, and in the species' range. The number of breeding pairs has increased from 10 in 2001 to 117 in 2014. This is relevant for predictions about potential habitat and conservation actions, and for understanding the population dynamics point of view of the Spanish Imperial Eagles in Andalusia. We analyzed the distribution, breeding age, productivity and distance to human activities of the new territories during the recent population expansion. During this time, new territories were closer to human activity, and were mainly occupied by immature pairs with higher productivity than older territories. While old breeding sites acted as shelters for the species during the time of direct human persecution in southern Spain, today a change in human attitudes has made new high quality territories available.

Effects of Age and Territory Quality in an Expanding Population Process

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Over 14 years we studied the expansion of the Spanish Imperial Eagle (*Aquila adalberti*) population in the Andalusia region of Spain. The number of breeding pairs increased from 10 in 2001 to 117 in 2014. We analyzed the effects of density, age of breeding, and habitat heterogeneity on the fecundity of the expanding population. New areas were occupied that were outside the limits of historic population, but that had high quality habitat with a low probability of occupation due to the philopatric behavior of the species. High-densities of eagles, and increasing levels of intraspecific competition in historically occupied territories may have promoted dispersal by unpaired individuals. The appearance of the first pairs outside of the historic range probably represented the most important step in the geographic expansion of the breeding range. Newly occupied areas were more frequently populated by immature pairs, and no difference was found between the productivity of adults and immature pairs in high quality territories. Our results confirm the importance of territory quality in population fecundity, and the ability of young pairs to produce young when those young pairs have the opportunity to occupy a high quality territory.

Seasonal Home Range Variation and Spatio-Temporal Ecology of Resident Peregrine Falcons (*Falco peregrinus*) in Coastal Humboldt County, California

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The home ranges, migratory habits, and migratory routes of Peregrine Falcons have been well studied across international borders and subspecies. To better understand space use within these home ranges we examined habitat utilization patterns in a non-migratory population of Peregrine Falcons. In 2014 and 2015 we deployed GPS/satellite transmitters on nine Peregrine Falcons from five coastal breeding pairs in Humboldt County, California. Using kernel density estimator and time local-convex-hull (T-LoCoH) methods to create utilization distributions (UDs), we will present preliminary home range analyses based on GPS datasets. We also used T-LoCoH methods to identify areas of more intense use within the UDs by calculating re-visitation and visit duration rates. We will use T-LoCoH derived metrics and ancillary transmitter data to identify preferential space use patterns within the UDs at different temporal scales. Environmental and temporal covariates will include habitat type, tide height, season, and indexes of prey density. We will present results for annual and seasonal UDs and compare the seasonal home ranges of male and female Peregrines. Early analyses indicates that males occupy a larger home range size than females at the 95% UD level (95% UD $\bar{x}$ = 62.6 ± 66.3 km2 vs. 12.4 ± 8.63 km2), but occupy a similar area to females at the 50% and 10% UD levels (50% UD $\bar{x}$ = 2.58 ± 1.20 km2 vs. 1.69 ± 1.38 km2; 10% UD $\bar{x}$ = 2.02 ± 1.62 km2 vs 1.12 ± 0.81 km2). Initial space use analyses do not identify any obvious movement patterns in daily space use within the estimated home range (excluding data for females collected during known incubation periods). These analyses will give us more in-depth and dynamic insight into how Peregrine Falcons utilize space and resources within their territories throughout the year.

First through Fourth-Year Dispersal of Golden Eagles from Natal Areas in the Colorado Plateau Region of the Southwestern U.S.

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Knowledge of age-specific dispersal by Golden Eagles (*Aquila chrysaetos*) from natal areas is needed to help manage the species in North America. During 2010–2015, we used satellite telemetry to document pre-adult dispersal by Golden Eagles from natal areas across the Colorado Plateau Region of the southwestern U.S. Here we report on 1) first-year dispersal timing, and monthly home range (HR) overlap and distance from natal areas; 2) overlap of early spring HRs at 12-month intervals through the fourth yr; and 3) distance from natal areas in early spring of the second through fourth yr. Sixty-one Golden Eagles tagged at an age of approximately 55 d yielded hourly GPS locations for ≥ 6 mo. Most (> 75%) dispersed from natal areas by the 31st of October, at 165-200 d of age. Size of HRs (minimum convex polygons) at ages 5, 8, and 11 mo was (medians) 19.3, 965.5, and 602.2 km2. HR overlap between 4-5, 7-8, and 10-11 mo averaged 94.2, 38.2, and 58.0% (SE = 1.3, 3.7, 4.5). Centroids of monthly home ranges at 5, 8, and 11 mo averaged 8.4, 144.8, and 118.0 km (5.0, 28.8, 29.6) from natal sites. HRs at the end of the first yr (i.e., at about 12 mo age), second yr, and third-fourth yr overlapped by averages of 27.2% (5.5) and 69.3% (9.7). Our findings on pre-adult dispersal of Golden Eagles generally contrast those of previous studies and reveal earlier settling and shorter dispersal distances than expected. The results provide crucial support for delineating population management units and estimating sustainable levels of take of Golden Eagles in the western U.S. We currently are completing analyses to determine whether movement, use of space, and location relative to natal area differed with yearly age class, sex, or annual migration status.

Integrating Home Range and Density Models can Improve Habitat Predictions for Ferruginous Hawks (*Buteo regalis*)

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Integrating home range and density models can use a hierarchical approach that incorporates landscape-scaled spatially-explicit population parameters with home range habitat selection. Our objective was to evaluate whether home range models for Ferruginous Hawks could be scaled up to predict nest density and to evaluate whether conservation and recovery planning could benefit from integrated home range and density models. We developed a home range habitat selection model using nests (n = 1,309) that were used between 2004 and 2010, and we developed a density model using surveys conducted in 2012 and 2013 (n = 223). Home ranges and density surveys were located

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across a gradient of land-cover types and industrial development in Alberta and Saskatchewan, Canada. Both models were validated using independent data sources. Home ranges were more likely to be selected in close proximity to grassland, but were also slightly positively associated with edge density. However, nest densities were strongly predicted by the proportion of surrounding grassland and were highest in areas with 49% grassland. Results from our home range and density models show a hierarchical influence of land-cover on Ferruginous Hawk habitat selection. If management recommendations were solely based on home range models, grassland land-cover would be identified as important habitat, but the landscape-level mosaic of grassland and cropland associated with high nest densities would not be recognized. At-risk species population management can be made easier from habitat modeling such as ours, when that modelling is linked to spatially-explicit density estimates.

Demographic Modeling Approaches for Golden Eagles

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Demographic analyses of wildlife populations are key components of management and conservation strategies, and fundamental to informing policy. For example, model representations of Spotted Owls (*Strix occidentalis*) underlie much of the Northwest Forest Plan, impacting land use across public lands in the Pacific Northwest. As emerging threats and new challenges for conservation lay ahead, demographic models provide a framework for evaluating potential consequences and solutions to key management problems in the face of imperfect knowledge. We present a brief primer on the statistical tools available for demographic analyses, and the challenges inherent when applied to a long-lived, highly mobile species such as the Golden Eagle (*Aquila chrysaetos*). Using a demographic model, we provide an example of models to characterize the population ecology of Golden Eagles. Following a far-reaching review of Golden Eagle demographic studies, we estimate the distributions that characterize components of individual and environmental variation across vital rates for productivity and survival. Using a stage-based population projection matrix representative of Golden Eagle life-history, we demonstrate how vital rates disproportionately contribute to population growth. As predicted, we found that population dynamics of Golden Eagles are dominated by breeding adult survival across the range of potential vital rates potentially realized by populations. Using this information, we simulate perturbations to survival that may be realized from an expanding human footprint. Our findings suggest that maintaining stable to positive population growth is tenuous when adult survival is reduced as little as 3%. Furthermore, management targeted at increasing reproductive output may have little recourse for buffering against depressed survival rates. Improved estimates of survival and an understanding of the additive nature of mortalities can help guide conservation planning for Golden Eagles moving forward.

The Smøla Wind-Power Plant in Norway: Effects on White tailed Eagle and Willow Ptarmigan, and Mitigation Efforts to Reduce Turbine-Induced Mortality

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At a 68-turbine wind-power plant at Smøla, coastal mid-Norway, White-tailed Eagles (*Haliaeetus albicilla*) are killed by turbines frequently, and are second only to the Willow Ptarmigan (*Lagopus lagopus*) as collision victims. Using GPS satellite telemetry and vantage point observations we have studied movement patterns and collision risks of the eagles, and used a bird radar (Merlin) to record flight patterns and intensity of bird movement. We conducted weekly searches with trained dogs to find collision victims. We subjected molted feathers from adults and feathers from nestlings of White-tailed Eagles to DNA analysis, enabling us to track the origins of and relationships between victims, and to produce a population model. The most influential demographic parameter in the model was adult survival, and we found that the distance from the nest to the power-plant was important. Molted feathers of many White-tailed Eagles could not be classified as breeders, indicating the presence of a relatively large proportion of floaters on the island. Mitigation efforts have been performed, including contrasting paint on the base of turbine towers and on the rotor-blades in order to make them more visible, and testing of the DT Bird deterrent system. The combined datasets of the telemetry and radar studies, and information on the location of nest sites and night-roosts of White-tailed Eagles and local grouse densities were used in a study for repowering of the Smøla wind-power plant. We have shown that turbine-induced mortality can affect the population dynamics of a large raptor, and that grouse species are vulnerable to collisions with turbine towers when such installations are placed in their breeding habitats. It is still too early to conclude of the effectiveness of the mitigation efforts, as these studies are still in progress, but some preliminary results will be presented.

Using Christmas Bird Count Data in Conjunction with Migration Counts to Provide Enhanced Understanding of Raptor Population Change

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An increasing pool of scientific evidence supports the idea that many avian species are changing migratory behavior due to climate change, land-use change, or both. We explore the utility of coupling Christmas Bird Count (CBC) winter data with fall raptor migration trends based on Raptor Population Index (RPI) data to create a more-complete picture of regional population trends for some raptors. We do this using a common and widespread North American raptor, the Red-tailed Hawk (*Buteo jamaicensis*), as an example. We conducted 10-, 20-, and 30-year trend analyses using pan-North American CBC and RPI data. We analyzed CBC trends at the migratory flyway and Bird Conservation Region (BCR) scales, and further subdivided each flyway into 3 latitudinal regions. We compared CBC and RPI trends within migratory flyways and BCRs over similar time periods. Red-tailed Hawk population trends at most migration sites in the eastern flyway were negative. In contrast, western flyway trends were stable or positive, although migration trends in the southwest were negative or stable. CBC population trends showed the following patterns 1) the largest increasing population trends in northern regions; 2) moderate increasing to stable trends in central, south-central, and south-west regions; and 3) decreasing to stable trends in southeastern regions. While trends in eastern fall migration counts of Red-tailed Hawks are declining, CBC trends indicate a stable to increasing Red-tailed Hawk population across much of North America; although particular negative RPI and CBC trends may warrant further study. In general, higher latitudes showed declining migration counts and increasing CBC counts suggesting significant changes in Red-tailed Hawk migratory behavior. Our findings demonstrate the benefit of assessing population status over multiple life-cycle stages, and highlight how coupling long-term data sources, such as CBC and RPI data, can provide a broader, more accurate picture of population change.

The Galapagos Hawk (*Buteo galapagoensis*): Host-Parasite Coevolution and Eradication Studies

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Since 1998, we have studied the Galapagos Hawk throughout its range in the Galapagos Islands, Ecuador, and we have conducted annual censuses of two study areas on the uninhabited island of Santiago. We estimated the colonization of the ancestral hawk at ~150,000 years ago, and have shown the significant genetic distinctiveness of the current 8 breeding populations isolated on different uninhabited islands. The ectoparasites that co-colonized with the ancestral hawk lineage have established a strong co-evolutionary relationship with Galapagos Hawks during their diversification on the islands, and themselves are today similarly differentiated by island. Our censuses on Santiago occurred before, during, and after the eradication of ungulates that was completed in 2006. There has been a significant decline in survivorship of adult Galapagos Hawks on Santiago in the years following goat eradication, and the decline continues today, with an estimated reduction of 33% of adults inhabiting territories on our two Santiago study areas, compared to pre-eradication numbers before 2005. Further, in hundreds of hours of observations of prey delivered to nests, we have documented a significant shift in the feeding ecology of Galapagos Hawks on Santiago. The hawks had a more diverse prey base prior to goat eradication compared to one that depends largely upon the introduced black rat following goat eradication.

Using Brownian Bridge Movement Models to Describe Winter Space Use of Migratory Juvenile Golden Eagles from Interior Alaska

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Golden Eagles (*Aquila chrysaetos*) that breed at high latitudes also migrate long distances between their summer and winter ranges. Conditions on the winter ranges are known to have carryover effects on health and survival of breeding-season individuals and ultimately on populations. To understand behavior of eagles during winter, we used Brownian Bridge Movement Models to define space use of telemetered first-year Golden Eagles hatched in Denali National Park and Preserve, Alaska (Denali). Telemetry data were collected from 44 nestling eagles tagged in Denali between 1997 and 1999 and tracked for up to two years. On average, eagles were tracked for 253 d (range: 81 – 1,031 d). At least one month of winter telemetry data was collected on 24 individuals, which were tracked for an average of 368 d (range: 132 – 1,031 d). The winter range for most juvenile Golden Eagles in this study was within the Rocky Mountain region and east to the Great Plains, and from British Columbia to southern New Mexico. Individual ranges

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were large, regularly covering more than one state. For example, a Brownian Bridge Movement Models winter range for one individual was 71,059 km². On average, 33 (range: 18-54) data points contributed to each winter home range estimate. The results of this study can inform managers on habitat use by juvenile Golden Eagles and indicate that management decisions concerning this population need to be at the federal or international scale.

Monthly Movements of Pre-Breeding Golden Eagles, with Implications for Connectivity of Populations at a Continental Scale

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Golden Eagles (*Aquila chrysaetos*) are a species of high conservation concern, in part due to their negative interactions with renewable energy development. Understanding the movement ecology of Golden Eagles at various life stages is critical in developing management and conservation plans for this species. We used global positioning system-global system for mobile communications (GPS-GSM) telemetry to study local and dispersive movements of pre-breeding and adult Golden Eagles in the foothills and mountains near Tehachapi, California, located between the San Joaquin Valley and the Mojave Desert. We estimated 324 monthly 95% home ranges and 317 monthly 50% core areas for 25 birds over 2.5 yrs to evaluate their local movements, and we calculated daily and hourly distances and movement rates for the five of these birds that engaged in long-distance movements. Mean (± SD) monthly home-range size was 253.6 ± 429.4 km2 and core-area size was 26.4 ± 49.7 km2. Age was an important predictor of home-range and core-area size; generally, younger-aged birds had larger home ranges and core areas than adult birds. As home range and core area size increased, variation in elevation increased. In contrast, landscape roughness decreased with home-range size but increased with core-area size. The five Golden Eagles with dispersive movements traveled long distances in the summer and early fall, with one bird flying as far away as Montana. Such long-distance movements have implications for connectivity of Golden Eagle populations throughout North America. Our results increase knowledge of the movement ecology of Golden Eagles and can assist in management to mitigate the negative impacts of renewable energy development on eagle populations.

Long-term Trends and Range Expansion of Breeding Osprey (*Pandion haliaetus*) in Michigan

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The status of Osprey breeding in Michigan was poorly understood prior to 1962 when annual surveys of Osprey breeding in the northern part of the Lower Peninsula (LP) of Michigan began, and 1965-2000 when annual surveys in the Upper Peninsula were conducted. These surveys indicated Osprey reproduction was low in the early 1960s due to effects of organopesticides, but improved during the late 1960s and 1970s, and by 2000 approximately 200 Osprey nests were present in Michigan. None of these nests were in the southern LP, so the Michigan Department of Natural Resources conducted a hacking program from 1998 to 2006, translocating 59 chicks from the northern LP to four locations in the southern LP. Natural colonization also occurred, including nesting in 1999 and 2001. Osprey breeding in the southern LP increased in number and distribution during the last decade. In 2008, 23 Osprey nests were reported in the southern LP, including nests on artificial platforms and cell towers. Given the increasing success of Ospreys in the southern LP, inventory and research efforts involving citizen scientists, traditional banding methods, and satellite telemetry are being conducted to increase our understanding on Michigan breeding Ospreys.

Golden Eagle Diet and Productivity in Relation to Fluctuations in Primary Prey Abundance in Wyoming's Bighorn Basin

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Between 2009 and 2015, Golden Eagle (*Aquila chrysaetos*) nesting success (number of nests producing at least one chick to fledging age/number of occupied nesting areas) ranged between 32% and 77%, with productivity between 0.33 and 1.25 fledglings/occupied nesting area. Cottontails (*Sylvilagus* species) were the most frequent prey remains in Golden Eagle nests for each year of our study, ranging from 48% to 86% of individuals identified. Hunter surveys indicate that cottontails in Wyoming exhibit dramatic, cyclic population fluctuations, peaking approximately every six to eight years. Data we acquired through roadside spotlight surveys in the Bighorn Basin are generally consistent with the statewide

hunter survey data. The number of cottontails we detected during our peak year (2015) was nearly triple the number of cottontails we detected in our trough year (2013). Golden Eagle nesting diet breadth increased when cottontail abundance declined, but no other single prey species gained singular importance. Golden Eagle nesting success and productivity plummeted when cottontail abundance dropped, despite nesting eagles exploiting a wider range of prey during years when cottontail abundance was low. The multiple-use, sagebrush-steppe environment in the Bighorn Basin is undergoing profound changes related to exurban sprawl, energy development, and recreational activities. Thus, a key to Golden Eagle conservation, at least in the changing world of the Bighorn Basin, lies in maintaining or enhancing environmental conditions that support robust, albeit cyclic, cottontail populations.

How Sufficient Are Designated Conservation Areas for Highly Dispersive Raptor Species? Comparing Movement Ranges of Saker Falcons and Imperial Eagles to Designated Conservation Areas in Hungary

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In the European Union, a network of Conservation Areas – called Natura 2000 – was designated to ensure the conservation of plant and animal species, and their habitats. The Member States designated the sites based on the presence of representative species and habitats, and selected areas to include cover habitat and distribution areas of sessile species and species of low dispersive capabilities. However, it is unclear how well the network covers important areas for highly dispersive species, such as raptors. We analyzed 101,758 GPS coordinates of 36 satellite-tracked Saker Falcons (*Falco cherrug*) and 22 Imperial Eagles (*Aquila heliaca*) relative to Conservation Areas. In Hungary, both species live mostly in agricultural landscapes and semi-natural grasslands. We focused on immature birds during pre-breeding dispersal. During this time, when the immature birds are seeking breeding habitat, they are increasingly vulnerable, and thus present special conservation requirements. Evaluation of data for both species showed that less than 50% of the coordinates were located on Natura 2000 sites. Thus, it appears tracked individuals spent less than half of their time on the relatively safe Natura 2000 sites, while they spent the rest of their time in areas with little or no conservation protection. Considering that the Natura 2000 sites cover 21% of Hungary, the birds were more than three times likely to be found in a Natura 2000 site, clearly indicating the conservation importance of the Natura 2000 network. However, our results suggest that although the Natura 2000 sites are essential, it is important to have complementary legal and financial instruments, like subsidized agri-environmental measures, to ensure the protection of such highly dispersive species outside of the Natura 2000 network.

Eagles and Energy: Minimizing the Impacts of a Fledging Wind Energy Industry in Africa

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Global climate change and an ever-increasing demand for energy are driving the rapid expansion of renewable energy production in Africa. The rapid growth of renewable energy is necessary and desirable, yet wind energy may be detrimental to birds. Conservationists in Africa need to act quickly to ensure that birds (including raptors) are provided adequate consideration in this "green rush". BirdLife South Africa and its partners have risen to the challenge in southern Africa by creating a specialist group to provide guidance, and a forum to promote communication among stakeholders. Best Practice guidelines for impact assessment and monitoring were developed (and are updated regularly), and an avifaunal sensitivity map was produced. Tools and guidance are of little value if it they are not implemented, so various strategies have been used to promote their uptake. Proposed wind farms in Lesotho and South Africa's Maluti and Drakensberg mountain regions (a transboundary World Heritage Site) could lead to the local extinction of the Bearded Vulture (*Gypaetus barbatus*, regionally Critically Endangered) and Cape Vulture (*Gyps coprotheres*, regionally Endangered). Other collision-prone raptors in southern Africa include the Verreaux's Eagle (*Aquila verreauxii*), Martial Eagle (*Polemaetus bellicosus*), Lesser Kestrel (*Falco naumanni*), Booted Eagle (*Hieraaetus pennatus*), Amur Falcon (*Falco amurensis*), Rock Kestrel (*Falco rupicolus*), Jackal Buzzard (*Buteo rufofuscus*), Steppe Buzzard (*Buteo buteo*), and the near-endemic Black Harrier (*Circus maurus*). The next challenge is to study the results of pre- and post-construction monitoring of birds at wind farms in order to identify and implement mitigation measures, and guidelines for priority species will be developed to help wind energy be more sustainable in Africa.

Barn Owls Crossing the Road: Examining Interplay between Occupancy, Behavior and Roadway Mortality in Southern Idaho, U.S.A.

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Barn Owls (*Tyto alba*) are frequent victims of roadway mortality. They are killed in greater numbers along roads than any other North American bird of prey, and Interstate-84 (I-84) in southern Idaho has among the world's highest rates of Barn Owl vehicle collisions. Juveniles and females are killed most often, with mortality typically peaking in winter. Nothing is known about patterns of Barn Owl occupancy in this region, thus it is unclear if owls are killed in proportion to their abundance, or if they are equally abundant in areas with lower mortality and escape collisions. We were interested in determining which landscape-level and local features of habitat were related to Barn Owl occupancy, and using model-based results of occupancy to compare with Barn Owl mortality locations. During winter and the following autumn of 2014 we surveyed for owls at 289 randomly selected point count locations (three times each, 867 total surveys) along a 300 km stretch of I-84. Each point count included silent listening followed by broadcast of Barn Owl vocalizations, with spotlighting to aid in visual detection. We detected Barn Owls during 102 (11.8%) point counts and at 70 (24.2%) locations. For winter, the probability of Barn Owl detection was 0.32 ± 0.06 (SE). Detection increased with playback of Barn Owl calls, and with increasing date, moon illumination, and cloud cover. Barn Owl occupancy increased with proportion of water and crops, and decreased with development. In autumn, detection was 0.45 ± 0.07 (SE). Occupancy increased with decreasing distance from the Snake River, greater stream lengths, and decreased with development. Our paper discusses results of mortality vs. occupancy analyses, multi-season occupancy models, and radio-tracking studies to help understand Barn Owl roadway mortality.

Selected Comments on the California Condor Reintroduction Program – Past, Present, and Future

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Reintroduction of the California Condor (*Gymnogyps californianus*) into an environment in which the principal cause of its near-extinction was still active broke a fundamental rule of Conservation Biology. Yet the decision to re-introduce has resulted in benefits for both condors and humans. However, additional data are required to support a national campaign to reduce the use of lead ammunition. Rideout et al. (2012) assembled data on the deaths of 64 juvenile and adult condors that had died in the wild in California through 2009. To date the bones of 10 condors that died of lead toxicosis or that died of undetermined causes with high concentrations of bone lead have been analyzed for both lead and lead isotopes. In six of these the ratios of the lead isotopes 207/206 were outside the 'ammunition range' determined by Finkelstein et al. (2012) from the analysis of 76 samples of ammunition used for hunting in California. The mortality data are therefore not consistent with the exposure data derived from determinations of lead in the blood that indicate an ammunition origin. A convincing case against lead ammunition will require resolution of these and other questions. DDE contamination and eggshell thinning are expected to decline but contaminant data from the analyses of Big Sur condor eggs indicate a major scientific flaw in the Montrose Restoration Program. The Recovery Team had accomplished its mission, but its disbanding eliminated a forum for discussion of the broadest range of relevant scientific and conservation topics. The critical habitat issue in southern California was never adequately resolved. There appears to be no scientific justification of the current chelation program. Its suspension for about two years would generate sufficient survival data to quantify the lead hazard, and other issues.

