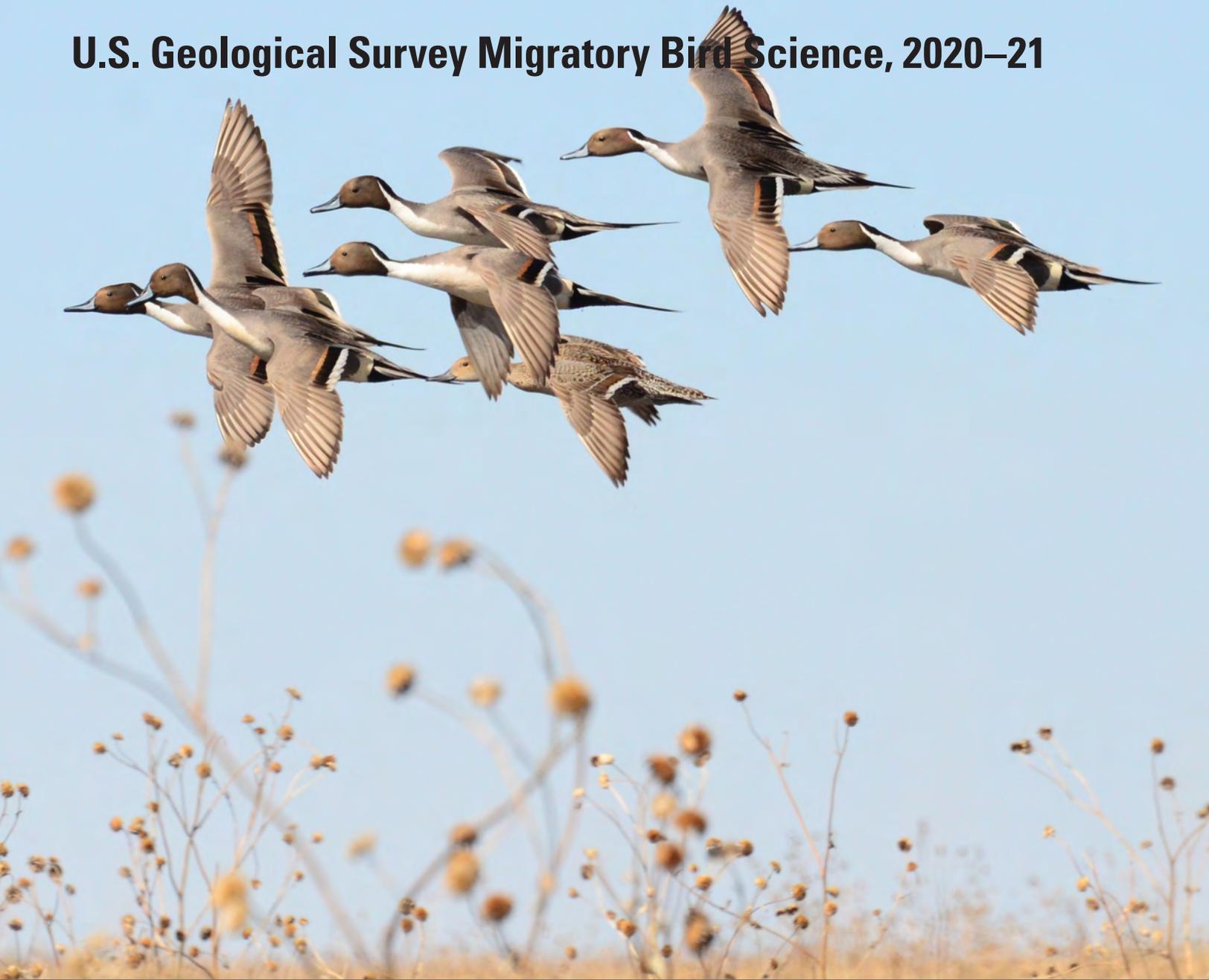


U.S. Geological Survey Migratory Bird Science, 2020–21



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Long-billed curlew. Photograph by
Kari Cieszkiewicz, U.S. Fish and
Wildlife Service.



Front cover. Northern pintails during spring migration. Photograph by Brandon Jones, U.S. Fish and Wildlife Service.

Inside front cover. Long-billed curlew. Photograph by Kari Cieszkiewicz, U.S. Fish and Wildlife Service.

Facing page. Trumpeter swans at LaCreek National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

U.S. Geological Survey Migratory Bird Science, 2020–21

Edited by Aaron T. Pearse, Mark H. Sherfy, Mark Wimer, Mona Khalil, and Mark T. Wiltermuth



Trumpeter swans at LaCreek National Wildlife Refuge.
Photograph by Tom Koerner,
U.S. Fish and Wildlife Service.