The Implication of Climate Change on the Diet of a Key Arctic Predator, the Gyrfalcon

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Climate change is predicted to impact the Arctic ecosystem in many ways. This has the power to cause ecosystem disruption with conservation implications for affected organisms, but also provides signals for the impacts of climate change on a broader scale. In the life-history of raptors, peak resource use occurs during the brood rearing period. Any disruption in prey populations during this time may impact the ability of raptors to raise young successfully. The Gyrfalcon (*Falco rusticolus*) depends on Ptarmigan as its main prey for much of the year, but uses alternative prey during the brief Arctic summer to supplement its diet during breeding, but the relative importance of alternative prey items for raising young is unclear. It is important to develop a complete understanding of the balance between Ptarmigan and alternate prey in the diet during brood rearing, as prey populations may experience changes in distribution and abundance due to climate change. Whether or not the Gyrfalcon has the ability to shift between prey sources and maintain the ability to produce offspring offers insight into how the species may manage climate induced changes in prey populations. In 2014 and 2015, we placed 23 Reconyx PC800 motion-activated cameras in Gyrfalcon nests on the Alaskan Seward Peninsula to record prey deliveries during brood rearing. We catalogued prey items to assess the relationship between breeding phenology, diet, and nest success. We also compared relationships between temporal parameters and diet breadth with nest success to evaluate prey patterns during brood rearing. This study provides insight into the ability of Gyrfalcons to adapt to fluctuating prey populations within the rapidly changing Arctic ecosystem.

Disease and Contaminant Surveillance in California Raptors: A Preliminary Analysis

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Disease and contaminant exposure in sensitive raptor species in California is poorly understood. Due to their small population sizes and dispersed nature, these species are underrepresented in mortality investigations led by the California Department of Fish and Wildlife's Wildlife Investigations Laboratory. As such, the role of diseases and contaminants as factors of mortality for these sensitive raptor species are unknown. In 2013 through 2016, we will enhance our surveillance of 11 sensitive raptor species in California for select diseases and contaminants. Since these sensitive raptor species tend to occur in low numbers, we also will increase disease and contaminant surveillance in 8 sentinel species that may serve as a proxy for exposure in the sensitive species. The timing of this surveillance is especially relevant given the recent passage of two critical contaminant regulations and the emergence of diseases in several raptor species including West Nile virus, avian trichomonosis, and mange. With recent regulations banning lead ammunition and restricting the use of second generation anticoagulant rodenticides in California, surveillance for exposure in raptors will highlight which species continue to be at risk post-regulation change. Non-disease sources of mortality for raptors such as trauma and starvation also will be discussed.

Wintering Ranges, Habitat Selection, and Site Fidelity of Rough-legged Hawks (*Buteo lagopus*) in Western North America

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As a grassland and seasonal wetland obligate species, Rough-legged Hawks are more susceptible to habitat loss than habitat generalists. Research also suggests that Rough-legged Hawks are highly sensitive to urbanization. Until now, few studies have examined the wintering habitat requirements for Rough-legged Hawks in western North America on a regional scale. We examined winter ranges, habitat selection, and site fidelity for 17 Rough-legged Hawks captured in California and Nevada during 2014 and 2015. We deployed 22 g GPS/satellite PTTs or 24g CTTs on 7 males and 10 females. Three of these individuals occupied two distinct winter ranges during 2014, while all others used only one range (n = 24 total ranges). Winter range areas varied from 3 to 2,971 km2 (average = 426 km2, SD ± 738 km2). There was no significant difference in winter range sizes between sexes or between years. Three out of four individuals captured in 2014 exhibited winter site fidelity in 2015 (91-100% overlap in area between 2014 and 2015 ranges). In contrast, two of these four hawks spent part of the winter further south in 2014 than 2015. Preliminary analysis revealed that cropland, the presence of grazing allotments, and distance to stream were all highly significant predictors of Rough-legged Hawk habitat selection within their 2014 winter ranges ($p < 0.001$ for each predictor). We hypothesize that hawks may be selecting for these habitat features during the winter as cues for prey density. With the effects of climate change altering habitat on their breeding grounds and urbanization contributing to habitat loss on their wintering grounds, Rough-legged Hawks are experiencing year-round population pressures. It is crucial to fully understand Rough-legged Hawk wintering behavior and habitat requirements in order to ensure that appropriate habitat is conserved or developed for the preservation of the species.

The Role of Experience and Multiple Meteorological Factors in the Migratory Performance of Golden Eagles (*Aquila chrysaetos*)

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Migratory performance of large soaring raptors is influenced by age and environmental conditions. However, the majority of studies on this issue have focused on single weather variables. In this study, we used GPS-GSM telemetry to examine the role of a suite of meteorological characteristics on the migratory performance of eastern North American Golden Eagles. To better understand the variation in the daily distance traveled of migratory eagles, we tested two competing hypotheses; 1) migratory performance is determined by weather, and 2) migratory performance is determined by age (and thus experience). We paired meteorological data on solar radiation, wind speed and direction, and availability of updraft with telemetry data for 65 eagles of three age classes (juvenile, sub-adult, and adult). Our results show that Golden Eagles traveled longer distances during spring migration than in fall migration, and that migratory performance was influenced by weather factors that differed

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between the two seasons. During autumn migration tailwinds and crosswinds most strongly influenced daily distance traveled. In contrast, during spring migration tailwinds were paired with downward solar radiation (which encourages thermal formation) to most strongly influence daily distance traveled. Adult Golden Eagles traveled similar distances through worst flying weather than did pre-adults, suggesting a role for experience in determining migratory performance. Our findings provide new insights into the mechanisms that eagles employ in response to different meteorological factors, and into how experienced individuals balance reproductive constraints with the need to travel in unfavorable flying weather.

Reproductive Responses of an Apex Predator to Changing Climatic Conditions: Implications for Forest Management

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Apex predators are ideal subjects for evaluating the effects of changing climatic conditions on the productivity of forested landscapes because the quality of their breeding habitat depends primarily on the availability of resources at lower trophic levels. Consequently, identifying environmental factors that influence the reproductive output of apex predators can enhance our understanding of ecological relationships, which may in turn provide a foundation for forest management strategies. To assess breeding habitat quality for an apex predator in a forest food web, I quantified relationships between site-specific environmental attributes and the reproductive probabilities of Northern Goshawks (*Accipiter gentilis*) over a 6-yr period (1999-2004) on the Kaibab Plateau in northern Arizona. I used dynamic multistate site occupancy models to estimate annual breeding probabilities (eggs laid) relative to temporal and spatial variation in climatic conditions (precipitation, temperature), forest attributes (vegetation composition, structure, productivity), and prey resources (abundances of five mammal and bird species). I used an information-theoretic approach to evaluate environmental components that might explain spatiotemporal variation in goshawk reproductive parameters. The food-resource availability model provided the most parsimonious explanation of variation in goshawk reproduction by incorporating effects of temporal variation in climatic conditions, and spatial variation in vegetation attributes on the abundance and distribution of prey species. More diverse prey communities mitigated effects of changing climatic conditions on goshawk reproductive probabilities by increasing the abundance of food resources during and following drought. Therefore, to reduce the effects of drought on the productivity of forest food webs, management actions should focus on manipulating vegetation structure to enhance water retention, and the diversity of habitats within landscapes occupied by breeding goshawks.

Delayed Independence in Young of the Desert-dwelling Grey Falcon (*Falco hypoleucos*) of Australia: A Description and Possible Explanation of a Unique Behavior in Raptors

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The nomadic Grey Falcon is endemic to Australia's arid zone. It has an estimated population size of less than 1,000 mature individuals, and breeds exclusively in areas that experience high summer temperatures. The species is of medium size: adult males averaged 392 g (n = 5), adult females 517 g (n = 6). Based on data collected from 2003–2014, I describe a behavior of the Grey Falcon that is unique among falcons and similar-sized raptors. Specifically, first-year Grey Falcons and their parents often stay together for 5–9 mo after fledging. This duration exceeds the postfledging periods of congeners (< 2 mo) and raptors of sizes similar to Grey Falcons (< 3 mo). On eight occasions, juvenile Grey Falcons 11–12 mo after fledging were found in the company of their parents, i.e. well within the next breeding season. In these cases, the adults did not breed in that season. This unique behavior may be an adaptation to an environment that is characterized by unpredictable and extreme climatic events such as prolonged periods of heat and drought. This is of particular relevance because the species breeds only in the hottest climate zones and summer is the first season the newly fledged young experience. In these areas, summer is associated with unpredictable and extended periods of daytime temperatures above 50˚C, strong winds, droughts, and disturbances from large cyclonic systems. During these climatic events the species' major prey, birds such as doves, small parrots and finches, may be less available or more difficult to obtain for young inexperienced falcons. Therefore, the unusually extended parental care may be an adaptation of the species to increase the reproductive success of breeding individuals in order to persist in an extreme environment.

Population Numbers and Distribution of Golden Eagles (*Aquila chrysaetos*) in Estonia

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The Golden Eagle is included in the Estonian native species list, with the first written mention of the species dating back to the second half of the 19th century. At that time, the Golden Eagle population in Estonia (45,000 km2) may have included up to 40 pairs, but intentional killing of birds of prey in the beginning of the 20th century reduced the population to just a few pairs. Numbers of Golden Eagles began to rise in the middle of the last century in areas with low human densities. Steady and sustained population growth in the following decades resulted in a rise in the

number of Golden Eagle pairs to 65. In the process of inhabiting new areas, Golden Eagle usurped nests previously occupied by White-Tailed Eagles (*Haliaeetus albicilla*). Golden Eagles breed on continental Estonia and its offshore islands, with breeding distribution directly influenced by the location of large natural landscapes where pristine forests and moors occur. These eagles seem to prefer moors without high standing vegetation, as these areas are more suitable for foraging. Golden Eagles do not inhabit south-east Estonia, presumably due to an absence of large moors. Due to the increasing population, most optimal habitats are occupied, and new pairs are forced to choose suboptimal habitats. Suboptimal habitats are characterized by a lower proportion of moors within the territory, and are in closer vicinity to human settlements. A decrease of fear of humans could be one reason why some breeding birds tend to attack humans more easily, for example during banding of nestlings.

American Kestrel Flaring Eyespots

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The feathered eyespots or ocelli on the back of the head of the American Kestrel are photographically shown to flare during instants of high stress associated with attacks by other birds. This behavior greatly emphasizes the kestrel's eyespot pattern to any mobbing songbirds that might attack from the rear during an instant when the kestrel is vulnerable or otherwise preoccupied in defense. Multiple explanations selecting for the presence of the eyespot markings on the nape of the American Kestrel are considered. To our knowledge, this behavior has never before been recorded or reported.

Effects of Industrial Noise on Owls and their Small Mammal Prey in Northeastern Alberta

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Noisy environments can pose problems for animals that communicate vocally because background noise can interfere with an animal's ability to detect and discriminate important communication signals. Owls use vocal communication to attract mates and defend territories, and use acoustic cues made by prey to aid in hunting. For species of owls living in the boreal forest of Northeastern Alberta, chronic noise from oil and gas facilities could reduce their ability to communicate with other owls, and negatively affect their hunting efficiency. Owl species in Northeastern Alberta prey mainly on small rodents, and it is not known whether industrial noise has an impact on prey availability for owls. Songbird abundance has been found to decrease with proximity to industrial noise, but little is known about how owls may be affected or their small mammal prey. To determine whether owls avoid forested areas surrounding industrial noise sources in the Lower Athabasca region of Northeastern Alberta, we conducted passive acoustic surveys for owls in the spring of 2013, 2014, and 2015 using autonomous recording units deployed at noisy and quiet sites. Detections of owls were extracted from the acoustic data and analyzed using occupancy models. We found owls were equally likely to occupy noisy sites compared to quiet sites. However, the pattern of space use by owls differed between noisy and quiet sites. To determine if prey availability is affected by industrial noise, we conducted a small mammal mark-recapture study at noisy and quiet sites in 2014 and 2015. Our study contributes to the expanding body of research on impacts of anthropogenic noise on animals. Understanding how animals such as owls and their prey respond to the presence of noise is necessary to predict the extent of habitat degradation due to noise.

Source-Sink Dynamics of Bald Eagles in Michigan's Great Lakes Ecosystem

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Bald Eagle (*Haliaeetus leucocephalus*) productivity is not consistent throughout Michigan. As the recovering Bald Eagle population expands, we speculate that breeding areas along the Great Lakes are experiencing chronically low reproduction relative to those inland because of higher concentrations of contaminants in Great Lakes' fisheries. We hypothesize nestlings may be initially exposed in ovo, and colonizers exposed through diet leading to reduced reproductive fitness. To assess the reproductive fitness of shoreline versus inland pairs, we used productivity data from 1981–2010. We used two parameters, length of site occupancy and decadal success rate. Length of site occupancy was calculated as the average years that one breeding pair occupied one breeding area between changeovers, and decadal success rate as the number of years that young were produced per number of years that the breeding area was occupied. Length of site occupancy and decadal success rates significantly decreased in lakes Michigan and Huron from 6.84 to 5.61 yrs and 7.04 to 4.72 yrs. Inland breeding pairs remained constant at 7.35 yrs. This indicates the length of time that Great Lakes shoreline pairs are reproductively capable has decreased. In addition, the decadal success rates of lakes Michigan, Huron, and Superior have decreased from 45.2% to 17.7%, 46.4% to 20.4%, and 42.0% to 31.7%, respectively; while inland breeding areas remained relatively stable at 46.9%. The decrease in reproductive fitness supports the idea that shoreline birds may be experiencing second-generation effects or chronic lifetime dietary exposure. Low reproductive fitness of Great Lakes breeding areas could be suggestive of a high turnover rate within the shoreline breeding population from uncontaminated inland areas. This constant

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turnover may contribute to underestimating the reproductive effects in Great Lakes shoreline birds caused by environmental contaminants.

Inter-Annual Golden Eagle (*Aquila chrysaetos*) Nest Use Patterns in Central Utah and Implications for Long-Term Nest Protection

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Temporal nest protections are regularly used by land managers to reduce the likelihood of raptor nest disturbance or abandonment, but without consistency. We assessed alternate nest use (i.e., egg laying) and nest spacing at 28 Golden Eagle territories in central Utah monitored for 25 years or more between 1976 and 2013. Territories contained 1–8 nests ($\bar{x}$ = 2.89), and average spacing between alternate nests was 0.5 km. Inspection of 21 territories monitored consecutively for 26–38 years suggested individual nests were used on average every 3.26 years, egg laying at any nest within the territory averaged 1.83 years, and nest switching occurred between 43.3% of egg laying events. Assessment of nest histories suggested protecting individual nests for 7 years when alternate nests were not considered, or protecting all nests within a territory for 4 years since the last documented use of any nest when alternate nests were considered, would have protected > 90% of all inter-annual nesting events observed in the dataset. These temporal protections are longer than individual nest protections commonly applied by land management agencies (e.g., 3 years), but shorter than those suggested by Golden Eagle data collected in southern Idaho in an area with more alternate nests per territory. We recommend that land managers take a territory approach to Golden Eagle nesting protection, including consideration of alternate nest dynamics. Management decisions should be based on the last use of any known nest within a territory, including nests within a reasonable distance when territory membership is unknown, and longer protections should be applied when knowledge of alternate nests is incomplete.

Movements of American Kestrels (*Falco sparverius*) Between Breeding Seasons

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To examine how American Kestrels join local breeding populations, I monitored about 100 nest boxes in northwestern New Jersey each year from 1995 to 2014. I observed 588 breeding attempts and marked all 1,734 fledglings with USGS bands. I also captured 376 (32.0%) of the incubating adults (81 males and 295 females) and banded all unmarked individuals. The return rate of marked birds (69.4% of returning birds had been marked as adults) was low, 28.8% for males and 21.7% for females. Thus, about 75% of the breeding population each year originated from sources other than these nest boxes. To better understand the movements of kestrels between breeding seasons, I obtained from the Bird Banding Lab all encounter records from 1916 to 2011. I used banding and encounter dates and other information (e.g., banding age = L) to distinguish birds banded on the breeding grounds and encountered the following year. To obtain an unbiased sample of dispersal distance, I eliminated all records reported by banders, who often do not report routine encounters with their own bands. The median distance for all encounters (n = 351) was 37 km, but ranged from 0 (the same 10-min block) to 4,082 km, an extreme amount of individual variability. Median distances for adult males, adult females, first-year males, and first-year females were 33, 19, 28, and 63 km, respectively. First-year birds dispersed significantly farther than adults (39 versus 23 km), and adult females were significantly more likely than adult males to be encountered in the same 10-min block (25.4% versus 2.4%). Dispersal distance was significantly correlated with latitude. I used 44° and 38° N latitude to categorize northern (presumably migrant), mid-latitude, and southern (presumably resident) populations. Median dispersal distances were 68, 28, and 15 km, respectively.

Mitigation of Raptor Fatalities in the Altamont Pass Wind Resource Area, California

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The Altamont Pass Wind Resource Area (APWRA) has the highest documented raptor fatality rates among wind projects worldwide. In response to legal actions, in 2005 Alameda County established an Avian Protection Plan and a Scientific Review Committee (SRC) to recommend mitigation measures and oversee implementation and monitoring of its plan. Mitigation measures included power pole retrofits, winter shutdown of wind turbines, phased repowering to modern turbines, removal of hazardous turbines, and adaptive management beginning in 2009 should the other measures prove unsatisfactory. Settlement of legal actions in 2007 added a 50% fatality reduction target for Golden Eagle (*Aquila chrysaetos*), Red-tailed Hawk (*Buteo jamaicensis*), American Kestrel (*Falco sparverius*), and Western Burrowing Owl (*Athene cunicularia*), but eliminated repowering as a requirement. Implementation of mitigation measures proved haphazard and inadequate depending on wind company compliance: many power pole retrofits are still pending, the SRC-recommended 4-month winter shutdown period was never achieved, and most hazardous turbine removals were delayed until 2008 or later. The most effective mitigation measure was hazardous turbine removal. This, along with repowering, i.e. replacing many smaller old-generation wind turbines with fewer, larger modern wind turbines in conjunction with research designed to produce collision hazard

maps to inform wind turbine siting based on raptor flight behavior, has reduced fatalities. Mitigation in the form of targeted research is proving to be one of the most effective measures undertaken in the APWRA to reduce raptor fatalities, yet other measures have been lacking, such as regulatory requirements for mitigating species other than Golden Eagles and law enforcement by agencies entrusted to protect the public domain.

Factors Affecting Landscape Level Nest Site Selection and Success of Louisiana Bald Eagles (*Haliaeetus leucocephalus*)

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The number of Louisiana nesting Bald Eagles has increased exponentially since the mid-1970s, but active nests have remained relatively concentrated within an area of the Mississippi Alluvial Plain referred to as the basin. However, as the number of nests continues to grow, nesting is expected to expand into new areas. To manage an expanding population, it is imperative to first determine parameters that influence nest-site selection. To evaluate site selection and success, we conducted GIS-based analysis to evaluate geographic variables such as land cover, and proximity to water, human activity, and other nests. Our analysis was based on 387 active nests from the 2007–2008 winter nesting season, and 387 random sites evaluated to compare available habitat. Our results suggest that success of a nest within the basin was not greatly influenced by the physical characteristics around a site, but sites with the highest probability of being selected for nesting generally had a higher probability of success. Initial selection of a nest site was most influenced by distance to road, houses per km2, and land cover within 3 km but the influence of these variables varied between sites within and outside the basin. Based on our results, managers should be able to make informed decisions about effects of future developments, conservation activities, and human use on current and future nesting habitat.

Is Earlier Nesting by American Kestrels (*Falco sparverius*) Driven by Changes in the Timing of Spring?

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American Kestrels in southwestern Idaho have advanced the timing of nesting by almost 11 d over the last 23 yr. The most commonly proposed hypothesis to explain why climate change has caused earlier nesting is that birds advance reproduction to synchronize with food resources that are available earlier as a result of warmer temperatures and early growing seasons. Empirical support for this hypothesis comes from species that specialize on prey with seasonal peaks in availability. The link between climate change and advancing breeding seasons may differ for species with generalist diets or temporally heterogeneous prey availability. We tested the hypothesis that changes in prey phenology have driven changes in the nesting phenology of a generalist predator, the American Kestrel. We verified that remotely sensed data (Normalized Difference in Vegetation Index, NDVI) accurately represents changes in prey abundance. We found that NDVI was associated positively with small mammal abundance estimates, and seasonal peaks in prey abundance coincided with seasonal peak NDVI values. Preliminary analyses for years 1992–2015 suggest that the start of spring and the date of peak NDVI have not advanced significantly. There was no significant relationship between nest discovery date and the start of spring or the date of peak NDVI. These results suggest that kestrel phenology has not responded to changes in spring vegetation growth or prey abundance. Results from this study will contribute to our understanding of how generalist predators, such as kestrels, respond to climate change and resource availability.

Recreation Disturbance to Golden Eagles (*Aquila chrysaetos*): Biological Consequences, Behavioral Mechanisms, and Management Implications

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Recreation in wild areas is increasing and can negatively affect wildlife via human disturbance. Golden Eagles in shrub-steppe habitats may be vulnerable to disturbance from recreation because canyons are popular areas for non-motorized and motorized (off-highway vehicle, OHV) recreation. We tested the hypothesis that recreation affects eagle breeding biology by monitoring eagle behavior and reproduction in relation to recreation volume and activity, and landscape features associated with recreation (e.g., trails and camping sites). Territory occupancy was lower at sites with higher OHV volumes. At occupied territories, early season volumes of pedestrians and other non-motorized recreationists negatively influenced the probability of a pair laying eggs. For pairs that did lay eggs, nest survival was negatively affected by interval-specific OHV volume. In addition, adult nest attendance, the strongest behavioral predictor of nest survival, was associated negatively with the volume of pedestrians. Direct observations of nesting eagles and recreationists revealed that most pedestrians in eagle nesting areas arrived using motorized vehicles. These results suggest that motorized recreation both reduces territory occupancy,

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and facilitates disturbance of nesting eagles by transporting recreationists, who often stop and become pedestrians, to areas near eagle nests. Landscape features suitable for eagle nesting, like steep canyons and rocky outcrops, also may inspire motorized recreationists to transition from predictable movements along a trail to less predictable stop-and-go hiking, exacerbating the perceived threat to eagles. Expanding existing trail management efforts to consider the effects of pedestrian and non-motorized recreation, especially during the early portion of the breeding season, may help improve eagle productivity. Management strategies such as "no-stopping" zones for OHV riders may provide an alternative to closing trails and effectively mitigate for disturbance to nesting eagles.

Marking and Resighting Peregrine Falcons in the Greater San Francisco Bay Area

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California's Peregrine Falcon (*Falco peregrinus anatum*) population was reduced to two known productive pairs by 1970, but probably exceeds three hundred pairs today. Surveys of local populations may be a useful indicator of regional population health. We initiated a mark and re-sight study of San Francisco Bay Area Peregrine Falcons in 2009 after randomly marking young across the state for many years. Two hundred nine nestling Peregrines were marked in the Bay Area from 1998–2015, with 145 marked from 2009–2015. A network of citizen scientists formed in response to fifteen years of life history educational support associated with nest cameras published at our web site. The network has been particularly helpful by monitoring urban young and by surveying the study area that includes at least 40 Bay Area territories, by boat, automobile, and hiking. Network observers reported the locations of 30 marked birds after dispersal from natal territories. Fourteen were nesting. We found an average distance of 3.5 km between six downtown San Francisco nest locations and we describe atypical nesting structures including the inside of an airplane maintenance hangar at San Francisco International Airport; the smokestack of a moored ship; and, the often-moving counterweight of a drawbridge crossing the Sacramento River. Several urban sites are known to present severe fledging hazards to young Peregrine Falcons. We report on productivity, fledging success, mate replacement, and the frequency of re-sighted young at one intensively observed urban site during nine nesting seasons.

Using GPS-GSM Telemetry Data to Aid Interpretation of Golden Eagle Survey Data

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Wind energy development is rapidly expanding in North America and this expansion causes potential conflict with conservation-dependent wildlife. To estimate Golden Eagle (*Aquila chrysaetos*) use of areas proposed for wind development, the USFWS "Eagle Conservation Plan Guidance" suggests point count surveys for eagle use. However, it is not always clear to what degree the data collected at on-site point counts relates to actual use of the project footprint by eagles. We used high-resolution GPS-GSM telemetry data collected at 15 minute intervals to understand the relationship between potentially observed and actual eagle use. To do this, we overlaid telemetry data on simulated project footprints and simulated different point count sampling strategies at those sites. We then compared eagle use within point count areas to eagle use within the project footprints and evaluated strength of the relationship (percent error) for different project footprint sizes (n = 8 footprints) and point count sampling designs (n = 3 designs; random, systematic, stratified), sampling intensities (n = 2 intensities; 30% or 60% area coverage). Point counts that covered small areas of the project footprint were dramatically less accurate than were points counts covering more of the project footprint ($t = 1.68$, $p < 0.05$). However, the percentage errors in measurement was not significantly affected by sampling designs but was affected by size of project footprint. The consistent high errors between eagle use of point count areas and eagle use of project footprints suggests a need for either development of an effective transfer function between point count areas and project footprints or of an alternative mechanism to survey eagle use of potential renewable energy project footprints.

Conservation Status of Island Raptors and the Role of Invasive Alien Vertebrates

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The world's islands comprise less than 5% of the earth's land area, but are home to an estimated 20% of all bird, reptile and plant species as well as close to 10% of the human population (over 600 million people). Not surprisingly nearly 80% of known species extinctions have occurred on islands, and today 40% of Critically Endangered species (IUCN) depend on island

habitats. This pattern is repeated for raptors; of the 101 species (Accipitriformes, Cathartiformes, Falconiformes, Strigiformes) listed by the IUCN as Critically Endangered, Endangered, and Vulnerable, 56 (55%) are restricted to islands, and 100% listed as extinct (8 species) were island endemic species. Primary causes of extinction in island birds are human hunting and the impacts of invasive vertebrates (Duncan and Blackburn 2007). At least 25 IUCN CR and EN raptor species occur on at least 76 islands with invasive vertebrates (tib.islandconservation.org) that prey on eggs, chicks, fledglings and adults, compete for nest sites, and degrade habitat. The successful recovery of the Mauritius Kestrel (*Falco punctatus*) from near-extinction included the control of invasive mongoose (*Herpestes auropunctatus*) and rodents (*Rattus* species) at nest sites to maximize nest success and fledgling survival. While other factors, including human persecution, habitat loss, disease, and small population effects, also have a role in the decline of island raptors, management of invasive vertebrates is a proven and effective conservation tool that may have significant value in recovery programs for threatened island raptors.

Adult Northern Goshawk Survival Rates: Why Is Moving Among Years Better For Adult Females—Is It Food?

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We estimated Northern Goshawk (*Accipiter gentilis*) survival rates on the Tongass National Forest, Alaska from 1992 – 2000. The Tongass National Forest is about 77,000km2 and has some of the largest tracts of remaining old growth temperate rainforest forest in western North America. The study area is an island archipelago and many of the islands have few prey that goshawks typically hunt. We radiotagged adult nesting goshawks at 41 nesting areas (31 males, 32 females) and used aerial radiotelemtry to locate birds across all months. Adult males make few long distance movements, even outside of the nesting season. However, some adult females make significant movements and successfully nest with a different male >100 km between years. Mean tracking time for males was 15.4 months and 22.7 months for females with some birds being tracked for ~72 months. We used program MARK with a known fates model to estimate monthly survival rates. Mean annual survival for males was 0.59 and no males changed territories among years; all were resident. Mean annual survival for females that changed territories between years was 0.95, and for females that did not move between years it was 0.57. The 95% confidence intervals did not overlap. Most mortality occurred from January – March. The combination of wet winter weather and poor prey resources (no red squirrels on many islands, few thrush-sized birds in the winter) suggests that those females that move between years may find better prey resources resulting in higher survival.

Using Predictive Models of Nesting Habitat to Inform Survey Design: An Example with Golden Eagles in the Colorado Plateau

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Identifying nesting territories is fundamental to learning about raptor ecology, and forms the basis for studies on demographics, impact and mitigation, and conservation prioritization. When financial resources are limited and nest sites are the currency for scientific and management endeavors, researchers frequently design surveys to detect as many nests as possible. However, these efforts may come at the expense of a probabilistic design necessary for unbiased inference on the demography and habitat use of raptors. We sought to balance the need for a robust nest sample while using a randomized sampling design for a 2015 helicopter survey for Golden Eagle (*Aquila chrysaetos*) nests in Utah, Colorado, and New Mexico. Using available historic nesting data, we developed predictive models of nest site occurrence based on topographic indices, land cover, and other environmental attributes. We then used spatially explicit predictions of nest occurrence to inform sampling design by 1) aggregating 30 m resolution predictions to 2.5 km2 hexagonal sample units, representative of an average Golden Eagle territory, 2) assigned sample selection probabilities to each hexagon corresponding to the underlying predicted values, and 3) surveyed selected hexagons for raptor nests by helicopter using a double-observer approach. Raptor nests identified during helicopter surveys (n = 143) were immediately useful for guiding management, including planning for wind development on public lands in Utah, while increasing our sample size and improving our efforts to accurately predict breeding habitat for conservation planning. Importantly, nest surveys were linked to a probabilistic design such that current inference and future research and conservation efforts are not vulnerable to potential survey biases. We propose that using widely accessible distribution modeling tools with available nesting data can aid in designing survey efforts for raptor nests while bridging survey paradigms of discovering new nest sites and remaining faithful to principles of random sampling.

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Environmental Conditions Affecting Capture Rates at Northern Saw-whet Owl (*Aegolius acadicus*) Fall Monitoring Stations in central Alberta, Results from 2002-2014

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Migration counts have been used to monitor bird populations for many years. Passive mist netting and an audio lure has become a standard way of gauging the relative abundance of Northern Saw-whet Owls moving through an area. Four stations in central Alberta have been monitoring fall movements of Saw-whet Owls: Beaverhill Bird Observatory (2002–2014), Pletz Park (2004–2014), Gehlert's Grove (2009–2014), and Priestley acreage (2014). Nets were set between 9 September and 14 November for between four and six hours each night. Capture rates ranged between 15.0 and 55.8 owls/100 net hours. We used Beaverhill Bird Observatory data to evaluate mean capture date and the 66% and 90% capture distributions around the mean to determine when Saw-whet Owl fall movements occur. In 2002 and 2003, mean capture date was 3 October and 4 October respectively, but had changed to 9 October by 2014. We also examined the owl sex and age ratios and found that most owls were hatch year and most were female. We examined whether moon phase, time of night, and time of year affected capture rates, and found that Saw-whet Owls were less likely to be captured on nights when the moon was full and that more owls are captured earlier in the night, indicating that six hours of netting is likely capturing most Saw-whet Owls.

Differential Foraging Success across a Light Level Spectrum Explains the Evolution and Spatial Structure of Color Morphs in a Polymorphic Bird

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The detectability of different color morphs under varying light conditions has been proposed to play an important role in the evolution and maintenance of color polymorphism through disruptive selection. However, no empirical studies have tested the hypothesis that different morphs have selective advantages under differing light conditions, which can vary dramatically through the course of a day, between habitats, or under different weather conditions. We tested this hypothesis in Black Sparrowhawks (*Accipiter melanoleucus*), a polymorphic raptor exhibiting a discrete white and dark morph. First, we tested whether foraging success (measured by chick provisioning rates) differed between the two morphs depending on light level. Our prediction being that through improved crypsis, dark morph males would have higher foraging success in lower light conditions, and white morphs more success in bright conditions. Our hypothesis and predictions were supported; dark morphs had a foraging advantage in low light (< 130 W/m2), there was no differences between the morphs at intermediate levels (130-650 W/m2), and white morphs had an advantage in brighter conditions (> 650 W/m2). Second, we explored whether variations in light levels during the breeding season might correlate with clinal variation in morph ratio seen throughout the species' South African distribution. We found a strong relationship between the morph ratio and average light level during the breeding season with white morphs numerically dominant where light levels during the breeding season were > 650 W/m2 (corresponding to the conditions where white morphs forage most successfully). Our results provide the first empirical evidence to support the idea that polymorphism within a bird species, and the spatial structuring of morphs across the landscape, may be driven by differential selective advantage of the two morphs under varying ambient light conditions.

Is Migration Phenology Affected by Climate Change in Eastern North American Raptors?

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Ongoing climate change has the potential to affect distribution, abundance and phenology of various organisms. In migratory birds, variations in the timing of departure and arrival of migratory journeys can have huge consequences at both the individual and population levels. However, the way changes in climate patterns affect top predators has received little attention. This is especially true for raptors during outbound migration. We used migration count data from seven eastern North American hawk watch sites to assess whether the increase observed in temperature during recent decades affects outbound migration phenology of 16 common North American raptor species. We also assessed whether species-specific differences in overall distance of migration, body mass and diet were affected differentially by ongoing climate changes. Results suggest an overall delay of outbound migration passage date (detected in 12 out of 16 species), which is correlated with the observed increase in temperature across eastern North America. This delay in average outbound passage date was longer in species migrating over medium and short distances compared to long-distance migrants, which only show a slight increase in passage

date. We did not detect an interaction with body mass of the studied species and the relationship between a delay in migratory passage date and an increase in temperature. Scavengers and species feeding predominantly on small mammals tend to exhibit a longer delay in their average outbound passage date compared to the other species. This suggests that migration phenology of eastern North American raptors is affected by climate change, but that the effects depend on life history traits of the species. More research is needed to pinpoint the mechanism(s) underlying this phenomenon and how this will affect population trends on a long-term basis.

Raptor Ecology and Conservation in Madagascar

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Madagascar is the fourth largest island in the world and one of the world's highest conservation priorities based on the diversity of and threats to its fauna and flora. It has a high degree of endemism with 106 (42%) of the 256 regularly occurring bird species endemic, including 14 (61%) of the 23 diurnal and nocturnal raptor species. Since 1990, The Peregrine Fund's Madagascar Project has conducted research and conservation on 19 Malagasy raptors with a focus on endangered and threatened birds, such as the critically endangered Madagascar Fish Eagle (*Haliaeetus vociferoides*) and the rediscovered Madagascar Serpent Eagle (*Eutriorchis astur*) and Madagascar Red Owl (*Tyto soumagnei*). The main threats to Malagasy raptors are habitat loss and persecution. To address help this, in 1997 The Peregrine Fund assisted in the creation of the largest national park (230,000 ha) for protecting lowland rainforest for serpent eagles, red owls and other forest-dependent biodiversity. The Madagascar Project is currently in the process of finalizing three new protected areas (NPA) with involvement of local communities and associations. Two of these NPAs will include 77,800 ha of western wetlands and dry forests for fish eagles and other wetland biodiversity while the other NPA will protect 36,515 ha of mosaic habitat of high elevation rainforests, lakes, marshlands and grasslands in northern Madagascar for serpent eagles, red owls, the threatened Madagascar Harrier (*Circus macrosceles*) and other forest and wetland biodiversity. The Peregrine Fund has provided academic opportunities to Malagasy university students and 28 have obtained postgraduate degrees with 18 specific to studies on raptors. These students are the next generation of scientist and conservationists in Madagascar who have an attachment to raptors.

Golden Eagles and California Condors Meet "Big Data": Scientific Visualization for High-resolution Biotelemetry

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The capability of modern GPS biotelemetry technology has increased dramatically over the last two decades. For example, some solar-powered GPS telemetry units are now capable of obtaining locations in three-dimensional space at 30-second intervals. Potentially, such telemetry units can collect over 0.5 million fixes per year if operating during daylight hours. While these high-resolution data allow us to ask questions that were once unanswerable, they create challenges in exploratory data analysis, interpretation of analysis results, and presentation. We present methods that combine statistical analysis of telemetry data with 3D scientific visualization to help raptor biologists better understand their data. We illustrate these methods using two data sets: California Condors (*Gymnogyps californianus*) in Baja California, Mexico and Golden Eagles (*Aquila chrysaetos*) in coastal southern California. Using the open-source software packages R and ParaView, we demonstrate how to estimate space use (utilization distributions) with 3D movement-based kernel density estimator (MKDE) techniques, visualize movement and behavior in 2D and 3D, animate movement data in 3D, and interpret spatial patterns in movement behavior using geographically-weighted regression. These tools can help turn an unintelligible pile of points into meaningful visualizations, allowing biologists understand their data better and communicate the insights they yield.

A Resource of Genome-Wide Single Nucleotide Polymorphisms for the Conservation and Management of Golden Eagles

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Elucidating the genetic structure and ascertaining the natal origin of Golden Eagles (*Aquila chrysaetos*) has been challenging for numerous reasons including the lack of available genetic loci. The main goal of this study was to develop a suite of single nucleotide polymorphisms (SNPs) using a population genomics approach to delineate biologically relevant population boundaries and assign individuals of unknown origin to their natal area. First, we generated a Golden Eagle reference assembly using DNA derived from a male bird. With an estimated genome size of 1.2 Gb, the total assembled coverage of this draft assembly is 88X and is comprised of 1,141 scaffolds with an N50 scaffold length of almost 9.2 Mb and an N50 contig length of over 172 Kb.

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Next, we generated unique genomic resources for Golden Eagles by performing whole genomic sequencing for 32 individuals representing nine of the fifteen Golden Eagle Management Units. We targeted approximately 10X of sequence depth per individual and aligned these reads to the Golden Eagle reference. We finally identified SNPs that were highly distributed across the Golden Eagle genome and calculated measurements of significant variation across individuals and within management units. These genomic resources, consisting of a reference genome and population samples with associated SNPs, provide valuable tools for the conservation and management of Golden Eagles and will allow for targeting specific loci for evaluating the effects of many anthropogenic stressors.

Habitat Use and Dispersal Behavior of Martial Eagles in Kruger National Park: Keys to Understanding Population Declines

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The principal aim of protected areas is to provide habitats for species unable to cope with the highly transformed habitats in the surrounding environment, or with high human pressure. In South Africa, raptors display higher rates of occurrence in protected areas than in non-protected areas, likely due to anthropogenic factors such as persecution and habitat transformation. The Martial Eagle (*Polemaetus bellicosus*) however, in addition to steady declines across its range, has also shown alarming declines in protected areas such as the Kruger National Park. To understand these declines, we studied the habitat use, breeding, and dispersal behavior of the species. Martial Eagles held territories averaging 110 km2 and habitat factors such as drainage line density influenced their behavior and distribution. Individuals that crossed into unprotected landscapes were at increased risk of mortality, and their behavior was greatly influenced by fragmented and transformed habitats. As Kruger National Park was a protected area proclaimed under historical influences, the park's landscape, size, and shape is unlikely ideal throughout its coverage for such a wide-ranging predator. Martial Eagles are also sporadic breeders with low productivity, which increases their vulnerability to stochastic processes on the population. Following a post nesting dependency phase of 3–9 mo, juvenile birds disperse over large areas beyond the safety of protected areas and often traverse into neighboring countries where they are at increased risk of unnatural mortality. Our findings demonstrate the importance of appropriately sized and shaped protected areas incorporating appropriate habitats for the conservation of top predators. We also demonstrate the difficulty in conserving dispersing individuals as the threats they encounter act as population sinks that are the likely drivers behind declines observed in South Africa's protected areas.

Status of the Endangered Puerto Rican Broad-winged Hawk (*Buteo platypterus brunnescens*): Conservation Challenges and Opportunities

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Destruction and fragmentation of habitat limits populations and recovery of endangered island woodland raptors. Knowledge of raptors in the West Indies is limited compared to other groups. The Broad-winged Hawk is a non-migratory endemic subspecies of Puerto Rico listed as endangered by the US Fish and Wildlife Service and the Puerto Rico Department of Natural and Environmental Resources. The Broad-winged Hawk is known from the principal montane regions of Puerto Rico including; the Luquillo Mountains (i.e., El Yunque National Forest), Sierra de Cayey (i.e., Carite Forest), Cordillera Central (e.g., Guilarte Forest) and the north-central moist karst forest region (i.e., Rio Abajo Forest). The species is rare throughout the island with the exception of Rio Abajo Forest and surrounding lands, where individuals are locally common. At Rio Abajo, nests are placed in the upper reaches of large trees emerging from the canopy of abandoned timber plantations (e.g., *Calophyllum brasiliense*) and mature secondary forest. Nest tree diameter at breast height, understory stem density, and distance to karst cliff wall best predict location of nest sites. Like other endemic raptors of oceanic islands, Broad-winged Hawks are relatively sedentary. Annual home ranges of adults (95% kernel) average 213.1 ha (range 62.9–446.1 ha) and juveniles 130.7 ha (range 48.2–250.9 ha). Relative abundance in Rio Abajo Forest and surrounding lands averages 0.0106 Broad-winged Hawks/ha (SE = 0.3), with an estimated population of 56 individuals for the region. During 2016–2017 we will conduct an island-wide assessment to determine status of the species with an emphasis on presence in private lands. Additional research is needed on demography and multi-scale resource selection. The potential for using individuals from the moist karst forest region to supplement or establish new populations should be will be considered to support recovery of this Caribbean woodland raptor.

Gyps vultures in South Asia: Ten years after the ban of veterinary diclofenac — is the crash over?

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In 2003, The Peregrine Fund identified the veterinary drug diclofenac sodium as the cause of the catastrophic population collapse of three species of *Gyps* vulture in South Asia. Vultures that consumed livestock carcasses contaminated with residues of diclofenac died of renal failure at rates so high that their populations declined by >30% per year. In February 2004, a high-level summit meeting was held in Kathmandu, Nepal to disseminate results to government authorities from Pakistan, India, and Nepal. By 2006, these governments had banned the veterinary use and manufacture of diclofenac. We present encouraging results of post-ban vulture population monitoring in India, Nepal, and Pakistan for three species of *Gyps* vultures. Our results suggest that their populations may have started to stabilize, and at some sites may even be increasing as a result of the ban. We emphasize the need for continued work to restore vulture populations, especially the Slender-billed Vulture (*Gyps tenuirostris*), and continued population monitoring, and public awareness, especially on the emergence of new non-steroidal anti-inflammatory drugs (NSAIDs) in the veterinary market. These drugs could potentially jeopardize vulture conservation efforts in the region.

Long Term Goals to Reestablishing California Condors into Areas of their Former Range

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Due to continuing and poorly understood declines in the wild California Condor (*Gymnogyps californianus*) population in the mid- 1980s, the controversial decision was made by the USFWS to capture the remaining wild flock and place it into the protective custody of the Los Angeles and San Diego Zoos for captive breeding in the hopes of eventually releasing offspring back to the wild. Behavioral pair management and advances in incubation techniques induced the 27 remaining condors to increase their reproductive rate to 4–6 times normal. The resultant genetically and demographically managed populations have been developed through continued releases at 5 sites within their former range and are currently expanding. The 1996 Recovery Plan down-listing goals have been nearly reached. However, while captive reproduction and releases have been successful, not all mortality factors are sufficiently mitigated in their former habitat. After four power line collision deaths in our first release cohort, a power pole aversion program was successfully devised and tested at the Los Angeles Zoo and has subsequently minimized this mortality factor for condors in the wild. Hunter-killed animals shot with lead ammunition have proven particularly dangerous for condors, causing high morbidity and mortality. Legislation (California) and education programs (Arizona and Baja California, Mexico) are tools gradually making a difference in condor survivorship, but changing the human hunting and shooting culture to non-poisonous ammunition has proven slow and difficult. We are gradually approaching self-sustaining populations in the wild, and with the proper mitigation of the lead poisoning issue we should also achieve overall success in the program.

Tyrannosaurus rex and the Puzzling Reversed Sexual Size Dimorphism in Raptors

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At least 14 different hypotheses have been proposed over many centuries to explain the often astonishing size differences between males (smaller) and females (larger) in many birds of prey and owls. None has found universal acceptance and research concerning reversed sexual size dimorphism (RSSD) has continued. Is there a single causal factor responsible for the evolution of extreme RSSD in some bird-hunting hawks, falcons, and owls? I have previously called for a holistic approach to the RSSD phenomenon (Walter 1979) and will now present more specific data and rationale pointing to a single physiological process underlying the evolution and adaptation of RSSD. Recent findings on the importance of the leg medulla in Tyrannosaurus rex have pointed to the essential role of the leg bone in birds generating the calcium needed for eggshell formation. It is this bone that is uniquely stressed during the impact of a bird-hunting raptor when hitting its prey. No other birds face this often violent event because only raptors hit and grab prey with their feet. My thesis postulates that raptor females have grown larger than their males in order to better protect the fragile nature of the medulla anatomy and the entire reproductive apparatus.

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Highly Pathogenic Avian Influenza and Raptors: Updates Regarding the 2015 Disease Outbreaks and Emergency Response Actions

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Worldwide, there are many strains of Avian Influenza virus that can cause varying degrees of clinical illness in birds (both domestic and wild). Highly pathogenic avian influenza (HPAI) virus strains are extremely infectious and fatal forms of the disease that once established, can spread rapidly through wild flocks, backyard poultry operations, and commercial poultry farms and facilities. The U.S. has the strongest avian influenza surveillance in the world, and Federal, state, and industry partners respond quickly and decisively when disease outbreaks occur. Beginning in December of 2014 and increasing through today (30 June 2015), HPAI viruses have been reported in some commercial poultry facilities, backyard poultry flocks, captive wild birds, and free-ranging wild birds within the U.S. Two strains of HPAI (H5N2 and H5N8) have been reported in the Pacific Flyway, whereas the H5N2 strain has been the primary variant reported in the Mississippi Flyway. To date, over 48,000,000 poultry (primarily chickens and turkeys) have been affected by these HPAI outbreaks. Also, 5 incidents of these HPAI strains infecting and killing captive raptors (i.e., falconry birds) have been reported. During the last 7 months, ongoing surveillance of wild birds has been conducted and a total of 84 free-ranging birds have been confirmed to be infected with HPAI. Various species of waterfowl (93%) and raptors (7%) account for these birds, which were found in 14 states. We will provide the latest information on the HPAI outbreaks and emergency response actions as well as discuss the impact on raptors and their role in the disease ecology of these HPAI strains within the U.S.

Risk-assessment of Renewable Energy Development to Golden Eagles (*Aquila chrysaetos*) in the California Desert: Insights from a Spatially Structured Population Model

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Predictive demographic models can help guide monitoring and management activities targeting at-risk or indicator species, especially when baseline data are lacking. Here we demonstrate how changes in land-use, climate, and other dynamic stressors can be integrated into a spatially structured population model to investigate population dynamics of Golden Eagles and guide conservation efforts. Our case study focused on a desert population of Golden Eagles exposed to rapid increases in renewable energy development under California's Desert Renewable Energy Conservation Plan (DRECP). We used a spatially-explicit, individual-based population model that integrated published data on movement behavior and population dynamics of Golden Eagles with spatial data on the arrangement of nesting habitats, prey resources, and planned development activities in the DRECP. Our model permits simulated eagles of different stage classes to disperse, establish home ranges, acquire resources, prospect for breeding sites, compete for territories, and reproduce. The amount and quality of nesting habitat and prey resources within each individual's home range influences reproduction rates and survival. We included environmental stochasticity in the model by allowing the distribution and availability of prey resources to vary over space and time in response to changes in precipitation. We then introduced proposed development scenarios to assess potential effects of increasing land-use, and associated mitigation strategies, on distribution and abundance. Preliminary results suggest that anticipated changes in land-use could have greater impacts on resource distribution than climate, and threats associated with increasing development infrastructure (e.g., habitat loss, electrocution, collisions with wind-turbines or vehicles) could have large consequences for population trajectories. The management-relevance of our approach stems from its use of dynamic disturbance maps as principal drivers influencing simulated biological, ecological, and behavioral mechanisms influencing Golden Eagles and their resources.

Raptors and Highly Pathogenic Avian Influenza Virus: With Comments Regarding Implications for Captive Managed Raptor Populations

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In late November 2014, Highly Pathogenic Avian Influenza Virus (HPAIV) H5N8 arrived in North America via the Pacific Flyway where it quickly re-assorted with North American low pathogenic strains to create HPAIV H5N2. The re-assorted virus is expected to disseminate through all flyways this fall when the southward migration season begins. Some raptor species appear to be highly vulnerable to HPAIV infection. Testing of various tissues from deceased raptors identified HPAIV infection as causing or contributing to mortality. It is not clear however, what

the prevalence or mortality rate of HPAIV is in raptors. Captive managed raptor facilities are in a position to assist with the national surveillance for HPAIV. However, potential consequences of introduction of HPAIV into a captive managed raptor population include nosocomial spread, zoonotic spread, spread to domestic avian species by humans, and spread to free-ranging birds and wildlife from birds that have been rehabilitated and released. These consequences can be mitigated by education and strict enforcement of biosecurity protocols.