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U.S. Geological Survey

U.S. Geological Survey, Reston, Virginia: 2021

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
Area		
hectare (ha)	2.471	acre
square kilometer (km ²)	247.1	acre
hectare (ha)	0.003861	square mile (mi ²)
square kilometer (km ²)	0.3861	square mile (mi ²)

Abbreviations

BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
DoD	Department of Defense
DOI	Department of the Interior
EPA	U.S. Environmental Protection Agency
GPS	Global Positioning System
GSM	Global System for Mobile Communications
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	National Resource Conservation Service
NWR	National Wildlife Refuge
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Meadowlark at Reed Ranch, Douglas Wyoming. Photograph by Jennifer Strickland, U.S. Fish and Wildlife Service.





A bald eagle at the National Elk Refuge. Photograph by Kari Cieszkiewicz, U.S. Fish and Wildlife Service.

U.S. Geological Survey Migratory Bird Science, 2020–21

Edited by Aaron T. Pearse, Mark H. Sherfy, Mark Wimer, Mona Khalil, and Mark T. Wiltermuth

Migratory Bird Science at U.S. Geological Survey

Bird conservation as an endeavor engages a broad range of partners and a coordinated effort across State and Federal agencies, nongovernment organizations, universities and, at times, international partnerships. To understand information needs and respond to the many challenges in bird conservation, U.S. Geological Survey (USGS) scientists participate in Flyway committees, on Joint Venture boards and working groups, in professional organizations, and in other conservation partnerships. These activities connect USGS scientists to conservation partners with whom they work to address substantial challenges. More than one hundred USGS scientists are dedicated to the scientific study of migratory birds.

This report presents the current (2021) representative breadth of activities of USGS scientists supporting the conservation and management of migratory birds. Ninety USGS scientists contributed to the project descriptions and other information detailing the work of the USGS. The science herein is organized and presented thematically by research strengths and by management topics. The report emphasizes the geographic framework of the North American Flyway councils through which USGS engages regularly with Federal and State government agencies and others who are responsible for managing migratory bird populations.

USGS scientists lead activities that are central to bird conservation today—such as the activities spearheaded by the North American Bird Banding Laboratory and the North

American Breeding Bird Survey, which are in partnership with Canada and Mexico. USGS scientists lead research, research support, and monitoring from the continental scale to the local scale; organized in this report based on nine research themes. The breadth of research activity includes many new approaches for measuring the health of bird populations, for assessing threats to birds, and for addressing to those threats.

For each activity described, contact information is provided for project leads; therefore, please contact the corresponding project leader for more information. All activities represent collaborations, and partners also are listed. Finally, less visible in the activities are the students who are contributing to many of these studies, trained as part of a broader mission and an explicit mission for the Cooperative Fish and Wildlife Research Units, to become future scientists and conservationists.

USGS science is focused on a changing world. A 2019 article published in *Science*, which included USGS data and analysis, pointed to an estimated loss of 3 billion birds in the last 50 years (Rosenberg and others, 2019). Individuals and organizations across the bird conservation community are forming larger partnerships to help understand the causes of these declines and how to prevent them. USGS scientists will continue to add to the understanding of changes in bird populations and, I invite you to work with the USGS in helping meet existing and new challenges.