Shifts in Migration Phenology by Raptors at Hawk Ridge, Duluth, Minnesota, U.S.A.

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Migration phenology shifts in response to climate change have been observed across numerous taxa from insects to songbirds, yet it is unknown whether this pattern holds for many ecologically and culturally important species of raptors. Migrating raptors have been counted at Hawk Ridge Bird Observatory in Duluth, Minnesota every fall for more than 40 years (1972–2014), offering a unique opportunity to explore migration trends for many species over a time period coinciding with rapid climate warming. We analyzed changes in migration phenology for nine species of raptors from 1972 to 2014, and five species from 1991 to 2014 by regressing the 25th, 50th, and 75th percentile migration dates against year for each species. A shift ($\alpha = 0.10$) to later migration was detected for five species: American Kestrel (*Falco sparverius*), Golden Eagle (*Aquila chrysaetos*), Merlin (*Falco columbarius*), Sharp-shinned Hawk (*Accipiter striatus*) and Turkey Vulture (*Cathartes aura*). Migration date decreased significantly ($\alpha = 0.05$) over time for two species, Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*). Overall our results show that responses to climate change in raptor migration may be complex and depend on the ecology of individual species or groups of species. A better understanding of the mechanisms behind these shifts is needed to assess the risk to ecosystems in which these raptors play key roles.

Western Burrowing Owl (*Athene cunicularia hypugaea*) Breeding and Foraging Ecology in San Diego County, California

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Successful management of Western Burrowing Owls and their grassland habitat depends on a thorough understanding of their population dynamics and resource use. Since 2013, we have monitored over 20 breeding burrowing owls per year, representing nearly half of the breeding population in San Diego County. We examined survivorship, parental care, reproductive success, diet, foraging movements, and burrow microclimate at both natural and artificial burrows. We used remote cameras to document prey deliveries, predation events, and productivity; GPS dataloggers to record foraging locations of provisioning males; and iButtons to record temperature and humidity inside and outside burrows. Through this research, we hope to gain a better understanding of local factors that may influence productivity and survival, and to ultimately provide a scientific framework for informing wildlife management decisions in the region. Here we present an overview of our results to date, and discuss implications for the management of Burrowing Owls and their habitat.

Examination of Effects of Ecological Differentiation on a Highly Variable Plumage Trait in the American Kestrel (*Falco sparverius*)

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Disruptive or divergent selection is believed to be a driving factor for the evolution and maintenance of plumage polymorphism in many avian species. One indication of this type of selection is temporal or spatial patterns in the distribution of morphs across a species' range. Such patterns may be a manifestation of the physiological or behavioral advantages that different morphs have in various habitats or under different environmental conditions. The American Kestrel is a wide-ranging species of New World falcon that shows extensive plumage variability. One of its most diverse plumage traits is the color of the tail of male kestrels, which can be divided into three distinct morphs dependent on

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the amount of black and white found on the outer tail feather. To explore what may be driving the evolution and maintenance of this highly variable plumage trait, I studied the relationship between climate and habitat, and male tail color for two North American subspecies of the American Kestrel (*F. s. sparverius* and *F. s. paulus*). Using a combination of museum specimens and photographs from banded birds, I examined the geographic distribution of the three morphs across North America. I then used BioClim and Level I and II Ecoregion data to search for correlations between morph occurrence and climate variables and habitat type. I found a difference in the prevalence of morphs from east to west, with a greater number of morphs showing high amounts of black and white color found along the Atlantic coast. However, despite this geographic pattern of morph type, no strong relationships were found between plumage distribution and either climate or habitat type. The evolution and maintenance of tail color variation in male American Kestrels does not appear to be driven by adaptation to different ecological conditions.

A Conservation Planning Framework for Golden Eagles (*Aquila chrysaetos*) in the Western U.S.

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The US Fish and Wildlife Service has begun a proactive conservation planning process for Golden Eagles across 17 western states. Increasing rates of renewable and fossil energy development in combination with other anthropogenic stressors (climate, electrocution, contaminants) motivated this effort. We synthesized the published literature, and existing (but unanalyzed) data about Golden Eagle distribution, reproduction, survival, habitat use, and biotic relationships within our study area. Because Golden Eagle populations are widely distributed across a broad range of ecological conditions with complex patterns of dispersal and migration, the species presented the additional challenge of conservation planning across extensive space and time. Our conservation planning framework sought to identify areas of high value to eagles during three primary overlapping life history stages; breeding, dispersal and migration, and overwintering. Spatial data from 89,609 nest records were used to develop predictive models of relative breeding habitat quality at ecoregional scales. We also developed predictive models of the distribution and relative abundance of eagles during the nonbreeding season, using encounter rates based on 860,428 survey events with 21,805 observations from eBird, the California and Rocky Mountain Avian Data Centers, and the USGS mid-winter Bald Eagle surveys. Model performance was evaluated with independent data and by eagle researchers. For dispersal and migration we evaluated spatial and temporal patterns of movements and habitat selection based on movements by > 540 PTT-tagged eagles. We used the conservation prioritization program Zonation to identify priority conservation areas based on eagle habitat values. We also mapped actual and predicted anthropogenic mortality risks and overlaid those maps with high-value eagle habitats. Our use of systematic conservation planning tools allows for identification of important areas for, and risks to, Golden Eagles. It is adaptable to new information and changing conditions, and thus provides a strong framework for proactive and adaptive conservation decision making.

The Osprey Nest Excluder for Cellular Towers: A Case Study Aimed at Reducing Nest Site Conflicts and Bird Strike Hazards around Airports

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The use of cellular communication towers as nesting structure by Ospreys (*Pandion haliaetus*) has increased dramatically in the past decade, allowing Ospreys to exploit increasingly urban habitats. This leads to conflict when the presence of Osprey nests prevent upgrade and maintenance of equipment, since human disturbance at active nests is prohibited under The Migratory Bird Treaty Act. Airport safety concerns are also heightened, as risks for bird strikes increase with nearby Osprey nesting and the fledging of young. Furthermore, nesting on cellular towers can pose additional risks for Ospreys, including combustion of nest material, entanglement potential in coaxial and electrical wires, and potentially adverse effects from exposure to non-ionizing electromagnetic radiation emitted by communication infrastructure. We describe the development and efficacy of an Osprey nest exclusion device, that when paired with providing safe alternative nest structures, allows year round access to cellular communication equipment, reduces bird strike hazards around airports, and aids Osprey conservation.

Northern Goshawk (*Accipiter gentilis*) Genetic Diversity and Connectivity among Naturally Fragmented Forests of the Northern Great Basin

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Forest fragmentation limits movement of individuals, and even highly mobile species, like birds, can fail to disperse across such landscapes. The naturally fragmented forests of the northern Great Basin are thought to have led to the evolution of unique species. Other species in these forests may also exhibit unique genetic diversity. The Northern Goshawk, a species occupying these forests, has shown low integration between geographically dispersed populations elsewhere in its range. We evaluated genetic diversity and connectivity of the goshawks in the northern Great Basin by extracting mitochondrial DNA and placing birds in the biogeographical context of other populations in the West. We used blood and feather samples from nestling and adult birds from five forest islands in south-central Idaho, the Owyhee Mountains in South West Idaho ,and Malheur National Forest in Eastern Oregon to compare mitochondrial DNA sequences among individuals. Our work provides a continuation of understanding the genetic ecology of Goshawks in the northern Great Basin, and the genetic health and integration of these birds compared with other populations.

Gang Behavior at Winter Carcasses and Response to Playback of Vocalizations in Striated Caracaras (*Phalcoboenus australis*) in the Falkland Islands (Malvinas)

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The IUCN Near-Threatened status and highly restricted range of the Striated Caracara have not made it the subject of intense study, although conservation concerns show they warrant much deeper research. The Striated Caracara is a socially scavenging falconid, reliant on seabird colonies during the breeding season in the Falkland Islands (Malvinas). The birds have been persecuted as livestock pests since the late 1800s, and although the population is now protected and remains stable, it does not appear to be growing. Striated Caracaras are in general curious, destructive, and unafraid of people, traits which frequently put them at odds with the Falkland's sheep farmers. Their reliance on human settlements as winter foraging grounds makes them an ideal species to examine age-stratified carcass consumption over the entire period of a carcass's availability. During austral winter when seabird carcasses are scarce, juvenile birds will forage in groups or "gangs," similar to ravens, and vocalize frequently in what seems to be an advertisement to the food source. This study was undertaken to investigate whether juvenile vocalization instigates grouping behavior, a potentially adaptive strategy for juvenile survival through their first few winters, when raptor mortality is highest. The study should provide insight into juvenile Striated Caracaras dependence on social foraging to survive their first few years, a tactic chosen by very few raptor species.

Capturing Current and Historical Raptor Research Using the Alaska Raptor Metadata Database

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The Alaska Raptor Group, a subcommittee of Boreal Partners in Flight, recognizes the rich and long history of raptor research and survey efforts in Alaska, dating back to the middle of the last century. Collectively, these data represent a massive shared investment of time, money, and effort. However, the value of historical and current raptor projects is reduced if others are not aware of this work. Therefore, the Alaska Raptor Group has created a database to catalog and display the basic who, when, where, what, and why of raptor research, surveying, and conservation projects in Alaska. We ask all those who conduct raptor work in the state or on birds that spend time in the state to share your metadata through the Alaska Raptor Metadata Database. This includes both past and present projects. The metadata contained in the database is available for general use to assess what has been done in the past and help guide future priorities. The database is also used as a straightforward means to summarize all raptor-related field projects that occurred within the state annually. No actual survey data, nest locations, or results are requested or included in the database. The interactive form is available online at http://www.adfg.alaska.gov/index.cfm?adfg=wildlifediversity.raptors and can be completed within several minutes. By collecting this valuable metadata information from biologists who conduct raptor research or survey projects in Alaska, we can gain a better understanding of what has been done in this field and help guide future projects.

Nighttime Callback Detections for Forest Owls and Nesting Demographics for Great Gray Owls in Jackson Hole, Wyoming, U.S.A.

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Breeding surveys for forest owls can be difficult, particularly at remote high altitude locations. From 2013 to 2015, we conducted off-trail nighttime callback detection surveys for Great Gray Owls (*Strix nebulosa*) and Boreal Owls (*Aegolius funereus*) during the spring courtship period for these species (ca. 1 March – 30 April). We surveyed a total of 1,478 unique locations across years (with an additional 440 re-surveyed locations) in the boreal forests in Jackson Hole, Wyoming. Great Horned Owls (*Bubo virginianus*) were detected most often, followed by Great Gray Owls, Boreal Owls, Saw-Whet Owls (*Aegolius acadicus*), Northern Pygmy Owls (*Glaucidium californicum*), and others. There was no pattern detected in call times for Great Gray Owls but Boreal Owls called at higher than expected rates from 20:00 to 22:00 hr. Our surveys lead to discovery of 36 active Great Gray Owl nests, with average production of 1.50, 1.56, and 1.83 fledglings/nest in 2013-15, respectively. Nest success was generally consistent among years and high (75-78%) but there was fluctuation in nest initiation rates among years. The majority of nests occurred on the tops of broken trees (43%), followed by stick nests (39%), growths caused by mistletoe (13%) and other substrates (4%). Nest timing was highly variable and fluctuated by an average of ca. 30 d between years.

Assessing the Status and Conservation Priorities of the Short-eared Owl in North America

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North American Breeding Bird Surveys, Christmas Bird Counts, and regional and national conservation assessments provide convincing evidence that the Short-eared Owl (*Asio flammeus*) is experiencing a range-wide, long-term decline in North America. However, the species has received little conservation or research attention. The Short-eared Owl is vulnerable to decline because it relies heavily on large, intact grasslands and a specialized diet of unpredictable small mammal prey. The specie's nomadic movements compound these vulnerabilities by making a decline difficult to detect with current monitoring programs while obfuscating stewardship responsibilities for managers. The primary threat to the species is loss, fragmentation, and degradation of large tracts of native grasslands and wetlands. We propose the following conservation priorities to better understand and begin addressing the Short-eared Owl's decline: 1) better define and protect important habitats, 2) improve population monitoring, 3) determine seasonal and annual movements, 4) re-evaluate NatureServe's Short-eared Owl national conservation classifications, 5) develop management plans and tools, and 6) classify raptors, including Short-eared Owls, as migratory birds in Canada. We contend that the Short-

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eared Owl's need for habitat conservation at large spatial scales, status as a predator, and high reproductive potential that affords the species capacity to recover, make it an effective and useful candidate as an umbrella species for grassland conservation.

A Recently Expanding Osprey Nesting Population in Industrialized Locations of San Francisco Bay

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Ospreys (*Pandion haliaetus*) rarely nested on San Francisco Bay (SF Bay) prior to 2005, although Ospreys were breeding throughout Northern and Central California, and in a wide variety of habitats throughout North America. This breeding status has changed markedly over the last decade, beginning with a steady increase in the number of Osprey nests in the northern portion of SF Bay, and an expansion southward. Beginning in 2012, we began a systematic census of Osprey nests along the heavily developed SF Bay shoreline. After four years of surveys we have documented the number of active Osprey nests increased from 23 in 2013 to 31 in 2015. Between 2012 and 2015 we observed an increase from 30 to 56 fledgling Ospreys. Two areas of highest nest density are along the Mare Island Strait in the north end of SF Bay, where Osprey nests first began to be established, and the Richmond shoreline further south along the eastern shoreline. Nearly all nests observed were built on anthropenic structures, such as cranes, light towers, and utility poles. This propensity for nest-building on such structures has sometimes resulted in conflicts that led to nest deterrence efforts, which are often unsuccessful, when alternative artificial nest platforms are not provided. Some progress has been made in using nest platforms to divert Ospreys from nesting on problematic structures while allowing the continued successful nesting of this charismatic raptor species.

Using a Live Web Camera to Monitor a California Condor Nest In Big Sur, California

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The first California Condor (*Gymnogyps californianus*) released by the Ventana Wildlife Society in the Big Sur area of California was in 1997, and by 2006, condors began breeding in the wild in Big Sur. There are currently 70 condors in central CA but the population still is not self-sustaining. A high mortality rate associated with lead poisoning necessitates continued supplemental feeding and monitoring at our remote management facility. To improve our monitoring capability, we installed two Pan Tilt Zoom web cameras at the site in October 2013. The camera was designed by Camzone and HD on Tap, with funding provided in part by the Oakland Zoo and FedEx. The camera is powered by solar panels, and the video signal is linked to a T1 internet line in a local residence by a series of antenna relays. The camera is operated by our biologists via the internet. These biologists identify individual condors by their numbered wing tags, and monitor their feeding and associated behaviors. In 2015, we expanded the cam monitoring system to include a wild nest. The camera is located in a redwood cavity near Big Sur, in the Santa Lucia range of the central California coast, 0.8 km from the Pacific Ocean. The nest camera provides efficient means of monitoring condors with minimal disturbance, and facilitates a worldwide audience of their behavior at the nest. In terms of nest threats, biologists can chronicle nest activity and potentially curb the impacts of man-made threats like micro-trash, lead poisoning, or natural threats like predation.

Blood-lead levels of Golden Eagles (*Aquila chrysaetos*) and Bald Eagles (*Haliaeetus leucocephalus*) wintering in Montana's Bitterroot Valley

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Lead has long been documented as a serious environmental hazard to eagles and other predatory, opportunistic, and scavenging avian species. The use of lead shotgun pellets for waterfowl hunting on federal and state lands was banned in 1991 due to lead poisoning in Bald Eagles, Golden Eagles, and numerous waterfowl species. At that time, this was thought to be the major source of the lead exposure. More recently, lead poisoning from ingested lead-bullet fragments and shotgun pellets has been identified as the leading cause of death in California Condors (*Gymnogyps californianus*), leading to a ban of lead ammunition within the "California Condor Recovery Zone." Another on-going study on Common Ravens (*Corvus corax*) and Bald Eagles in Wyoming has shown a direct correlation between very high blood-lead levels and the on-set of rifle hunting season. Indeed, there is overwhelming evidence showing that lead toxicity is still prevalent in the environment and mounting data points to fragmented rifle bullets as the source. We sampled blood from 32 Golden Eagles and 11 Bald Eagles captured on wintering grounds in the Bitterroot Valley from 2011–2014. Eighty-six percent of eagles tested showed blood-lead concentrations higher than natural background levels. These preliminary results suggest exposure to lead is prevalent among eagles from northern latitudes wintering in the Bitterroot Valley.

Diet and Prey Selection of Dung Beetles (Scarabaeidae: Scarabaeinae) by Burrowing Owl (*Athene cunicularia*) at Grasslands of Itirapina Ecological Station, State of São Paulo, Brazil

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Predator's food choice can change with prey abundance, physical and behavioral traits both of predator and prey, and energy cost. The aims of this research were to study Burrowing Owl diet, analyze dung beetle prey selection, and identify whether prey or predator traits, or climatic parameters influenced predation. We used prey remains (bones, mandibles, pelvic girdles, elytron, and heads) in pellets and at nesting sites at the grasslands of Ecological Station of Itirapina (São Paulo, Brazil) to identify prey species and to quantify consumed individuals and biomass. We evaluated seasonality in diet via a G-test. We calculated an index of food niche breadth (Bst) for each month, and evaluated seasonality between rainy and dry season via Mann-Whitney U-tests. We used Pearson's correlation to evaluate relationships between weather variables such as mean and number of prey items in pellets and in the environment. We used Bailey's confidence intervals to evaluate selection of dung beetles. We collected 421 pellets and 183 debris yielding 4,341 prey individuals and 6,185 g of biomass. Insects were the most frequent prey (92.9%), mainly Coleoptera (48.4%), Orthoptera (10.1%) and Blattaria (16.7%). The most frequent beetle families were Scarabaeidae (26.2%) and Carabidae (8.7%). Vertebrates were important in terms of biomass (40.2%). There was no seasonality in food-niche breadth ($U = 11$, $p = 0.153$), but by frequency (number of prey), there was higher consumption of insects (mainly scarabs) and frogs in wet seasons, and rodents in dry seasons ($G = 644.9$; d.f. = 11; $p < 0.0001$). Dung beetles were more consumed and available in the environment with increasing temperature, humidity and rainfall averages. Food-niche breadth was wide despite Bst values near zero. Burrowing Owls selected some dung beetles (Scarabaeidae: Scarabaeinae) like *Dichotomius* species during rainy seasons and *Dichotomius glaucus* and *Coprophanaeus ensifer* during dry seasons.

Toward a Foundation for Determining the Ecological Effects of Climate Change on Arctic Ecosystems: Dietary Composition of and Overlap between Two Avian Apex Predators on the Seward Peninsula, Alaska

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Temporospatial patterns of climatic processes are changing rapidly in arctic ecosystems, but the long-term effects of these changes on species interactions and energy flow are poorly understood. We sought to provide baseline data for understanding the effects of climate change by evaluating the diets of two sympatric avian apex predators in Alaska, the Golden Eagle (*Aquila chrysaetos*) and the Gyrfalcon (*Falco rusticolus*). We quantified Golden Eagle diet by analyzing regurgitated pellets and prey remains collected at 32 occupied nest sites (11 successful, i.e. with young present) in July 2014, and we estimated Gyrfalcon diet by direct observation at 10 successful nest sites, May-July 2014. We found the diets of both raptors consisted primarily of Arctic ground squirrel (*Urocitellus parryii*) and Ptarmigan (*Lagopus* species), but the relative proportions of prey biomass were reversed, with Golden Eagles preying more on squirrel (57% vs. 15% for Gyrfalcons), and Gyrfalcons more on Ptarmigan (78% vs. 15% for Golden Eagles). The diets of Golden Eagles occupying successful and unsuccessful nests did not vary and overlapped greatly, both in composition and along the prey size axis. Golden Eagle diets varied significantly from the diet of Gyrfalcons, yet their diets exhibited a relatively high degree of overlap. These results illuminate the shared niche space and potential competition for prey between Golden Eagles and Gyrfalcons in Alaska and, possibly, variation between these predators' abilities to adapt to climate change. Additionally, these data provide a baseline for future study of the effects of climate change on inter- and intra-trophic interactions in arctic ecosystems.

Climate Correlates and Implications for Organochlorine Contaminants in the Great Lakes Ecosystem from 1999 to 2014

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We examined spatial and temporal trends, and possible environmental correlates of organochlorine (OC) pesticides and sum polychlorinated biphenyls (PCB). We collected blood samples from Bald Eagle (*Haliaeetus leucocephalus*) nestlings from 1999–2014. We performed extraction and cleanup of nestling plasma, from which 23 OC pesticides and 22 PCB congeners were quantified. We assigned all samples ($n = 794$) collected under the stratified sampling design to three spatial scales. Next, we calculated the geometric mean of the concentrations at our

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three scales. We also described temporal trends in the annual geometric mean concentrations using linear models. We report the back-transformed annual mean concentrations at spatial scale categories where those mean concentrations exceed established NOAELs. We determined the relationship of log-transformed contaminant concentrations with environmental variables using a Pearson's correlation coefficient. Our environmental variables were collected from NOAA weather stations across Michigan from 1998 to 2014; we summarized these data annually across three broad spatial scales. We determined that of 794 plasma samples, 109 had no detectable (ND) concentrations of all PCB congeners. PCBs in all samples ranged from ND to 498 µg/kg. We also determined that out of all OC pesticides and metabolites, only the 4,4'-DDE metabolite of DDT had detectable concentrations (n = 749) in at least 50% of all of our samples. Concentrations of 4,4'-DDE in all samples ranged from ND to 257 µg/kg. We documented annual geometric mean PCBs greater than the NOAEL from samples collected along the Great Lakes shorelines and Anadromous rivers. Concentrations of 4,4'-DDE exceeded NOAELs from samples taken along Great Lakes shorelines, Anadromous rivers, and Inland. Regionally, we found significant decreases in annual geometric mean PCBs in samples along lakes Erie and Michigan, and 4,4'-DDT in Lake Michigan. Environmental variables associated with rain, snowfall, and temperature correlated to contaminant levels, particularly PCBs.

High Predictability of Occurrence of Raptor Nest Sites on North Baffin Island, Nunavut

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Resource selection functions are often used to estimate and predict habitat most often used by free ranging wildlife species, but resource selection functions are rarely validated using data independent of those from which models were built. Our objective was to evaluate resource selection function predictions for two arctic-nesting raptors with an independent dataset, by comparing predicted versus observed occurrence. We conducted aerial surveys from 2006 to 2013 and identified 172 Peregrine Falcon (*Falco peregrinus*) nests and 160 Rough-legged Hawk (*Buteo lagopus*) nests. We used these survey data to build habitat selection models by pairing logistic regression with landscape teledetection data. Field model validation was performed in 2014 in six locations adjacent to, but distinct from, the source of our data. Comparison of predicted versus observed nest site selection was be done by calculating correlation coefficient and fitting linear regression for each species. Results from regression show high R2 values, slopes similar to 1 and intercepts not different from zero for both species, which indicate the models made good predictions for both species. Therefore, these models will be useful for management planning in areas with similar landscape features.

Simultaneous, Complete Tail Molt of Great Gray Owls (*Strix nebulosa*)

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Information surrounding the tail molt sequence of owls is limited. Little documentation exists regarding the molt patterns of Great Gray Owls in particular because few year-round studies have been conducted on this secretive species. We studied the tail molt of wild sub-adult and adult Great Gray Owls in western Wyoming between 2013 and 2015. Replacement of rectrices occurred in what is known as a "simultaneous" or rapid, complete molt over the course of several days, rendering the owls temporarily "tail-less." Rectrices were lost either in unison or centrifugally (from the innermost to outermost), but molt always occurred rapidly, usually within a couple of days and at the most within two weeks. No disjunct, or gradual, tail molt was observed. We observed simultaneous molt in breeding and non-breeding adults, and in sub-adults. Simultaneous tail molt has been documented in other owl species including Spotted Owls (*Strix occidentalis*) and Barred Owls (*Strix varia*), but the advantages and implications of this molt pattern in large owls are not well understood. No flight impairment was observed and no connection between simultaneous tail molt and survivorship or nest success was apparent. More research investigating the benefits and impacts of owls undergoing a rapid, complete tail molt is warranted.

Yellowstone Raptor Initiative: An Overview, Five Years of Fieldwork

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In 2010 at Fort Collins we presented The Yellowstone Raptor Initiative (YRI), a five-year program in Yellowstone National Park (YNP) designed to establish baseline data on diurnal and nocturnal raptors. YNP's previous raptor program had focused only on Bald Eagles (*Haliaeetus leucocephalus*), Ospreys (*Pandion haliaetus*), and Peregrine Falcons (*Falco peregrinus*). An additional nine diurnal and seven nocturnal species breed in YNP and a further fourteen used, or currently use, the YNP landscape for seasonal movements. Prior to 2011, YNP had few data for any of these raptors. The YRI primarily focused efforts on Golden Eagles (*Aquila chrysaetos*), Red-tailed Hawks (*Buteo jamaicensis*), and Swainson's Hawks (*B. swainsoni*) with opportunistic searches for American Kestrels (*F. sparverius*) and Prairie Falcons (*F. mexicanus*). The goal was to establish population estimates and monitor occupancy, nest success, and productivity for these species. A standardized road-based survey was designed to determine population estimates and

trends over time for specific diurnal species across the northern range of the park. A separate road-based survey was conducted over the last three years to provide an index of site occupancy for breeding owl species. Fall migration counts have occurred in Hayden Valley over the past five years. A raptor sightings program was established to encourage the public to report observed raptors. Here we present an overview of the last five years of fieldwork. Red-tailed Hawks occur in high density throughout the northern range, and productivity suggests a stable population. We have confirmed 28 Golden Eagle territories park-wide with multiple unconfirmed sites remaining to be investigated. Swainson's Hawks breeding in Yellowstone primarily occur at higher elevations in more densely forested areas and lack the agricultural influence commonly described. Our work will be further described in a detailed technical report for the National Park Service.

Evaluating the Use of Trail Cameras to Study Diet, Behavior, and Productivity in Cliff Nesting Golden Eagles (*Aquila chrysaetos*)

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Studies of cliff-nesting raptors are challenging because direct observation of nest contents is difficult, and repeatedly climbing into nests can disturb nesting birds, potentially affecting outcomes. Our objectives were to: 1) develop a method for camera installation at cliff nests of Golden Eagles, 2) evaluate the effectiveness of cameras at documenting eagle diet compared to analysis of prey remains and pellets, and 3) explore other potential uses of nest cameras. In the 2014 and 2015 breeding seasons, we installed commercially available cameras at 10 nests when nestlings were 2 - 6 wk old. We used multiple techniques to mount cameras with average installation times of 20 - 30 min. Parent eagles accepted all cameras that were properly concealed. Image capture was triggered by the motion sensor with a 1 min delay. Preliminary results show that cameras recorded ~ 57% more prey items than were enumerated by analysis of prey remains and pellets collected from the nests every 4 d. Both methods provided comparable information for larger prey items such as black-tailed jackrabbits (*Lepus californicus*) and Mallards (*Anas platyrhynchos*). However, traditional analysis of prey remains and pellets, under-represented smaller prey items such as Rock Pigeons (*Columbia livia*; 44% under-representation), Piute ground squirrels (*Urocitellus mollis*; 62%) and gopher snakes (*Pituophis catenifer*; 75%). In addition to collecting diet data, we determined the number and estimated age of fledglings and, in one case, we determined the cause of a nestling death by using the cameras. We monitored parental behavior post-installation, and we ensured that camera installations did not negatively affect nesting attempts. When properly implemented, nest cameras proved to be cost effective and efficient at recording diet, behavior, and productivity. Nest cameras also minimized bird stress due to a reduced number of visits compared to traditional dietary techniques.

The Use of Hydrogen Stable Isotopes in Claws to Distinguish between Migratory and Resident Birds in a Partial Migrant Population of American Kestrels (*Falco sparverius*)

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Comparative studies of partial migrants are useful for understanding the consequences of migration strategies, but when migrants and residents are sympatric, it can be difficult to identify whether a bird migrated or not. Ratios of Hydrogen and Deuterium in precipitation (δDp) vary along a latitudinal gradient, and birds feeding at different latitudes may incorporate this latitudinal variation in δD into their tissues. We evaluated whether δD of keratin in claw tissue (δDc), which reflects the δD in the diet 3–4 months prior, could be used to distinguish between migratory and resident American Kestrels in southwestern Idaho. From 2013–2015 we captured adult and nestling Kestrels during the breeding (Apr–Jul) and winter (Nov–Feb) seasons, marked each bird with a band, and collected a small claw sample. Claw samples were washed, weighed, and δD was analyzed using a mass spectrometer. If a Kestrel was recaptured in a subsequent season (e.g., breeding and winter) we considered it to be a "known resident", otherwise all adults were assigned an "unknown" migratory status. We found that nestling δDc was significantly depleted compared to adult δDc. For adults, δDc of known residents captured in spring were similar to δDc of known residents captured in winter and did not differ by year, suggesting a consistent local signature in δDc. δDc of unknown Kestrels caught in winter were not significantly different than known residents suggesting that unknown kestrels wintering in the study area were not migrants from northern breeding areas. However, δDc of unknown kestrels caught in spring were significantly enriched compared to known resident δDc Kestrels, suggesting that many unknown Kestrels that were breeding on the study site wintered in more southern latitudes prior to nesting. These results suggest that δDc could be a powerful tool in distinguishing between migrant and resident Kestrels.

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Effects of Hematophagous Parasites on Golden Eagle Nestling Physiology and Stress

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Ectoparasites can have a variety of negative effects on their avian hosts, from minor irritation to death. Parasites in the family Cimicidae (bed bugs) include the obligate hematophagous Mexican chicken bugs (*Haematosiphon inodora*) that live in nest material and emerge to feed on the blood of young birds. Golden Eagle (*Aquila chrysaetos*) nestlings on cliff-nests may be particularly susceptible to the negative consequences of these parasites because nestlings cannot flee from the source of parasites and nestlings require substantial energy for growth and development, leaving little capacity to deal with health challenges. Further, repeated exposure to irritating bites from parasites may elicit a stress response resulting in increased corticosterone (CORT) levels that can have negative effects on nestling development. We studied whether the presence of ectoparasites in nests of Golden Eagles affected the physiological condition or CORT concentrations of nestlings. We entered nests when nestlings were 4 and 7 weeks old, measured mass, collected blood, and noted the presence or absence of ectoparasites. We evaluated physiological condition using hematocrit and age. We also sex-corrected body mass and performed an enzyme-immunoassay to determine CORT concentrations. We found blood-feeding parasites in 15 of 19 nests. Presence of ectoparasites did not significantly affect either body mass or hematocrit. CORT concentrations ranged from 3.7 ng/mL-80.6 ng/mL and were significantly higher in nestlings with ectoparasites. Chronically elevated CORT during development can have detrimental effects on cognitive abilities and may affect long term survivability. In addition, elevated CORT concentrations may facilitate premature fledging that leads to death, a relatively common fate for young from nests with high parasite loads. This is one of the first studies to report circulating CORT concentrations for Golden Eagles and it illustrates a potential mechanism for long-lasting effects from ectoparasite infection.

Evaluating Recreational Ground Squirrel Harvest as a Potential Vector for Lead Exposure in Breeding Avian Scavengers

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Avian scavengers face unique risks of lead (Pb) exposure because of the widespread dispersal of Pb through hunting and predator management activities. Whereas big game and upland bird hunting have been commonly linked with Pb exposure and associated toxic effects in avian scavengers, less is known about other shooting activities. Specifically, the rising popularity of recreational ground squirrel shooting in western North America to control ground squirrel-induced agricultural damage has raised the specter of these small mammal carcasses providing a localized and high-density source of Pb to scavengers. Recreational shooters almost exclusively use expandable Pb bullets that result in numerous Pb fragments in ground squirrel carcasses. Thus, ground squirrel shooting events could be a substantial episodic source of high level Pb exposure to avian scavengers such as hawks and ravens. To quantify the risk of harvested ground squirrels as a vector for localized Pb exposure in avian scavengers we surveyed scavenger use of shooting fields before and after harvest events, estimated the occurrence and distribution of lead bullet fragments in harvested ground squirrel carcasses, and evaluated blood-Pb concentrations in local breeding raptors and ravens. Preliminary data suggested that shooting events acted as strong cues to scavenging birds, with increased time spent feeding on carcasses. Preliminary results indicate scavengers were exposed to Pb at levels above background concentrations from between 6-40% depending upon species, with species effects likely linked to the proportion of each species' diet derived from scavenged carcasses.

Temporal Trend of Second Generation Anticoagulant Rodenticide Residues and the Associated Toxicosis Risk Levels in the Barn Owls (*Tyto alba*) of British Columbia

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Second generation anticoagulant rodenticides (SGARs) are pesticides widely employed in urban and rural farmlands worldwide to reduce rodent infestations. Ingestion of SGARs leads to the inhibition of vitamin K clotting factors essential to normal blood coagulation, which at lethal doses causes internal hemorrhage and death. SGARs provide a fatal dose to rodents after only a single ingestion of bait and have relatively long half-lives compared to their less lethal counterpart, warfarin. Not surprisingly, avian predators that extensively hunt small rodents are at risk of secondary poisoning, including the Barn Owl that is currently listed as a Species at Risk in Canada. For the past 3 decades, raptor-monitoring programs worldwide have demonstrated a generally increasing trend in the number of birds exposed to SGARs. In this study, we used SGAR residue data

collected from 1999–2013 in British Columbia (BC) to evaluate the potential toxicosis risks in Barn Owls. We found that the concentration of total SGAR residues (mg/kg) detected from Barn Owl livers significantly increased from 1999–2013, with the highest value found in 2011 (1.08mg/kg). Concentrations of difethialone and bromadiolone alone showed significant increases over time, while brodifacoum did not. A previous study estimated the probability of developing toxicosis symptoms (toxicosis risk level) in Barn Owls predicted by their liver SGAR residues. Using this calculation, we showed the proportion of owls having 20% of toxicosis risk level increased significantly from the past (1999–2003) to recent years (2006–2013). These results suggest that not only is exposure to SGARs increasing in the BC population of Barn Owls, the probability of these raptors dying from intoxication is also escalating. We recommend that continuous long-term monitoring will be necessary in the future to assess anthropogenic threats to this population.

An Improved Mechanical Owl for Capture of Nesting Accipiter Hawks

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Logistical constraints can reduce the efficacy of sampling wildlife populations; this is especially true for predator species that occur in relatively low densities. The use of live lure birds is a common trapping technique for secretive North American Accipiters. However, this method creates numerous challenges including building and maintaining housing for the lure bird, the cost of feeding and equipment, the difficulty of transport to nest sites, and the potential danger during trapping to both lure bird and targeted wild birds. Mechanical owls have been used in the past to trap wild nesting raptors, but with limited success compared to using live lure birds. Thus, there is a need to advance mechanical lures to improve trapping success and further facilitate research. We constructed an improved mechanical lure bird from a salvaged Great Horned Owl (*Bubo virginianus*) that has a greater diversity of movement than previously reported lure birds. We attempted to capture 23 Accipiters during the 2015 nesting season using this owl in conjunction with playback calls. We successfully captured 20 individuals (87%) and all except one was captured within an hour of trap set-up. Additionally, over 50% of targeted birds were captured less than 5 minutes after becoming visible to researchers. We hope that this new lure bird design can be used in future trapping efforts for nesting birds of prey to reduce costs, mitigate logistical issues, and simultaneously maintain or improve trapping efficiency.

Body Size and Dietary Niche of Sympatric Northern Boobooks (*Ninox japonica*) and Oriental Scops Owls (*Otus sunia*) in Korea

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Two insectivorous forest owls, the Northern Boobook and the Oriental Scops Owl, are among common breeding migrants in the Republic of Korea. However, very limited ecological information is available on these nocturnal raptors. In this study, I focused on their diets via stable isotope analysis (SIA), and related to inter- and intra-specific body size. SIA showed significant distinctions between the two species, both in carbon and nitrogen isotope ratios. Northern Boobooks had higher values in nitrogen and carbon isotope ratios, and greater variance in carbon isotope ratios than Oriental Scops Owls. According to the multi-source mixing models, Northern Boobooks mainly consumed vertebrate prey, especially birds. Oriental Scops Owls utilized mainly ground insects followed by birds, mice, and moths. Each individual owl's overall body size index was extracted from principal component analysis, and compared with individual trophic level (nitrogen isotope ratio). Only Oriental Scops Owls showed significant correlation with smaller individuals consuming higher trophic level diets. In conclusion, Northern Boobooks and Oriental Scops Owls demonstrated distinct food niche separation in a sympatric habitat. In particular, the larger bodied Northern Boobooks occupied a higher trophic level with more flexible foraging habits, and selected diverse prey sources from forests to open environments, whereas the smaller Oriental Scops Owl belonged to a lower trophic level and was a more specialized forager relying on forest ecosystems. Furthermore, individual trophic level was found to be related to body size only for the more sexually dimorphic Oriental Scops Owls, but not in the less dimorphic or monomorphic Northern Boobooks. These findings partially support the 'small male hypothesis', in Oriental Scops Owls that smaller males are efficient foragers, which is beneficial in reproductive success and thus more adaptive in raptors with reversed sexual dimorphism.

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Preferential Raptor Predation on Rozol®-Poisoned Black-tailed Prairie Dogs in Colorado during Winter

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Several diurnal raptor species forage on black-tailed prairie dogs (*Cynomys ludovicianus*) during autumn and winter. Applications of first generation anticoagulant rodenticides, Rozol® Prairie Dog Bait (active ingredient chlorophacinone) and Kaput®-D Prairie Dog Bait (active ingredient diphacinone) to prairie dog colonies during this time of the year raises concern about secondary poisoning of raptors through consumption of contaminated prey. We documented raptor foraging and above ground prairie dog activity on two Rozol® Prairie Dog Bait-treated wards and one untreated ward of a prairie dog colony during January and February, 2011. Northern Harriers (*Circus cyaneus*), Red-tailed Hawks (*Buteo jamaicensis*), Ferruginous Hawks (*Buteo regalis*), a Rough-legged Hawk (*Buteo lagopus*) and Prairie Falcons (*Falco mexicanus*) were observed at the study colony post Rozol® Prairie Dog Bait application but only Ferruginous Hawks and Red-tailed Hawks were observed feeding on prairie dogs post-Rozol application®. Ferruginous Hawks homed-in on prairie dogs in the Rozol®-treated wards while ignoring overtly healthy prairie dogs in the adjacent untreated ward. The selective predation on vulnerable (poisoned) prey follows foraging theory postulating that raptors should hunt such that they minimize their energy expenditure and maximize their net energy status. Given preferential predation on poisoned prairie dogs and the toxicities of the first generation anticoagulant rodenticides, we hypothesize that successive foraging on intoxicated prairie dogs will result in adverse effects to raptors. Bald Eagles (*Haliaeetus leucocephalus*), and Golden Eagles (*Aquila chrysaetos*) also are known to forage on prairie dog colonies and hence other raptor species in addition to those observed in this study may be at risk when rodenticides are applied to control prairie dogs. To date, monitoring efforts at prairie dog colonies treated with rodenticides have been inadequate to document adverse secondary toxic effects on raptors and other wildlife species.

Issues Currently Affecting *Gyps* Vulture Populations in Assam, India

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Populations of three species of *Gyps* Vultures have been declining precipitously on the Indian subcontinent over the last decade as a result of contamination of livestock carcasses with diclofenac and possibly to other NSAIDs (non-steroidal anti-inflammatory drug) with similar properties. To identify population levels and factors affecting survival for two critically endangered vultures (*G. tenuirostris*, and *G. bengalensis*), we conducted a survey from 2003 through the present. We found three-year running averages of the number of nestlings of both species suggest declines on the order of 50% over the eight year period, with a particularly sharp drop recorded in 2010–2012. Factors impacting survival included destruction of nests, cutting and thinning of nest trees, egg collection for medicinal purposes, hunting chicks and adult birds for meat, collision with vehicles and trains while feeding on carcasses on roads and railway tracks, and deliberate poisoning of carcasses with pesticides and insecticides to kill carnivores. To ensure the long-term conservation of vultures in wild in Assam, we propose awareness campaigns among local communities to protect nests, nestlings, and nesting trees. We also suggest the use safer drugs in veterinary medicine instead of diclofenac and other NSAIDs with similar properties, and avoidance of poisoning carcasses likely to be consumed by vultures.

Rapid Brood Reduction and Failures Caused by the Massive Outbreak of an Ectoparasite in an Arctic-Nesting Bird

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Because the emergence of arthropods is closely linked to temperature, arthropods are expected to be among the first to respond to the warming of the Arctic. This response can be in the form of an earlier emergence, an increased abundance, or a range shift. Since the emergence of arthropods can be episodic, and detection usually requires intensive monitoring, the impacts of ectoparasites such as black flies (Diptera: Simuliidae) on wild animals are poorly documented. Here we document the first observations of partial and complete brood losses resulting from a massive outbreak of black flies in a population of Arctic-nesting Peregrine Falcons (*Falco peregrinus tundrius*) breeding on the west coast of the Hudson Bay near Rankin Inlet, Nunavut. On 20 July 2013, motion-sensitive cameras positioned at nest sites recorded the rapid death of 13 nestlings at six nest sites, likely as a result of a combination of body fluids lost to, and enhanced energetic expenditure attributable to, harassment by black flies. Mortalities occurred within a few hours following the beginning of the infestation. Nine additional weekly monitored nest sites without cameras also experienced the loss of a least one young on or around 20 July, which is likely related to the cumulative effects of black flies. This event may be the result of a range shift, local increase in the abundance of this ectoparasite due to improved environmental conditions, or simply the result

of a normal but rare outbreak in our study area. Regardless, to our knowledge this is the first documentation of infestation by black flies in birds nesting in the Canadian Arctic. Indirect effects of climate changes on arctic wildlife, through direct effects on terrestrial arthropods, deserve further investigation.

The Keratin Killers: An Analysis of Feather Degrading Bacteria on Idaho Raptors

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Feather-degrading bacteria (FDB) degrade the β-keratin matrix of bird feathers. This bacteria damages functions that rely on feather integrity including flight, thermoregulation, and mate attraction. Prevalence of FDB can be greater in ground foraging birds when compared to aerial insectivores and bark-probers, which may be related to the soil-dwelling nature of FDB (Burtt and Ichida 1999). Burrowing Owls (*Athene cunicularia*) nest underground in burrows dug by fossorial mammals and spend substantial time on the ground exposed to soil. Thus, we hypothesized they would be especially susceptible to FDB. We compared the prevalence and intensity (load) of FDB in Burrowing Owls to other birds of prey that nest in tree cavities or other above-ground situations. We used Q-swabs to sample feathers and collected feathers to evaluate FDB through swabbing and full feather hydrolysis. Samples were plated on feather meal agar, a media that selects for keratinase activity, from which we quantified colony-forming units. Individual colonies were sequenced and speciated. We also conducted qPCR using 16S and keratinase-specific primers to determine the ratio between FDB and total bacteria load for each species. We found that female Burrowing Owls had significantly higher loads of FDB than males, possibly related to increased soil contact and decreased UV exposure from spending proportionately more time in the burrow. Nestlings had significantly lower levels of FDB than adults, which potentially points to migration as one source of FDB. Furthermore, FDB differed significantly among the species of Idaho raptors we sampled. On average, raptors nesting underground or in tree cavities had significantly more FDB than open-air nesters. This difference could be related to increased UV exposure for open-air nestlings. Further research should determine if behavioral or other traits have evolved in raptors to fight feather-degrading bacteria.

Diet of American Kestrels (*Falco sparverius*) During Breeding Season in a Vernal Pool and Grassland Habitat

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The diet of American Kestrels varies depending on habitat and prey availability. The Vernal Pool and Grassland Reserve located in Merced, CA, is a unique environment that offers a multitude of potential prey sources for American Kestrels. We examined kestrel pellets and nest box contents to determine the dietary composition of the reserve population and followed the variations in their diets from spring to early summer. We found the dietary composition of kestrels varied substantially among individuals and over time. We estimated our preliminary diet assignments based on the weight and number of animal remains in pellets. For the entire breeding season, arthropod prey comprised 60.0% of the population diet, avian prey 31.1%, and mammalian prey 8.7%. In March, however, pellets indicated that the diet of the entire population (12 occupied nest boxes) consisted primarily of mammalian prey at 57.7% and arthropods at 43.3%. In June, the diet majority consisted of arthropods at 85.9%, with order Orthoptera making up 68.2% of the total population diet. The large breadth in dietary composition reflects the environmental conditions at the Vernal Pool and Grassland Reserve. For example, changes in diet could be attributable to rising temperatures through the summer, which decreases the availability of mammalian prey and increases arthropod abundance. Lastly, variation in diet among individual kestrels from nest boxes could indicate that location of nest boxes might impact feeding behavior of individuals hence influencing the bird's diet composition. We are beginning a full study of the stable isotope compositions of kestrel diets to confirm incorporation of prey items into feather tissue. Our work will further define American Kestrel diet, which is necessary to fully understand prey preference and the role of location in diet composition of individuals.

On the Move: Extralimital Observations of the Crested Caracara (*Caracara cheriway*) in North America

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In the U.S., the Crested Caracara is typically found in Florida, Texas, and Arizona. During the last two decades, this species has been observed over a broader geographic area throughout northern North America including the west coast states of California, Oregon, Washington, and the Province of British Columbia, and in several east coast states including Virginia, Delaware, New Jersey, Maine, and the Province of Nova Scotia. We compiled all records since 1995 of the Crested Caracara in the U.S. outside of Florida, Texas, and Arizona. While many caracaras observed outside the species' typical range have been younger birds, adults in definitive basic plumage have also been recorded. Observations often are of single individuals, which is somewhat unusual for this generally social species. Linking these observations to place revealed that several sites, including some National Wildlife Refuges, have been used by caracaras over

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multiple years. In July 2015, we tagged a caracara in Arkansas with a GPS/GSM transmitter. This bird was the first record of the species in this state. Since then this caracara has traveled north in the state and is regularly found in farm fields and pastures. Previous research in Florida indicates that caracaras there are relatively sedentary and do not migrate, and no banding records exist from outside the state. Caracara populations in Texas and Arizona have not been studied, but population increases in these states may be one possible explanation for this increasing pattern of vagrancy. Other hypotheses include loss of habitat in many areas throughout the species' North American range, or climate change.

Does Being 'Bugged' Cause Stress and Alter Behavior in Burrowing Owls?

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Western Burrowing Owls (*Athene cunicularia hypugaea*) are small, ground-dwelling owls of western North America that frequent prairie dog (*Cynomys species*) towns and other grasslands. As the owls rely on rodent prey and occupy burrows once or concurrently inhabited by fossorial mammals, the owls can often harbor fleas. One predominant species of flea infesting Burrowing Owls is *Pulex irritans* (Family Pulicidae), the so-called human flea. Recent molecular analyses confirm that *Pulex irritans* obtains blood meals from the Burrowing Owls they infest rather than simply using owls as a phoretic host. Ectoparasites of birds, such as fleas, sometimes cause behavioral and physiological changes, including increased preening, lower hematocrit, higher corticosterone, and higher heterophil/lymphocyte (H/L) ratios. Our objective was to examine the potential role of fleas on Burrowing Owls in altering their preening behavior and stress physiology. We examined wild Burrowing Owls nesting in the Morley Nelson Snake River Birds of Prey National Conservation Area in southern Idaho, where Burrowing Owls are frequently infested with fleas. We indexed flea abundance at Burrowing Owl nests, captured and bled nestlings and used motion-activated infrared trail cameras placed near nests to recorded owl behavior. Using trail camera data collected in 2014–2015, we calculated behavioral time budgets for owls at flea-infested and non-infested nests. With blood collected from adult and nestling Burrowing Owls in 2015, we determined hematocrit, plasma corticosterone levels, and H/L ratios and examined them in relation to their flea load. We found no significant relationship between flea index and hematocrit, corticosterone or H/L ratios. However, the proportion of birds preening and the location of the body being preening varied in relation to flea index. Nestlings with a high flea index preened significantly more on their abdomen and breast not on their tail and flight feathers.

The Breeding Biology of the Hook-Billed Kite (*Chondrohierax uncinatus*) in Belize: Triple Brooding

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The Hook-Billed Kite is an uncommon species across a wide distribution from southern Texas to northern Argentina. It remains enigmatic and little studied species, particularly its breeding biology. Its population trend appears to be decreasing, but due to its large distribution, the species is listed as Least Concern by the IUCN. Over a three year period, 2012–2014, we made observations of six nests from a presumed same pair in the Cayo District of Belize to better understand the breeding biology of the species and to potentially solve the mystery of why the northern population is migratory. Two nests were studied in 2012, one nest in 2013, and three nests in 2014. In 2012, one young fledged from the first nest and two young of near fledgling age were observed in the second nest, but fledging was not observed. In 2013, two young successfully fledged, but we suspect that this was a second nest this year. In 2014, we documented three different nests from the presumed same pair, which successfully fledged five young from all three nests. This represents the first observation of a triple brooding for Hook-Billed Kites, which has only been documented in a few raptor species and is usually due to failure of a prior nest, though not in this case. High productivity in certain years may be a response to increased snail detectability and abundance, but further research is needed. Prey at these nests was 100% snails of two species, *Orthalicus princeps* and a smaller unknown snail species. *O. princeps* represented 99% of the diet at all nests. These kites have a very specialized diet leading to high vulnerability of being impacted by human activities, such as climate change, habitat degradation or pollution.

Sagebrush Steppe Management for Greater Sage-Grouse: An Umbrella Approach for Conserving Golden Eagles?

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We evaluated habitat protection and restoration plans for Greater Sage-Grouse (*Centrocercus urophasianus*) and their potential effects to Golden Eagles (*Aquila chrysaetos*), and their prey communities. Sagebrush steppe habitats cover approximately 165 million acres across the western U.S. and Canada. Several environmental pressures threaten sagebrush steppe landscapes, creating a loss and degradation of these habitats and the resources provided to the associated wildlife, including Greater Sage-Grouse, Golden Eagles and Golden Eagle prey species. However, unprecedented conservation efforts are underway across the West to reduce threats to Greater Sage-Grouse and the ecosystems on which they depend. Recent efforts were accelerated by the determination that Greater Sage-Grouse warrant protection under the Endangered Species Act on March 2010. Since then, federal agencies, states, and stakeholders have initiated efforts to address known threats to Greater Sage-Grouse, such as fire and establishment of invasive plant species, resource extraction, and urbanization on Federal and non-federal lands. As part of this effort, the Bureau of Land Management, in cooperation with the Forest Service and their collaborating partners, recently finalized a series of Environmental Impact Statements to incorporate conservation measures for Greater Sage-Grouse into federal land use plans. In addition to large-scale measures such as protection from fire and invasive plants, Greater Sage-Grouse habitat objectives incorporate fine scale attributes important to key Golden Eagle prey, including sage, grassland, and wetland habitat mosaics that should act to increase prey diversity. Previous research suggests a positive correlation between Greater Sage-Grouse lek counts and abundance of cottontails (*Sylvilagus* sp.), a key prey species. Although no one species can completely represent another in terms of habitat needs, with the amount of funding and resources devoted to Greater Sage-Grouse conservation, this species likely serves as a useful 'umbrella species' for conserving Golden Eagles in this landscape.

Habitat Loss Due to a Vertical Avoidance of Wind Farms: Preliminary Results of a Study on Saker Falcons' (*Falco cherrug*) Habitat Use in Relation to Wind Farms

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Numerous studies indicate soaring migratory birds tend to avoid wind farms, or if not, to be at risk of collision. Fewer studies, however, focus on habitat use of local breeding birds in relation to wind farm developments. In our study, forty-three Saker Falcons (mostly adult males) were satellite-tracked in existing, developing, and planned wind farm areas in Hungary. Some of the devices were capable of recording GPS coordinates and altitude as frequently as every 5 min. Results confirmed that falcon eyries were stable across years and individuals, with adult males replacing previous males in long-occupied eyries. Size of the territory and important feeding areas varied between years probably due to prey abundance. Saker Falcons usually avoided wind farms, unless transmission line pylons (attractive perch sites in the lowland area), were located among the wind turbines. Flight altitude data (far from, in moderate distance, and near) the wind turbines suggested that falcon's mean flight altitude was significantly higher in close range (< 100 m) the turbines (vertical avoidance). Considering the standard deviation however, the lower part of the data range was still within the rotor-swept zone. Spatial structure of wind farms also had an impact. Saker Falcons more noticeably avoided the large wind farms with densely deployed turbines organized in grid, compared to smaller wind farms with fewer more widely-spaced turbines in a single row or several rows. Our study suggests that habitat loss due to wind farm development is a bigger threat for Saker Falcons than collision with turbines.

Consequences of Timing: How Does Synchronization between Brood Rearing and Prey Abundance Affect American Kestrel (*Falco sparverius*) Reproduction?

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Over the past 24 yrs, mean winter temperatures have increased in southwestern Idaho, but mean spring temperatures have remained unchanged. During this time, American Kestrels have advanced their nesting period by about 11 d. Changes in nesting phenology may affect the synchronization between breeding and seasonal changes in prey abundance, and could ultimately influence reproductive outcomes. We hypothesized that the degree of synchronization affects kestrel reproduction, and we predicted that nesting events that are synchronized with peak prey abundance would produce young in better condition than asynchronous nests. To calculate kestrel growth rates and condition, we used morphological measurements of nestlings gathered since 2008 from a sample area containing ≈ 120 nest boxes. We calculated an index of synchrony for each nest based on the clutch initiation date and annual patterns of Normalized Difference Vegetation Index (NDVI), a predictor of prey abundance. We then used the index of synchrony to predict the growth of nestlings. Our results show that most kestrel nests over the past 7 yr (2008–2015, excluding 2012) are synchronized with NDVI. The advancement in nesting phenology and high degree of synchrony could perhaps be a result of earlier spring emergence. Future studies are needed to address this possibility. Some nests, were significantly later than peak NDVI (prey abundance). The broods reared by later breeding birds fledged young that weighed less compared to fledglings from synchronized broods. Because lighter fledglings are likely to have higher mortality rates, our findings have important implications for the reproductive success of other species with a mismatch between reproduction and prey abundance.

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Non-Eagle Use of Active and Inactive Golden Eagle (*Aquila chyrsaetos*) Nest Sites: New Insights Gained through Digital Trail Camera Monitoring

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Traditionally, observations of non-target species are obtained sporadically after long hours of direct observation of nest sites. However, recent advances in digital trail camera technology provide a reliable and cost effective means of long-term intensive non-invasive monitoring, allowing for the observation of rare, difficult to observe, or infrequent events. Herein we present preliminary data and observations regarding the biotic community inhabiting active and inactive Golden Eagle nest sites in the Mojave Desert ecoregion of southern Nevada and California. We placed digital trail cameras in 28 historically active Golden Eagle territories during 2014 and 2015 in an effort to monitor food habits, nest success and other behaviors. We theorized that Golden Eagle and other raptor nest sites constituted concentrations of resources and sites of increased biotic diversity. We observed over 20 non-target avian and mammalian species, including ringtail (*Bassariscus astutus*), woodrat (*Neotoma* species), bobcat (*Lynx rufus*), Great Horned Owl (*Bubo virginianus*), Prairie Falcon (*Falco mexicanus*), American Kestrel (*Falco sparverius*), and Common Raven (*Corvus corax*) entering nest sites of Golden Eagles. Behaviors observed in non-target species included courtship, provisioning of fledged young, foraging, and kleptoparasitism by mammalian and avian scavengers.

Nationwide Blood Lead Levels of North American Golden Eagles

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Lead is prevalent in the environment, especially in association with human activity. Despite increased regulation on the use of lead in consumer and industrial products, lead poisoning persists as one of the nation's highest profile wildlife health issues. Lead poisoning is particularly problematic for avian scavengers, including Golden Eagles (*Aquila chrysaetos*), who ingest lead in offal, carcasses, and wounded game animals. To assess nationwide patterns of lead exposure, we captured and tested ≥ 300 free-flying individual Golden Eagles from across North America. Our research goals were to examine spatial, temporal, and age related patterns in lead exposure and to identify the specific mechanisms of this exposure through lead isotope analysis. Blood lead levels of Golden Eagles in North America differed by region, season, and age class, and lead isotope composition also varied regionally. These patterns suggest that lead poisoning may not affect all avian scavengers equally, and that pathways of exposure may differ in complex and unexpected manners. The prevalence of lead in Golden Eagles identifies potential opportunities for improved management of anthropogenic lead sources, and its impacts to wildlife and humans, in North America.

Modeling Raptor Migration Habitat in the Western U.S.: A MaxEnt Approach

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Migrating raptors often utilize ridges as movement corridors due to the orographic uplift generated as winds are funneled across ridges. Ridgelines with significant wind resources are also valuable locations for wind energy development, where turbines may kill significant numbers of migratory birds. Migration monitoring networks, such as the one operated by HawkWatch International, Inc (HWI), function as large-scale measures of the health of raptor populations. Better understanding of the characteristics of ridgelines that increase their value for migrating raptors may improve our ability to identify areas of conflict between wildlife and future wind development, as well as better focus continuing migration monitoring efforts. Using maximum entropy estimation, we created a predictive model of ridgeline selection by raptors during fall migration throughout the western U.S. HWI's long-term migration monitoring sites, and other exploratory and historic migration observation sites with sufficient volume of raptors observed during fall migration were modeled with MaxEnt against topographic and environmental characteristics. MaxEnt modeling is a machine-learning based approach for modeling species habitat distributions based on presence-only data. Ridge prominence was the most significant contributor to the model, with higher ridges more likely to be used for migration. Isolation from other ridges to the east and west also increased the value of potential migration sites, as did connectivity with ridges to the north and south. Finally, north-south oriented ridges were of greater value to migrating raptors, likely due to their interception of westerly winds. We highlight results of the model within Utah, outlining potential raptor corridors and preliminary results from exploratory 2015 fall surveys in Utah.

Introducing the Utah Eagle Working Group

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The Utah Eagle Working Group (UEWG) was formed in January 2014 to address Utah-specific concerns regarding Bald (*Haliaeetus leucocephalus*) and Golden Eagles (*Aquila chrysaetos*). During its short history, the UEWG has amassed 35 members from state and federal agencies, non-governmental organizations, energy industry, tribes, and other eagle-related interests. The group meets three times per year, with individual members and sub-groups pursuing action items between meetings. Thus far, the group has completed or made considerable progress on the following UEWG objectives: 1) compilation of a statewide raptor database containing nest histories and territory associations (e.g., > 3,000 unique Golden Eagle nest site records, 2) compilation of a statewide eagle mortality database with an emphasis on road strikes (e.g., ~25 reported eagle road strikes per year in southern Utah alone), 3) adaptation of an existing roadkill reporting phone app to capture eagle road strike data 4), production and distribution of an informational "tri-fold" on Utah's Bald and Golden Eagles, 5) creation of management plans for Utah's limited number of Bald Eagle nest and roost sites, and 6) distribution of information to the public on an unprecedented winter die-off of > 54 Bald Eagles from West Nile Virus during November and December of 2014. In addition to these objectives and accomplishments, the UEWG interfaces with the US Fish and Wildlife Service Western Golden Eagle Conservation Team (WGET) and provides data and feedback to WGET's west-wide Golden Eagle nest modeling efforts. We provide information on Utah's historic and current eagle monitoring programs, and Golden Eagle population concerns as they relate to habitat change and anthropogenic features.

Nest-Camera Installation Near Urban Tree Nesting Red-tailed Hawks (*Buteo jamaicensis*) and one Golden Eagle (*Aquila chrysaetos*)

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We installed nest cameras near the nests of 24 Red-tailed Hawks, and one Golden Eagle, in the Reno, Nevada urban area during the 2015 breeding season as part of breeding ecology and parental behavior studies. We present the successes and failures of the installations from a methodological perspective. Cameras used for Red-tailed Hawks (Moultrie M-550s) were affixed to a 3 m long, 2.5 cm wide metal pole to position cameras in cases where nests were inaccessible. The cameras took photos once per minute from 06:00–11:00 H from four–eight days after hatch, until fledging. Photos were 4-megapixel resolution and proved sufficient to document prey items, usually to the species level, and plumage patterns in both adults. The camera used for the Golden Eagle nest (Browning BTC-6HD) was screwed into a large branch just above the nest. Photos were 8-megapixel resolution for 24 hours per day, with "low" motion sensitivity selected. Prey items were more easily identifiable with the increased resolution; yet, federal ID and color band numbers proved nearly impossible to discern. Temperature readings via camera revealed a canopy temperature relatively stable between 10–27 C°. The angles for all cameras relative to the sun had little effect on whether or not photos were useful. One camera's lens was sliced open early in its deployment yielding no useful data, one Red-tailed Hawk nest failed (we believe because of the camera presence), and one camera's position was altered by hawks perching atop it. We further describe the logistical constraints, if and how we amended our protocol to account for these constraints, comparison of cameras used, and our recommendations for future nest camera installations based on different data needs.

Human Disturbance and Golden Eagle Populations: Investigating the Effects of Recreation and Eagle Tolerance Using Individual-Based Models

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Population-level consequences of non-lethal threats, like human disturbance, can be difficult to quantify. We used results from a behavioral and demographic study of Golden Eagles (*Aquila chrysaetos*) in the Owyhee Front, Idaho to develop a spatially-explicit individual-based model of Golden Eagles nesting in an area with different forms of recreation. In the model, breeding behavior of female and male eagles was affected by interactions with their environment (volume of motorized and non-motorized recreation), interactions with other eagles, and individual tolerance to disturbance. Population dynamics, like territory occupancy, population size and growth, and time to extinction, emerged from eagle behaviors. We simulated eagle population dynamics in the absence of recreation, with 2014 levels of recreation, and with annual increases in recreation volume. We also tested whether tolerance to disturbance, through habituation or inherited individual variation, would lessen the effects of recreation on eagle populations. In the presence of recreation, eagle populations had lower and more variable territory occupancy, growth rates, and population sizes compared

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to the absence of recreation. Annual increases in recreation of 1-2%, greatly exacerbated population declines. Finally, we determined that while tolerance to human activity may act to buffer eagle populations from detrimental effects of disturbance, the habituation or adaptation of eagles to disturbance is unlikely to keep pace with increasing human presence in wild areas. These results show that human disturbance can have population-level impacts on eagles, and suggest management strategies should be implemented to decrease the volume of recreation near nesting eagles. Also, results illustrate the usefulness of individual-based models for evaluating non-lethal threats, forecasting population changes, and assessing alternative management strategies.

Power Poles, Platforms, and Snags: The Habitat Suitability and Breeding Success of Ospreys (*Pandion haliaetus*) in West-Central Idaho

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Ospreys are fish-eating, top predators of aquatic ecosystems, are adapted to human landscapes, and can serve as sentinel species for monitoring environmental contaminants and ecosystem health. Ospreys have been a focal point of conservation and study since their extensive decline from 1950–1970. While the majority of populations in the U.S. have recovered, breeding densities in many areas are variable; with several areas unoccupied despite the apparent existence of high quality habitat. Distance to human disturbance, prey abundance, water quality and characteristics, distance to other raptor nests, and land use and land cover (LULC) are known to affect Osprey nesting success. In light of increasing human encroachment on Osprey breeding habitat in Long Valley, Idaho, we set out to evaluate relationships among nest site characteristics and Osprey nesting success. We used multivariate generalized linear models with model selection procedures to evaluate the relative importance of LULC and nest site characteristics on Osprey nesting success. Our results suggest a correlation between higher percentages of shrub/grassland and agricultural cover and reduced osprey nesting success. Agricultural and shrub/grassland land cover classes were found to include lands featuring current or past cattle grazing activity. Our results support previous studies reporting correlations among cattle grazing and reduced nesting success of fishing birds. We suggest further studies over additional breeding seasons, and experimental approaches, are needed to isolate and assess potential mechanisms associated with reduced Osprey nesting success on grazing lands.

Family Morph Matters: Factors Determining Survival and Recruitment in a Long-lived Polymorphic Raptor

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From an evolutionary perspective, recruitment to breeding represents one of the most important life history stages that ultimately determine effective population size. To contribute to the next generation, offspring must survive to sexual maturity, secure a territory and find a mate. We explore factors influencing offspring survival and recruitment into the breeding population in a long-lived urban raptor, the Black Sparrowhawk (*Accipiter melanoleucus*). Adults show discrete color polymorphism (dark and light), and in South Africa morphs are distributed clinally with the highest proportion of dark morphs (c.75%) present in Cape Town. Parental morph was associated with survival and recruitment, with young produced by pairs of contrasting morphs having higher survival rates compared with young fledged from like-pairs. The association between recruitment and morph was more complex, with an interaction between male morph and breeding time, whereby recruitment of offspring from dark morph fathers was more likely when fledging earlier in the season. The opposite relationship was found for light morph fathers, whereby their offspring were more likely to be recruited when fledging later in the season. This interaction may be due to differential morph-specific hunting success of fathers, linked to background matching in different weather conditions. Dark morph males may hunt more successfully in rainier and cloudier conditions which occur more frequently earlier in the breeding season, and light morph males may be more successful later on, when weather conditions are increasingly lighter and drier. Our results reveal a complex situation, revealing morph-specific benefits dependent on the timing of breeding. These empirical data are among the first to support the idea that differential fitness consequence of morph combination may explain balanced polymorphism in a vertebrate population.

Northern Pygmy Owl (*Glaucidium gnoma*) Distribution and Status in Alberta

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We investigated Northern Pygmy Owl distribution and status in Alberta using records (1915–2015) from the literature, museum and zoo specimens, nest cards, bird surveys, volunteer raptor banders, and naturalists. Northern Pygmy Owls were distributed throughout much of the boreal forest, foothill, and mountain ecoregions of Alberta. Owls were associated with older mixed wood forests, which contain cover and nesting habitat (older

trembling aspen trees), that had natural or anthropogenic openings nearby, presumably facilitating hunting. According to Alberta Sustainable Resource Development, the Northern Pygmy Owl is listed as Sensitive (not at risk of extinction or extirpation) but it may require special attention or protection to prevent it from becoming at risk. Our findings support this. The Northern Pygmy Owl, originally found in the mountains and foothills is expanding its range eastwards across the boreal forest, and we present maps showing its range expansion. Although range expansion is ongoing we have insufficient long-term monitoring data to determine population trends, though monitoring data indicate populations remain stable in the foothills ecoregion.

Satellite Telemetry of a Peregrine Falcon (*Falco peregrinus*) at Vandenberg Air Force Base (VAFB), Santa Barbara County, California

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Peregrine Falcons are a managed species for the protection of the Western Snowy Plover (*Charadrius nivosus nivosus*) and the California Least Tern (*Sternula antillarum browni*) throughout California. Vandenberg Air Force Base (VAFB) has a 0.24 km2 tern colony and 22.2 km of sandy beach plover habitat stretched over 33.8 km of coastline. Since 2000, VAFB has adopted a non-lethal Ecosystem Based Management Program for raptors. As a known predator of plovers and terns, Peregrine Falcons are monitored and marked with color-anodized alphanumeric Visual Identification bands. Peregrine pairs nesting on VAFB have increased from one in the 1990s to three by 2011, resulting in more frequent sightings and the recovery of plover leg bands from one eyrie (Lion's Head). Despite known predation of plovers by the pair in Lion's Head, plover productivity at VAFB has been higher than prior to their arrival. Since plover productivity has been increasing towards recovery goals, we attached a 22-g solar backpack transmitter to the Lion's Head female Peregrine in lieu of capture and translocation. Utilization Distribution for the first 12 mo period were calculated based on a 95% Isopleth. The banded Peregrine visited every plover beach at VAFB, but showed a stronger affinity for the coastal terrace and rocky shores just north of her eyrie, routinely visited other Peregrine territories to the south, and it made at least one trip to those on Santa Rosa Island perching within 1 km of her mate's natal site.

Documenting an Emerging Population of Ferruginous Hawks (*Buteo regalis*) in Northern California

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Historical and recent breeding records of Ferruginous Hawks in California are too sparse and insufficient to suggest the presence of breeding populations. Since 2002, field surveys in northern California indicated successful breeding attempts. In 2012, we located three occupied nests in Butte Valley, California, an area that has been routinely surveyed for breeding raptors for over 30 years. From 2013–2015, six occupied territories have been monitored annually. Since 2013, 37 fledglings have been produced, averaging 2.1 chicks per nesting attempt. Banding efforts have involved nestlings only, but have produced two band encounters to date. The high density of raptors and long term monitoring of breeding Swainson's Hawks (*Buteo swainsoni*) in this area provide historical references detailing spatial and temporal interspecies interactions. As an emerging population with unknown dispersal behavior and wintering habits, we deployed a GSM transmitter on one female fledgling. This individual did not overwinter in California, and a year of movement data shows little fidelity to its natal area.

Intruders in the Home: Characteristics of Burrowing Owl Behavioral Responses and Alarm Vocalizations in Response to Avian and Mammalian Nest Predators

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Ground nesting birds are especially vulnerable to nest predators. Thus, natural selection has likely shaped behavior in such species to enhance their ability to escape detection or to defend their nests once detected. Burrowing Owls (*Athene cunicularia*) nest beneath the ground in abandoned mammal burrows, so nest predation often determines their reproductive success. Burrowing Owls defend nests by altering their posture, flight, aggression, and vocal displays, including uttering alarm calls. Both ground dwelling and aerial predators prey on Burrowing

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Owl nests. These include coyotes (*Canis latrans*), American badgers (*Taxidea taxus*), Great Horned Owls (*Bubo virginianus*) and Common Ravens (*Corvus corax*). We considered coyotes and badgers the most dangerous and virulent nest predators because they have the capacity to plunder entire nests, including adults, whereas Common Ravens kill only young nestlings at nests. To understand Burrowing Owl nest defense behavior, we conducted a field experiment by exposing Burrowing Owls to models of predator species, which varied in size, virulence, and mode of attack. We determined approach distance, and the number of hovers, strikes, and vocalizations uttered by owls in response to the predator and control stimuli. Additionally, we examined characteristics of alarm calls (bout duration, notes per bout, frequency at maximum amplitude, inter-note interval, and note duration). We found that behavioral responses of Burrowing Owls and characteristics of their alarm vocalizations differed by predator type in that the most intense responses were exhibited in the presence of more virulent predators.

Impacts of 2014 Wildfires on Reproductive Performance of Nesting Golden Eagles in North-Central Washington

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Wildfires can alter habitat of raptors and result in short and long-term reductions in presence, territory occupancy and success, and survival. Impacts of wildfires on Golden Eagles (*Aquila chrysaetos*) have been little-studied except in the Snake River Plain of Idaho where eagles nest exclusively on cliffs in shrub-steppe habitat. In summer 2014, several forest fires converged in north-central Washington in the Carlton-complex fire that burned 1,035 km2 of lower montane habitat. In spring 2015, we studied 17 Golden Eagle territories within the fire boundary to document post-burn habitat conditions, occupancy, and nest success. All eagle territories we visited 7 months after the fire showed evidence of an intense burn. Zones < 500 m from nests on 10 of 17 territories (59%) had totally burned understories, moderate to extensive evidence of ground erosion, and completely or nearly-completely burned conifer stands. Burn intensity on remaining territories had a mosaic pattern. Only one nest tree on six territories (17%) where eagles nested in trees was destroyed by fire, and these eagles built a new tree nest. Nests on three of nine (33%) territories where eagles nested on cliffs were burned. There was no difference in the number of occupied Golden Eagle territories in control areas (n = 14) versus fire-damaged areas (n = 12; P = 0.686), and we did not identify any shifts in eagle use to adjacent areas or new territories. The number of successful territories in control areas (n = 6) was not different from success in fire-damaged areas n = 2; P = 0.225). We found that Golden Eagles were resilient nesters despite expected significant impacts on initial post-burn nesting performance. A follow up evaluation of reproduction performance would provide information on territory attrition or range shifts during a period of prey recovery.

The Influence of Habitat Characteristics and Nest Box Design on Barn Owl (*Tyto alba*) Nest Box Occupancy in a Vineyard Ecosystem

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Barn Owls provide valuable rodent pest removal services in agricultural systems worldwide, including rice paddies, oil palm plantations, row crops and orchards. For decades, viticulturists have erected nest boxes in vineyards to attract Barn Owls, but ecologists have never studied how surrounding habitat characteristics and nest box design influence occupancy. Placing nest boxes in optimal sites benefits farmers and Barn Owls by increasing rodent pest removal rates and providing increased nesting habitat. The aim of this research was to understand how nest box placement and design influences occupancy. We sampled 297 nest boxes in Napa Valley, California during the spring breeding season of 2015. Nest boxes were distributed on vineyards that varied in surrounding vegetation type, urban density, tree density, vineyard age and size, and percent uncultivated land. Vineyards were managed as organic, sustainable, or conventional. Nest boxes were constructed of plastic or wood. They were mounted on differing pole types at varying heights off the ground, with the entrances facing all cardinal directions. Barn Owls bred in 92 of the nest boxes. Nest boxes near grassland and oak savanna habitat were more likely to be occupied than boxes near oak scrub or riparian areas. There was a higher proportion of occupied nest boxes on organic farms. Wooden nest boxes were preferred over plastic. We conclude that habitat type and nest box design greatly influence Barn Owl nest box occupancy in Napa Valley vineyards. We suggest that viticulturists place wooden nest boxes in vineyards near grassland or oak savanna habitats to increase occupancy.

Nesting and Reproductive Success of Red-tailed Hawks (*Buteo jamaicensis*) Across an Urban Gradient in the Great Basin, U.S.A.

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Urban-raptor studies in the U.S. have well documented various aspects of breeding ecology in urban versus rural or among urban classifications (i.e. suburban, urban) for Red-tailed Hawks, but less

often have these traits been monitored along an urban gradient or measured beyond broad population density estimates. Our objective was to identify patterns of nesting and reproductive success along an urban gradient measuring urban density characteristics at the five-m2 pixel resolution. We observed an 82.3% nesting success rate among 62 Red-tailed Hawk nests. Our nesting success rate was consistent with other national averages in various habitats (80% and 83%). Eight nests failed during incubation because of human construction (one), wind (two), Great Horned Owl displacement (three), and unknown causes (two). Two nests were abandoned post-hatch (causes unknown) and one nest failed presumably because chicks fell out one by one between eight and 30 days after hatch. Of 129 documented chicks, 124 reached fledging age; though, two nests that failed post-hatch had unknown chick counts. We recorded egg counts for 20 of the nests resulting in 71 eggs, 10 of which did not hatch and were left in the nest. Three nests were constructed on human-built structures with five of the eight chicks surviving. Initial results did not reveal a strong effect of urban density.

Do Urban Red-tailed Hawks (*Buteo jamaicensis*) Depredate Domestic Animals for Nestling Consumption in Reno-Sparks, Nevada?

***JUSTIN H. WHITE** (justinwhite@unr.edu), BONNIE LARUE WOOD, SCOTT D. BASSETT, and JEREMY M. SMITH, Department of Geography, University of Nevada, Reno, NV, U.S.A.

Raptors depredating domestic animals has been reported globally. This is especially the case in developing countries where raptors hunting chickens can be a daily or weekly occurrence, and multiple raptor species are locally called 'chicken-hawk.' In the developing world, raptors are often the subject of conflict with small game hunters, conservation initiatives, or ecological health assessments. From April–June 2015, we recorded prey deliveries to 45 successful Red-tail Hawk nests in the urban area of Reno and Sparks, Nevada. Activity at 22 nests was recorded by wildlife cameras capturing one photo per minute from 06:00–11:00 (totaling ~248,000 photos) and the remaining nests were observed by field researchers from 06:30–08:30 and 09:00–11:00. Nests were watched once per seven-day period beginning 3 days after hatch. Where possible, plucking sites were identified and observed. We identified prey items fed to nestlings from 12 species in three classes. We observed no conclusive evidence of domestic livestock or pets being delivered to the nest. While it remains unknown whether hawks observed in our study consumed domestic prey away from the nest or whether hawks hunt domestic animals during the winter months, our observations add to anecdotal evidence and ongoing dialogues regarding depredation of domestic animals.

The Western Golden Eagle Team: An Overview of Objectives, Strategies, Products, and Status

***GARY E. WILLIAMS** (gary_e_williams@fws.gov), and BRIAN WOODBRIDGE, US Fish and Wildlife Service, Lakewood, CO, U.S.A. KATIE POWELL, US Fish and Wildlife Service, Boise, ID, U.S.A. JESSI BROWN, University of Nevada-Reno, Reno, NV, U.S.A. TODD LICKFETT, US Fish and Wildlife Service, Lakewood, CO, U.S.A. DAVID LEAL, US Fish and Wildlife Service, Portland, OR, U.S.A. GREG BEATTY, US Fish and Wildlife Service, Phoenix, AZ, U.S.A. GEOFF BEDROSIAN, US Fish and Wildlife Service, Lakewood, CO, U.S.A. THOMAS DIETSCH, US Fish and Wildlife Service, Carlsbad, CA, U.S.A. GJON HAZARD, US Fish and Wildlife Service, Carlsbad, CA, U.S.A.

US Fish and Wildlife Service Regions 1, 2, 6, and 8 established the Western Golden Eagle Team (WGET) in June 2013 to proactively address energy-related conservation needs of Golden Eagles (*Aquila chrysaetos*) by developing landscape-scale conservation strategies. Development of conservation strategies will be informed by 1) spatially explicit predictive models of Golden Eagle distribution and habitat, including models of breeding, wintering, and migration, 2) spatially explicit assessments of threats such as lead poisoning, rodenticides, electrocution, and other concerns, and 3) information resources to support management of Golden Eagles and their prey. Together, these strategies will allow identification of important areas for, and risks to, Golden Eagles, and ways to improve their management throughout the West. Completed or near-complete WGET projects include 1) ecoregion-based models of breeding habitat throughout the West, 2) West-wide model of winter habitat, 3) West-wide analysis of Golden Eagle prey community composition and variability in space and time, 4) assessment of land management strategies for important prey species 5) a Colorado and Wyoming-wide model of electrocution hazard, and 6) a field-based model to assess and rank electrocution risk of individual power poles. Projects in progress include, 1) reviews and field assessments of contaminant levels of and contaminant sources for Golden Eagles, 2) review and field assessments of parasites and diseases, 3) telemetry-based models of migration patterns, 4) home-range, territory, and core area review, 5) population ecology review, 6) review and meta-analysis of productivity information, 7) review and expert elicitation on disturbance effects and buffer distances, 8) habitat-based population estimates, 9) "lessons learned" assessment of eagle mortalities at previously retrofitted power poles, and 10) surveys to support development, refinement and validation of habitat models. Copies of selected progress and final reports for WGET projects will be available during the poster session.

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

SPEAKER INDEX

California Ballroom Locations

Room 2/3 | Room 4 | Redwood Room

LEAD	ROOM	DATE	TIME	TYPE
Allison, T.	CA 2/3	Nov 5	3:40 pm	TALK
Allshouse, M.	CA 4	Nov 6	11:30 am	TALK
Anderson, C.	CA 2/3	Nov 5	6:00 pm	POSTER
Anderson, R.Y	RDWD	Nov 5	11:00 am	TALK
Askelson, K.	CA 2/3	Nov 5	6:00 pm	POSTER
Autilio, A.	CA 2/3	Nov 5	6:00 pm	POSTER
Barger, C.	CA 2/3	Nov 5	6:00 pm	POSTER
Barnes, J.	CA 2/3	Nov 7	2:40 pm	TALK
Bednarz, J.	CA 4	Nov 5	1:40 pm	TALK
Bedrosian, B.	CA 4	Nov 5	10:20 am	TALK
Bedrosian, B.	CA 4	Nov 6	1:40 pm	TALK
Bedrosian, B.	CA 2/3	Nov 5	6:00 pm	POSTER
Bedrosian, G.	CA 4	Nov 5	3:40 pm	TALK
Binothman, A.	RDWD	Nov 5	10:40 am	TALK
Booms, T.	CA 2/3	Nov 5	6:00 pm	POSTER
Bowerman, W.	CA 2/3	Nov 7	10:20 am	TALK
Boyce, D.	RDWD	Nov 6	4:20 pm	TALK
Brake, A.	CA 2/3	Nov 5	6:00 pm	POSTER
Brandes, D.	CA 4	Nov 6	2:40 pm	TALK
Brown, J.	CA 2/3	Nov 5	11:00 am	TALK
Brown, J.	CA 4	Nov 6	10:50 am	TALK
Buechley, E.	CA 2/3	Nov 7	10:00 am	TALK
Burnett, J.	CA 2/3	Nov 7	11:00 am	TALK
Burnett, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Caballero, I.	RDWD	Nov 5	10:20 am	TALK
Choi, C.	CA 4	Nov 6	10:10 am	TALK
Clark, W.	RDWD	Nov 6	9:00 am	TALK
Clark, W.	RDWD	Nov 6	9:20 am	TALK
Crandall, R.	CA 4	Nov 5	11:20 am	TALK
Cruz-McDonnell, K.	RDWD	Nov 6	3:40 pm	TALK
Datta, S.	CA 4	Nov 5	10:40 am	TALK
DeLong, J.	RDWD	Nov 7	4:20 pm	TALK
Di Siervi, T.	CA 2/3	Nov 5	6:00 pm	POSTER
Diller, L.	CA 4	Nov 5	11:40 am	TALK
Domenech, R.	CA 4	Nov 6	9:00 am	TALK
Domenech, R.	CA 2/3	Nov 5	6:00 pm	POSTER
Downs, C.	CA 2/3	Nov 5	2:20 pm	TALK
Dudek, B.	RDWD	Nov 7	10:00 am	TALK
Duerr, A.	CA 2/3	Nov 6	2:40 pm	TALK
Dwyer, J.	CA 2/3	Nov 6	2:00 pm	TALK
Eakle, W.	RDWD	Nov 5	3:40 pm	TALK
Eisaguirre, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Elliott, J.	CA 4	Nov 6	10:40 am	TALK
Ely, T.	CA 4	Nov 6	3:20 pm	TALK
Emmons, G.	CA 2/3	Nov 7	11:20 am	TALK
Farmer, C.	CA 2/3	Nov 6	10:20 am	TALK
Ferrer, M.	CA 2/3	Nov 6	10:40 am	TALK
Fields, L.	CA 4	Nov 6	8:20 am	TALK
Franke, A.	CA 4	Nov 6	3:40 pm	TALK

LEAD	ROOM	DATE	TIME	TYPE
Franke, A.	RDWD	Nov 5	10:00 am	TALK
Fuentes, L.	CA 2/3	Nov 5	6:00 pm	POSTER
Galipeau, P.	CA 2/3	Nov 5	6:00 pm	POSTER
Gallardo, J.	RDWD	Nov 5	4:40 pm	TALK
Garcia-Heras, M.S.	CA 2/3	Nov 7	1:40 pm	TALK
Gosford, R.	RDWD	Nov 7	3:40 pm	TALK
Gura, K.	CA 2/3	Nov 5	6:00 pm	POSTER
Haimes, D.	CA 2/3	Nov 5	6:00 pm	POSTER
Hallingstad, E.	CA 4	Nov 6	11:00 am	TALK
Hane, M.	CA 4	Nov 6	10:20 am	TALK
Hansen, L.	CA 4	Nov 6	11:10 am	TALK
Haram, B.	CA 4	Nov 7	4:20 pm	TALK
Hardesty, J.	CA 2/3	Nov 5	4:00 pm	TALK
Harrington, K.	RDWD	Nov 7	2:40 pm	TALK
Harrison, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Hartmann, C.	CA 2/3	Nov 5	6:00 pm	POSTER
Hawkins, M.	CA 2/3	Nov 7	3:40 pm	TALK
Hayes, T.	RDWD	Nov 5	2:20 pm	TALK
Heath, J.	RDWD	Nov 6	1:40 pm	TALK
Hedlin, E.	CA 4	Nov 5	2:00 pm	TALK
Henderson, M.	CA 2/3	Nov 5	6:00 pm	POSTER
Hennessy, S.	CA 4	Nov 5	4:20 pm	TALK
Herring, G.	CA 2/3	Nov 7	2:00 pm	TALK
Herring, G.	CA 2/3	Nov 5	6:00 pm	POSTER
Heydinger, J.	CA 2/3	Nov 6	3:40 pm	TALK
Hindmarch, S.	CA 2/3	Nov 7	11:40 am	TALK
Horvath, M.	CA 2/3	Nov 6	4:40 pm	TALK
Huang, A.	CA 2/3	Nov 5	6:00 pm	POSTER
Hunt, G.	CA 2/3	Nov 6	8:20 am	TALK
Huso, M.	CA 2/3	Nov 6	11:40 am	TALK
Inselman, W.	CA 4	Nov 5	2:20 pm	TALK
Isaac, B.	CA 2/3	Nov 6	4:00 pm	TALK
Isaacs, F.	CA 4	Nov 7	1:40 pm	TALK
Jeffries, M.	CA 2/3	Nov 7	4:00 pm	TALK
Jensen, M.	CA 2/3	Nov 5	6:00 pm	POSTER
Jeter, M.	CA 2/3	Nov 6	1:40 pm	TALK
Johnson, D.	CA 4	Nov 5	2:40 pm	TALK
Johnston, N.	CA 2/3	Nov 6	9:20 am	TALK
Judkins, M.	CA 4	Nov 7	4:40 pm	TALK
Junda, J.	RDWD	Nov 6	4:00 pm	TALK
Katzner, T.	CA 2/3	Nov 6	8:40 am	TALK
Keyel, E.	CA 2/3	Nov 7	2:20 pm	TALK
Kidd, J.	CA 4	Nov 6	4:00 pm	TALK
Kidd, J.	RDWD	Nov 6	11:20 am	TALK
Kim, H.	CA 2/3	Nov 5	6:00 pm	POSTER
Kochert, M.	CA 4	Nov 5	3:20 pm	TALK
Kolar, P.	CA 2/3	Nov 6	10:00 am	TALK
Kritz, K.	CA 2/3	Nov 5	6:00 pm	POSTER
Kross, S.	RDWD	Nov 5	2:40 pm	TALK

SPEAKER INDEX

California Ballroom Locations

Room 2/3 | Room 4 | Redwood Room

LEAD	ROOM	DATE	TIME	TYPE
Kulojyoti, L.	CA 2/3	Nov 5	6:00 pm	POSTER
Kuspa, Z.	CA 4	Nov 6	11:50 am	TALK
Lahkar, K.	CA 4	Nov 7	4:00 pm	TALK
Lamarre, V.	RDWD	Nov 7	4:00 pm	TALK
Lamarre, V.	CA 2/3	Nov 5	6:00 pm	POSTER
Lenihan, C.	CA 4	Nov 7	2:00 pm	TALK
Lewis, S.	CA 4	Nov 6	2:00 pm	TALK
Lincer, J.	RDWD	Nov 6	10:00 am	TALK
Linkhart, B.	CA 4	Nov 6	4:20 pm	TALK
Macias-Duarte, A.	CA 4	Nov 6	10:30 am	TALK
Manchi, S.	RDWD	Nov 5	4:20 pm	TALK
Marks, M.	CA 2/3	Nov 5	6:00 pm	POSTER
McCabe, R.	CA 4	Nov 6	4:40 pm	TALK
McClure, C.	CA 2/3	Nov 6	4:20 pm	TALK
McDermot, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Melcer, R.	CA 4	Nov 5	10:00 am	TALK
Miller, R.	RDWD	Nov 5	11:20 am	TALK
Miller, R.	RDWD	Nov 6	11:00 am	TALK
Miller, T.	CA 4	Nov 7	10:00 am	TALK
Millsap, B.	CA 2/3	Nov 5	10:20 am	TALK
Millsap, B.	CA 2/3	Nov 5	3:20 pm	TALK
Morandini, V.	CA 2/3	Nov 6	3:20 pm	TALK
Morandini, V.	CA 4	Nov 7	2:40 pm	TALK
Morata, E.N.	RDWD	Nov 7	2:00 pm	TALK
Morrison, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Murphy, R.	CA 4	Nov 7	11:00 am	TALK
Nellis, C.	CA 2/3	Nov 5	6:00 pm	POSTER
Ng, J.	RDWD	Nov 7	10:20 am	TALK
Nygard, T.	CA 2/3	Nov 6	11:20 am	TALK
Paprocki, N.	RDWD	Nov 6	2:00 pm	TALK
Parker, P.	RDWD	Nov 5	4:00 pm	TALK
Paulson, M.	CA 4	Nov 7	10:20 am	TALK
Phillips, R.	CA 2/3	Nov 5	6:00 pm	POSTER
Poessel, S.	CA 4	Nov 7	10:40 am	TALK
Powell, K.	CA 2/3	Nov 5	6:00 pm	POSTER
Preston, C.	CA 2/3	Nov 5	11:20 am	TALK
Prommer, M.	RDWD	Nov 7	2:20 pm	TALK
Prommer, M.	CA 2/3	Nov 5	6:00 pm	POSTER
Ralston, S.	CA 2/3	Nov 6	11:00 am	TALK
Regan, T.	RDWD	Nov 7	10:40 am	TALK
Risebrough, R.	CA 4	Nov 7	3:20 pm	TALK
Robinson, B.	RDWD	Nov 6	2:40 pm	TALK
Rogers, K.	CA 2/3	Nov 7	3:20 pm	TALK
Rosebrook, S.	CA 2/3	Nov 5	6:00 pm	POSTER
Rozhon, G.	RDWD	Nov 7	11:00 am	TALK
Rus, A.	CA 4	Nov 6	2:20 pm	TALK
Salafsky, S.	RDWD	Nov 6	3:20 am	TALK
Schoenjahn, J.	RDWD	Nov 7	3:20 pm	TALK
Sein, G.	CA 4	Nov 7	11:20 am	TALK

LEAD	ROOM	DATE	TIME	TYPE
Sherrod, S.	RDWD	Nov 7	4:40 pm	TALK
Shonfield, J.	CA 2/3	Nov 6	2:20 pm	TALK
Simes, M.	CA 2/3	Nov 5	6:00 pm	POSTER
Simon, K.	CA 4	Nov 6	11:20 am	TALK
Slabe, V.	CA 2/3	Nov 5	6:00 pm	POSTER
Slater, S.	CA 4	Nov 7	2:20 pm	TALK
Slater, S.	CA 2/3	Nov 5	6:00 pm	POSTER
Smallwood, J.	RDWD	Nov 7	1:40 pm	TALK
Smallwood, S.	CA 2/3	Nov 6	9:00 am	TALK
Smith, J.	RDWD	Nov 6	11:40 am	TALK
Smith, N.	CA 4	Nov 5	11:00 am	TALK
Snook, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Spaul, R.	RDWD	Nov 7	11:20 am	TALK
Spaul, R.	CA 2/3	Nov 5	6:00 pm	POSTER
Stewart, G.	CA 4	Nov 6	8:40 am	TALK
Styhl, T.	CA 2/3	Nov 5	6:00 pm	POSTER
Sumasgutner, P.	CA 2/3	Nov 5	6:00 pm	POSTER
Sur, M.	CA 4	Nov 7	11:40 am	TALK
Swinnerton, K.	RDWD	Nov 5	1:40 pm	TALK
Tack, J.	CA 2/3	Nov 5	10:00 am	TALK
Tack, J.	CA 4	Nov 7	3:40 pm	TALK
Takats Priestley, L.	CA 4	Nov 6	9:20 am	TALK
Takats Priestley, L.	CA 2/3	Nov 5	6:00 pm	POSTER
Tate, G.	RDWD	Nov 6	8:40 am	TALK
Therrien, J.	RDWD	Nov 6	10:40 am	TALK
Thorstrom, R.	RDWD	Nov 5	2:00 pm	TALK
Titus, K.	CA 4	Nov 5	4:40 pm	TALK
Todd, N.	CA 2/3	Nov 5	6:00 pm	POSTER
Tracey, J.	CA 2/3	Nov 5	1:40 pm	TALK
Van Den Bussche, R.	CA 2/3	Nov 5	2:00 pm	TALK
van Eeden, R.	RDWD	Nov 7	11:40 am	TALK
Vennum, C.	CA 2/3	Nov 5	6:00 pm	POSTER
Vidal, A.	CA 2/3	Nov 5	6:00 pm	POSTER
Vilella, F.	RDWD	Nov 5	3:20 pm	TALK
Virani, M.	CA 4	Nov 6	11:40 am	TALK
Wallace, M.	CA 2/3	Nov 7	10:40 am	TALK
Walter, H.	CA 4	Nov 6	10:00 am	TALK
Washburn, B.	CA 2/3	Nov 7	4:20 pm	TALK
Washburn, B.	RDWD	Nov 5	11:40 am	TALK
Watson, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Weins, D.	CA 2/3	Nov 5	10:40 am	TALK
Wendt, C.	CA 2/3	Nov 5	6:00 pm	POSTER
White, J.	CA 2/3	Nov 5	6:00 pm	POSTER
Willette, M.	CA 2/3	Nov 7	4:40 pm	TALK
Williams, G.	CA 2/3	Nov 5	6:00 pm	POSTER
Winkler, K.	RDWD	Nov 6	10:20 am	TALK
Wisinski, C.	CA 4	Nov 5	4:00 pm	TALK
Wommack, E.	RDWD	Nov 6	8:20 am	TALK
Woodbridge, B.	CA 2/3	Nov 5	4:20 pm	TALK

CONFERENCE SCHEDULE

Thursday, November 5

	California Ballroom 2/3	California Ballroom 4	Redwood Room
8:00 am-9:40 am	Announcements and Plenary *Peter H. Bloom*	Announcements and Plenary *Peter H. Bloom*	
9:40 am	Break	Break	Break
	Golden Eagle Symposium I Brian Woodbridge	**Habitat** Adam Hutchins	**Population Ecology** Janet W. Ng
10:00 am	Using Predictive Models of Nesting Habitat to Inform Survey Design: An Example with Golden Eagles in the Colorado Plateau *Jason Tack*	Shifting Habitat Preferences and Migratory Strategies in a California Population of Swainson's Hawks *Ron Melcer*	Geographic Variation in Isotopic Composition of Feathers from Falconer-Harvested Peregrine Falcons *Alastair Franke*
10:20 am	Causes of Mortality of Golden Eagles in the U.S. *Brian Millsap*	Home Ranges, and Resource Selection of Great Gray Owls in Western Wyoming *Bryan Bedrosian*	Global Population Patterns and the Influence of Seasonal Migration on the Genetic Structure of Peregrine Falcons *Isabel Caballero*
10:40 am	Risk-Assessment of Renewable Energy Development to Golden Eagles in the California Desert: Insights from a Spatially Structured Population Model *David Wiens*	Ferruginous Hawk Ecology in the Northern Great Plains *Shubham Datta*	Current Status of Falcon Populations in Saudi Arabia *Albara Binothman*
11:00 am	Describing Landscape-Level Movement Patterns of Golden Eagles in North America using ARGOS and GPS Tracking Data *Jessi Brown*	Factors Affecting Landscape Level Nest Site Selection and Success of Louisiana Bald Eagle *Nickolas Smith*	Abundance and Density of Swainson's Hawks in California: a Statewide Sampling Framework for Population Monitoring *Richard Anderson*
11:20 am	Golden Eagle Diet and Productivity in Relation to Fluctuations in Primary Prey Abundance in Wyoming's Bighorn Basin *Charles Preston*	Habitat Selection and Factors Influencing Nest Survival of Golden Eagles in South-central Montana *Ross Crandall*	Short-eared Owl Surveys in the North American Intermountain West: an Innovative Approach using Citizen Science to Conduct Long-Term Monitoring *Robert Miller*
11:40 am	Panel Discussion	Owl vs. Owl: Experimental Removal Results and Implications from Managing Barred and Spotted Owls *Lowell Diller*	Long-Term Trends and Range Expansion of Breeding Osprey in Michigan *Brian Washburn*
12:00 pm-1:40 pm	Lunch	Lunch	Lunch
	Golden Eagle Symposium II Jessi Brown	**Prey and Diet I** Steve Slater	**Island Ecology Symposium I** Julio Gallardo
1:40 pm	Golden Eagles and California Condors Meet "Big Data": Scientific Visualization for High-Resolution Biotelemetry *Jeff Tracey*	Do Bald Eagles Capture Live Prey in Winter? *James Bednarz*	Conservation Status of Island Raptors and the Role of Invasive Alien Vertebrates *Kirsty Swinnerton*
2:00 pm	A Resource of Genome-Wide Single Nucleotide Plymorphisms for the Conservation and Management of Golden Eagles *Ronald Van Den Bussche*	Food, and Nestling Survival Among Peregrine Falcons Breeding in the Canadian Arctic *Erik Hedlin*	Raptor Ecology and Conservation in Madagascar *Russell Thorstrom*
2:20 pm	Integrating Ecological Immunology into Raptor Biology: Quantifying Individual Responses to Understand Population Health *Cynthia Downs*	Diet Composition and Provisioning Rates of Swainson's Hawk Nestlings in the Northern Great Plains *Will Inselman*	Conservation of the Critically-Endangered Ridgway's Hawk *Thomas Hayes*
2:40 pm	Panel Discussion	Prey Availability, Diet Selection, and Nesting Success of Golden Eagles in the Mojave Desert *Diego Johnson*	Case-study of New Zealand Falcon *Sara Kross*

CONFERENCE SCHEDULE

Thursday, November 5

	California Ballroom 2/3	California Ballroom 4	Redwood Room
3:00 pm-3:20 pm	Break	Break	Break
	Golden Eagle Symposium III Michael Collopy	**Prey and Diet II** Ross Crandall	**Island Ecology Symposium II** Kirsty Swinnerton
3:20 pm	The Devil in the Details: Conservation of Eagles Under the Eagle Non-Purposeful Take Rule *Brian Millsap*	Golden Eagle Dietary Responses to Habitat Alteration in the Morley Nelson Snake River Birds of Prey National Conservation Area, Idaho *Michael Kochert*	Status of the Endangered Puerto Rican Broad-winged Hawk: Conservation Challenges and Opportunities *Francisco Vilella*
3:40 pm	Assessing Possible Actions to Mitigate Take of Golden Eagles at Wind Energy Facilities *Taber Allison*	Spatial and Temporal Patterns in Golden Eagle Diets in Central Utah *Geoffrey Bedrosian*	Ecology and Conservation of Sanford's Sea Eagle in the Solomon Islands: a Review of the Literature *Wade Eakle*
4:00 pm	The Nature Conservancy's Development by Design Strategy: Lessons for Golden Eagle Conservation *Jeffrey Hardesty*	Western Burrowing Owl Breeding and Foraging Ecology in San Diego County, California *Colleen Wisinski*	The Galapagos Hawk: Host-Parasite Coevolution and Eradication Studies *Patricia Parker*
4:20 pm	A Conservation Planning Framework for Golden Eagles in the Western US *Brian Woodbridge*	Restoring Key Grassland Processes for Western Burrowing Owls Using Ecosystem Engineers and Vegetation Management *Sarah Hennessy*	Ecological Separation in Serpent Eagles of the Andaman Islands, India *Shirish Manchi*
4:40 pm-5:00 pm	Panel Discussion	Adult Northern Goshawk survival rates: why is moving among years better for adult females—is it food? *Kimberly Titus*	Population Estimates and Habitat Relationships of the Caribbean Red-tailed Hawk in eastern Puerto Rico *Julio Gallardo*
6:00 pm-10:00pm	Poster Reception		

Friday, November 6

	California Ballroom 2/3	California Ballroom 4	Redwood Room
8:00 am	Announcements	Announcements	
	Wind Turbine Symposium I Rick Watson	**Banding and Resighting** Matthew Hane	**Plumage** Elizabeth Wommack & Bill Clark
8:20 am	Golden Eagle Demography at Altamont Pass: An Update *Grainger Hunt*	Osprey Telemetry and Banding - Initial Data from Mono Lake — A Fishless Lake *Lisa Fields*	Examination of Effects of Ecological Differentiation on a Highly Variable Plumage Trait in the American Kestrel (*Falco sparverius*) *Elizabeth Wommack*
8:40 am	Origins of Golden Eagles Killed at Altamont Pass Wind Resource Area: Continental-Scale Environmental Consequences of Local-Scale Renewable Energy Development *Todd Katzner*	Marking and Resighting Peregrine Falcons in the Greater San Francisco Bay Area *Glenn R. Stewart*	Differential Foraging Success across a Light Level Spectrum Explains the Evolution and Spatial Structure of Color Morphs in a Polymorphic Bird *Gareth Tate*
9:00 am	Mitigation of Raptor Fatalities in the Altamont Pass Wind Resource Area, California *K. Shawn Smallwood*	Wing-tagged Encounters of Golden Eagles (*Aquila chrysaetos*) Captured in Montana *Robert Domenech*	Extreme Variation in the Tails of Harlan's Hawks *William S. Clark*

CONFERENCE SCHEDULE

Friday, November 6

	California Ballroom 2/3	California Ballroom 4	Redwood Room
9:20 am	Migrating Golden Eagles at a Mountain Top Wind Farm: Conclusions on Collision Risk from Pre- and Post-Construction Monitoring *Naira N. Johnston*	Environmental Conditions Affecting Capture Rates at Northern Saw-whet Owl (*Aegolius acadicus*) Fall Monitoring Stations in central Alberta, Results from 2002-2014 *Lisa Takats Priestley*	Remige Molt of Harris's Hawk, with Examples of Skipped Feathers *William S. Clark*
9:40 am-10:00 am	Break	Break	Break
	Wind Turbine Symposium II Todd Katzner	**Speed Talks** *(10 minutes each)* Travis Booms	**Raptors & Climate Change Symp. I** Jeff Lincer
10:00 am	Factors Influencing Wind Turbine Collisions and Indirect Effects of Wind Energy Development on Non-Eagle Raptor Species. *Patrick Kolar*	*Tyrannosaurus rex* and the Puzzling Reversed Sexual Size Dimorphism in Raptors *Hartmut Walter* Changes in Diet and Breeding Performance of Chinese Goshawks *Chang-Yong Choi*	Climate Stability, Can We/Raptors Afford To Lose It? *Jeffrey L. Lincer*
10:20 am	Post-construction Fatality Monitoring for Raptors: Balancing Cost vs Accuracy *Chris Farmer*	Use of Passive Acoustic Recordings to Examine Interactions of Northern Spotted Owls (*Strix occidentalis*) and Barred Owls (*Strix varia*) *Matthew E. Hane* Natal Dispersal of Wild Aplomado Falcons in Chihuahua, Mexico *A. Macias-Duarte*	Shifts in Migration Phenology by Raptors at Hawk Ridge, Duluth, Minnesota, U.S.A. *Gerald J. Niemi*
10:40 am	Avian Mortality in Wind Farms: The State of the Art in Spain *Miguel Ferrer*	Measurement of Mercury in Forage Fish from Mexico and Central America and Implications for Osprey and Other Fish-Eating Birds *John Elliott* Effects of Heat Stress on Golden Eagle Nest Survival Amplified by Lack of Nest Shade in Southwestern Idaho *Jessi L. Brown*	Is Migration Phenology Affected by Climate Change in Eastern North American Raptors? *J.F. Therrien*
11:00 am	Eagles and Energy: Minimizing the Impacts of a Fledging Wind Energy Industry in Africa *S. Ralston*	Can Operations Staff Effectively Monitor for Eagle Fatalities at a Wind Energy Facility? *Eric Hallingstad* Observations of Golden Eagles Breeding on a Managed Forest Landscape in Western Washington, U.S.A. *Leif Hansen*	Variable Impacts of Within-Year Weather Conditions and Among-Year Shifts in the Post-Breeding Migration Phenology of Soaring Birds at the Strait of Gibraltar *Robert A. Miller*
11:20 am	The Smøla Wind-Power Plant in Norway: Effects on White-tailed Eagle and Willow Ptarmigan, and Mitigation Efforts to Reduce Turbine-Induced Mortality *Torgeir Nygård*	Source-Sink Dynamics of Bald Eagles in Michigan's Great Lakes Ecosystem *Kendall Simon* Development and Mitigation of Raptor Habitat in Wyoming *Matthew Allshouse*	Effects of Drought and Wildland Fires on Breeding Raptors at Naval Weapons Station Seal Beach Detachment: a Twenty Year Case Study 1994-2015 *Jeff Kidd*
11:40 am	Providing Evidence of Compliance with Incidental Take Permits *Manuela Huso*	Gyps vultures in South Asia: Ten years after the ban of veterinary diclofenac – is the crash over? *Munir Z. Virani* Looking beyond mortalities: Lead exposure and stress in the California Condor (*Gymnogyps californianus*) *Zeka Kuspa*	Is Earlier Nesting by American Kestrels (*Falco sparverius*) Driven by Changes in the Timing of Spring? *Shawn H. Smith*
12:00 pm-1:40 pm	Lunch	Lunch	Lunch

CONFERENCE SCHEDULE

Friday, November 6

	California Ballroom 2/3	California Ballroom 4	Redwood Room
	Human Impacts I Jim Bednarz	**Migration I** Tricia Miller	**Raptors & Climate Change Symp. II** Neil Paprocki
1:40 pm	Raptor Take From a Law Enforcement Prospective: The Unlawful Killing, Sales and Possession of Raptors and Their Parts by the Public *Mark Jeter*	Golden Eagle Migration Corridors along the Rocky Mountain Front and Intermountain Flyways *Bryan Bedrosian*	The Benefits of Staying: How Warming Winters, Migration Strategies, and Seasonal Declines in Fecundity Drive Earlier Nesting in a Partial Migrant *Julie A. Heath*
2:00 pm	Power Pole Density Informs Spatial Prioritization for Mitigating Avian Electrocution *James F. Dwyer*	Striking Gold in the Mentasta Mountains: Insights about Population Size and Migration Monitoring Based on Observations of Migrating Golden Eagles (*Aquila chrysaetos*) in Alaska *Stephen B. Lewis*	Using Christmas Bird Count Data in Conjunction with Migration Counts to Provide Enhanced Understanding of Raptor Population Change *Neil Paprocki*
2:20 pm	Effects of Industrial Noise on Owls and their Small Mammal Prey in Northeastern Alberta *Julia Shonfield*	The Role of Experience and Multiple Meteorological Factors in the Migratory Performance of Golden Eagles (*Aquila chrysaetos*) *Adrian I. Rus*	
2:40 pm	Anthropogenic Influences to Landscape-Scale Distribution and Density of Wintering Raptors *Adam E. Duerr*	Availability of Roosting Sites Results in Eastward-Arcing Migration Route of Turkey Vulture (*Cathartes aura*) through the Great Plains of North America *David Brandes*	The Implication of Climate Change on the Diet of a Key Arctic Predator, the Gyrfalcon *Bryce W. Robinson*
3:00 pm-3:20 pm	Break	Break	Break
	Human Impacts II Libby Mojica	**Migration II** Alastair Franke	**Raptors & Climate Change Symp. III** Zac Ormsby & Sandy Boyce
3:20 pm	Consequences of Changes in Human Attitude: Expanding Nest Site Opportunities for the Spanish Imperial Eagle (*Aquila adalberti*) *Virginia Morandini*	Assessing Body Condition from Migrating American Kestrels as a Potential Cause of a Long-term Decline *Teresa E. Ely*	Reproductive Responses of an Apex Predator to Changing Climatic Conditions: Implications for Forest Management *Susan R. Salafsky*
3:40 pm	The Urban Incubator: Minneapolis' Peregrine Falcons and the Creation of the Natural *John M. Heydinger*	Population Estimates for Northern Juvenile Peregrine Falcons with Implications for Harvest Levels in North America *Alastair Franke*	Rapid Warming and Drought Negatively Impact Population Size and Reproductive Dynamics of Burrowing Owls in the Arid Southwest *Kirsten Cruz-Mcdonnell*
4:00 pm	Does Urbanization have the Potential to Create an Ecological Trap for Powerful Owls (*Ninox strenua*)? *Bronwyn Isaac*	Spring and Fall Migration, Summer Range Fidelity, and Route Fidelity of Adult Rough-legged Hawks Captured While Wintering in California and Nevada *Jeff Kidd*	Reducing Carbon Emissions by Using a Small Rotary-Winged Unmanned Aerial Vehicle (UAV) or Drone to Survey Nest Contents in Raptorial Birds *James H. Junda*
4:20 pm	Demography of the American Kestrel Lends Insight into Potential Causes of Population Declines and Suggests Future Research Needs *Christopher J.W. McClure*	Routes, Timing, and Wintering Areas of Migratory Flammulated Owls (*Psiloscops flammeolus*) *Brian D. Linkhart*	Climate Change and Raptors–Can They Adapt? *Douglas A. Boyce Jr.*
4:40 pm-5:00 pm	Estimating Key Parameters of Eagle Populations from Shed Feathers *Marton Horvath*	Conserving Broad-winged Hawks (*Buteo platypterus*) Throughout Their Life Cycle: Migration Behavior and Habitat Use *Rebecca McCabe*	Panel Discussion

CONFERENCE SCHEDULE

Saturday, November 7

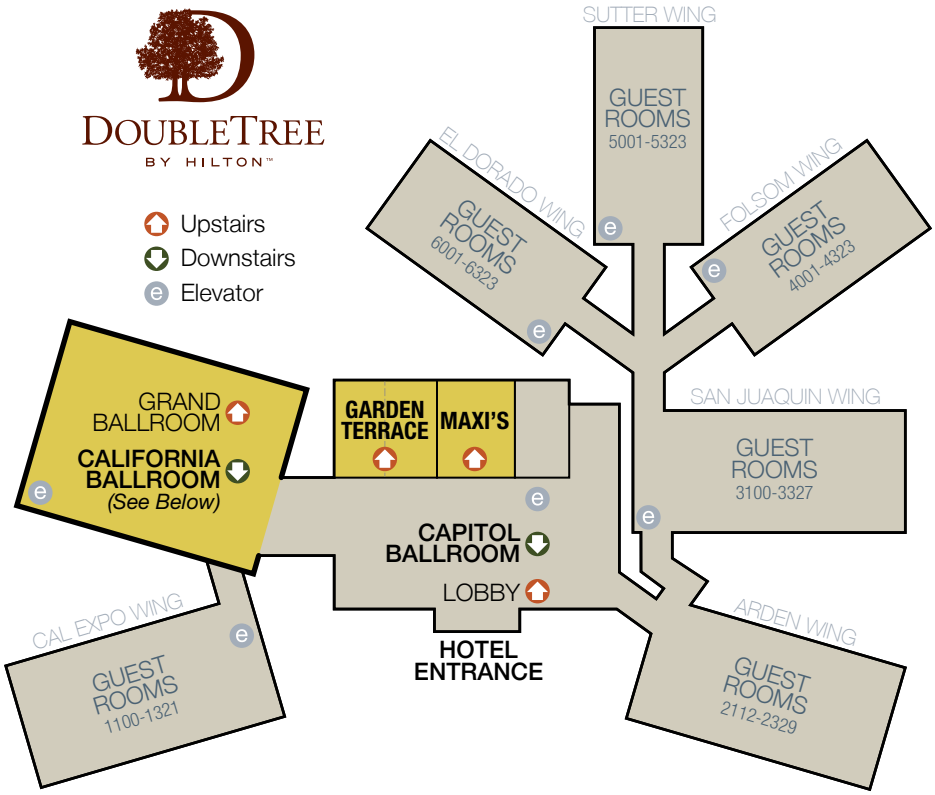
	California Ballroom 2/3	California Ballroom 4	Redwood Room
8:00 am-9:40 am	Announcements and Plenary	Announcements and Plenary	
	Plenary — Madison Peregrine Conference	Plenary — Madison Peregrine Conference	
9:40 am-10:00 am	Break	Break	Break
	Diseases & Toxins Symposium I Miguel Saggese	**Golden Eagle Ecology** Adam Duerr	**Andersen Award** Clint Boal
10:00 am	Causes and Consequences of Avian Scavenger Declines *Evan R. Buechley*	In-Flight Winter Habitat Use and Selection of Golden Eagles (*Aquila chrysaetos*) in Eastern North America *Tricia A. Miller*	Prevalence and Risk Factors for Infection of *Trichomonas gallinae* in Western Golden Eagle Nestlings *Benjamin M. Dudek*
10:20 am	Implications of Study Design in Long-Term Environmental Contaminants Monitoring *William W. Bowerman*	Using Brownian Bridge Movement Models to Describe Winter Space Use of Migratory Juvenile Golden Eagles from Interior Alaska *Mark Paulson*	Integrating Home Range and Density Models can Improve Habitat Predictions for Ferruginous Hawks (Buteo regalis) *Janet W. Ng*
10:40 am	Long Term Goals to Reestablishing California Condors into Areas of their Former Range *Michael Wallace*	Monthly Movements of Pre-Breeding Golden Eagles, with Implications for Connectivity of Populations at a Continental Scale *Sharon A. Poessel*	Barn Owls Crossing the Road: Examining Interplay between Occupancy, Behavior and Roadway Mortality in Southern Idaho, U.S.A. *Tempe Regan*
11:00 am	Continuing Shell Thinning of Eggs of the California Condor (*Gymnogyps californianus*) Is Attributed to Residual DDE Contamination of the Marine Food Web *L. Joseph Burnett*	First through Fourth-Year Dispersal of Golden Eagles from Natal Areas in the Colorado Plateau Region of the Southwestern U.S. *Robert K. Murphy*	Wintering Ranges, Habitat Selection, and Site Fidelity of Rough-legged Hawks (*Buteo lagopus*) in Western North America *Genevieve C. Rozhon*
11:20 am	Safe Haven and Uncertain Threats: Examining Rodenticide Exposure for California Condors (*Gymnogyps californianus*) and Prairie Falcons (*Falco mexicanus*) at Pinnacles National Park and the Surrounding Region *Gavin Emmons*	Population Numbers and Distribution of Golden Eagles (*Aquila chrysaetos*) in Estonia *Gunnar Sein*	Recreation Disturbance to Golden Eagles (*Aquila chrysaetos*): Biological Consequences, Behavioral Mechanisms, and Management Implications *Robert Spaul*
11:40 am	Habitat Use of Barn Owls (*Tyto alba*) across a Rural to Urban Habitat Continuum and the Associated Risk of Rodenticide Exposure *Sofi R. Hindmarch*	Using GPS-GSM Telemetry Data to Aid Interpretation of Golden Eagle Survey Data *Maitreyi Sur*	Habitat Use and Dispersal Behavior of Martial Eagles in Kruger National Park: Keys to Understanding Population Declines *Rowen B. Van Eeden*
12:00 pm-1:40 pm	Lunch	Lunch	Lunch
	Diseases & Toxins Symposium II Michelle Hawkins	**Eagle Nesting** Robert Spaul	**Dispersal** Joan Morrison
1:40 pm	Assessing the Health of a Scarce and Threatened Raptor Endemic to Southern Africa, the Black Harrier (*Circus maurus*) *Marie-Sophie Garcia-Heras*	Golden Eagles (*Aquila chrysaetos*) Nesting in Oregon, 2011–2014 *Frank B. Isaacs*	Movements of American Kestrels (*Falco sparverius*) Between Breeding Seasons *John A. Smallwood*

CONFERENCE SCHEDULE

Saturday, November 7

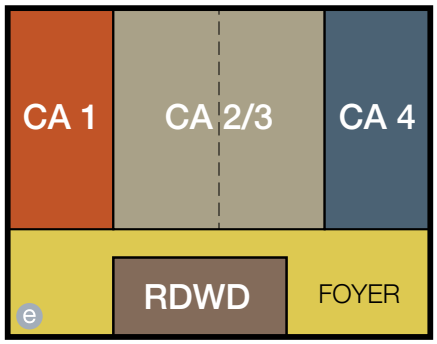
	California Ballroom 2/3	California Ballroom 4	Redwood Room
2:00 pm	Lead Exposure and Effects in Golden Eagles in the Pacific Northwest: Implications for Western Golden Eagle Population Management *Garth Herring*	A Tour Through the History of a Single Golden Eagle Nest: 27 Years of Adaptive Management *Colleen Lenihan*	Seasonal Home Range Variation and Spatio-Temporal Ecology of Resident Peregrine Falcons (*Falco peregrinus*) in Coastal Humboldt County, California *Elizabeth-Noelle Morata*
2:20 pm	Mercury Levels in Birds of Prey Captured at Hawk Ridge, Minnesota *Edward Keyel*	Inter-Annual Golden Eagle (*Aquila chrysaetos*) Nest Use Patterns in Central Utah and Implications for Long-Term Nest Protection *Steve J. Slater*	How Sufficient Are Designated Conservation Areas for Highly Dispersive Raptor Species? Comparing Movement Ranges of Saker Falcons and Imperial Eagles to Designated Conservation Areas in Hungary *Mátyás Prommer*
2:40 pm	Determining Mercury Contamination across a Suite of Raptor Species at Salt Lake City International Airport *Joseph G. Barnes*	Effects of Age and Territory Quality in an Expanding Population Process *Virginia Morandini*	Short Distance Seasonal Movements of Striated Caracaras (*Phalcoboenus australis*) in the Falkland Islands *Katie Harrington*
3:00 pm- 3:20 pm	Break	Break	Break
	Diseases & Toxins Symposium III Miguel Saggese	**Conservation Monitoring** Bronwyn Isaac	**Behavior** John Smallwood
3:20 pm	Disease and Contaminant Surveillance in California Raptors: A Preliminary Analysis *Krysta H. Rogers*	Selected Comments on the California Condor Reintroduction Program – Past, Present, and Future *Robert W. Risebrough*	Delayed Independence in Young of the Desert-dwelling Grey Falcon (*Falco hypoleucos*) of Australia: A Description and Possible Explanation of a Unique Behavior in Raptors *Jonny Schoenjahn*
3:40 pm	Mange Caused by a Novel Micnemidocoptes Mite in Free-ranging Golden Eagles (*Aquila chrysaetos*) *Michelle G. Hawkins*	Using Predictive Models of Nesting Habitat to Inform Survey Design: An Example with Golden Eagles in the Colorado Plateau *Jason D. Tack*	Ornithogenic Fire: Raptors as Propagators of Fire in the Australian Savanna *Robert A. Gosford*
4:00 pm	High Prevalence of Leucocytozoon Parasites in Nestling Northern Goshawks (*Accipiter gentilis*) in the Northern Great Basin, U.S.A. *Michelle I. Jeffries*	Chick Survival in Two Critically-Endangered *Gyps* Vultures in Assam, India *Kulojyoti Lahkar*	Linking Pre-Laying Energetic Allocation and Timing of Breeding in a Migrating Arctic Raptor *Vincent Lamarre*
4:20 pm	Highly Pathogenic Avian Influenza and Raptors: Updates Regarding the 2015 Disease Outbreaks and Emergency Response Actions *Brian E. Washburn*	Do Invasive Aquatic Plant Infestations Create Ecological Traps for Bald Eagles (*Haliaeetus leucocephalus*) and Waterbirds by Promoting Avian Vacuolar Myelinopathy Disease? *Brigette N. Haram*	DNA Sequencing (Barcoding) Reveals Prey Selection in Migratory Raptors *John P. Delong*
4:40 pm	Raptors and Highly Pathogenic Avian Influenza Virus: With Comments Regarding Implications for Captive Managed Raptor Populations *Michelle Willette*	Genomic Resources for the Management and Development of Conservation Units for Bald Eagles (*Haliaeetus leucocephalus*) *Megan E. Judkins*	American Kestrel Flaring Eyespots *Steve K. Sherrod*

CONFERENCE MAP



CALIFORNIA BALLROOM

(Downstairs from Grand Ballroom)



Raptor Research Foundation Annual Conference — Events & Locations		
Location	**Event**	
California Room 1	Registration-Vendors	Downstairs
California Rooms 2/3/4	Plenary Talks	Downstairs
California Rooms 2/3	Scientific Talks, Poster Reception, ECRR, Calif Raptor Center Receptions	Downstairs
California Room 4	Scientific Talks	Downstairs
Redwood Room	Scientific Talks	Downstairs
California Foyer	Food/Breaks	Downstairs
Maxi's	Clark/Schmitt Evening Lecture	Upstairs
Capitol Ballroom	Saturday Banquet	Downstairs
Garden Terrace	Opening Icebreaker	Upstairs

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