Mark Wimer, USGS–Wildlife Program Coordinator

List of Projects

Migration and Nonbreeding Ecology

- A01. Migration and Wintering Ecology in the San Francisco Bay-Delta and Pacific Flyway
- A02. Spring and Fall Stopover Food Resources and Land-Use Patterns for Rocky Mountain Population Sandhill Cranes in the San Luis Valley, Colorado
- A03. Body Condition Index of Overwintering Mallards in Arkansas
- A04. Conserving the Flow of Ecosystem Services for Migratory Species
- A05. Linking Nonbreeding Areas and Reproductive Success of Golden Eagles in Denali National Park and Preserve, Alaska
- A06. Evaluating Dynamics of Habitat Resource Availability for Diving Ducks at Pools 13 and 19 of the Mississippi River
- A07. Avian Food Webs, Prey Resources, and Foraging Ecology
- A08. Spatial Ecology of Brown Pelicans in the South Atlantic Bight
- A09. Investigating Postbreeding Movements and Molting Ecology of Gadwall and Mallards in California
- A10. Body Condition of Lesser Snow and Ross's Geese Harvested by Different Methods during the Light Goose Conservation Order
- A11. Boater Compliance with Efforts to Minimize Disturbance to Waterfowl during Fall Staging on the Upper Mississippi River National Wildlife and Fish Refuge
- A12. Agent-Based Modeling of Movements and Habitat Selection of Midcontinent Mallards
- A13. Migration Patterns, Habitat Use, and Food Habits of Long-Tailed Ducks Wintering on Lake Michigan
- A14. Ecology of Postbreeding Mallards in North and South Dakota
- A15. Sea Duck Harvest on Lake Michigan
- A16. Migration Ecology of North American Turkey Vultures Wintering in the Neotropics—Spatial and Population Dynamics
- A17. Distribution and Abundance of Migrating and Wintering Waterbirds on Lake Michigan
- A18. Avian Abundance and Use Patterns in Fields Managed for Mourning Doves—A Multiscale Approach
- A19. Determining the Relative Importance of Cisco in Diets of Common Loons among Cold-Water Cisco Refuge Lakes in Minnesota
- A20. Minnesota Trumpeter Swan Migration Ecology and Conservation
- A21. Identifying Migratory Routes and Wintering Grounds of Burrowing Owls that Breed on Department of Defense Installations in the Western United States
- A22. Migration Trends for King and Common Eiders and Yellow-Billed Loons Past Point Barrow in a Rapidly Changing Environment
- A23. Migration Patterns and Wintering Distribution of Common Loons Breeding in the Upper Midwest
- A24. Overwintering Survival of Shorebirds on Florida's Panhandle
- A25. Causes of Differential Migration in Birds
- A26. Movements and Overwinter Survival of Juvenile Red Knots in Southeast United States—Information Needs for Recovery Planning
- A27. Evaluating Wetland-Ecosystem Health Using Real-Time Nutrient Dynamics of Ducks
- A28. Effects of Extreme Disturbances at Wintering Areas on Piping Plover Survival and Migratory Connectivity
- A29. Ring-Necked Duck Wintering and Migration Studies
- A30. Modeling Avian Migration from First Principles
- A31. Ecology and Management of Midcontinent Sandhill Cranes
- A32. Golden Eagles in Yellowstone National Park and Their Role in the Greater Yellowstone Ecosystem
- A33. Eagle Movement Response to Environmental Stressors

Breeding Ecology

- B01. Waterfowl Breeding and Nesting Ecology in Suisun Marsh and the Pacific Flyway
- B02. Breeding Ecology of Cinnamon Teal within the San Luis Valley, Colorado
- B03. The Effect of Future Changes in Climate on Breeding Waterfowl Pairs in the Prairie Pothole Region
- B04. Predator Cascade and Nest Success—Changes in Foraging Patterns as a Function of Grassland Patch Dynamics and Vegetation Composition

- B05. Understanding Avian Predator Movement Ecology, Habitat Selection, and Effects on Breeding Waterfowl to Inform Habitat and Population Management in Suisun Marsh, California
- B06. Evaluating Avian Use of Cover Crop Fields in the Corn Belt
- B07. Response of Grassland Birds to Habitat Characteristics, Oil Wells, and Roads in the Little Missouri National Grassland in North Dakota
- B08. Ecology of Breeding Canvasbacks in Southwestern Manitoba
- B09. Least Tern and Common Tern Productivity on Poplar Island Restoration Site
- B10. Evaluating Nest Site Selection of Arctic Peregrine Falcons in the Colville River Special Area
- B11. Nearshore Marine Ecosystem Research Program
- B12. Structure and Connectivity of Midcontinental Snowy Plovers
- B13. Cause of Low Nesting Success and Recruitment of Clark's and Western Grebes in Idaho
- B14. Nesting Ecology of Songbirds Along an Urban to Rural Gradient
- B15. Reconciling Competing Models of Temporospatial Variation in Duck Nest Survival
- B16. Nest Ecology of Bluebirds Across Land Cover Types
- B17. Assessment of Temperate-Breeding Canada Goose Management in Kansas
- B18. Climatic Variability and the Productivity of Nongame Sagebrush Birds
- B19. Assessing Shorebird Use of Lagoons in Cape Krusenstern National Monument
- B20. Breeding Ecology and Demographics of Least Terns and Piping Plovers at the Central Platte River, Nebraska
- B21. Importance of Wetlands in Intensively Farmed Landscapes to Duck Production
- B22. U.S. Geological Survey Seabird and Forage Fish Program

Health, Disease, and Contaminants

- C01. Wildlife Health Investigations
- C02. Wildlife Disease in the Pacific Basin
- C03. Microcystin Toxin Exposure
- C04. Characterization of Avian Hazards After Chlorophacinone Use for Prairie Dog Control
- C05. Understanding Spatiotemporal Dynamics of Avian Influenza in Migratory Waterfowl Populations and Risk of Transmission to Domestic Livestock
- C06. Changing Arctic Ecosystems—Algal Toxins in the Arctic
- C07. Immune Components in Eggs of New World Blackbirds
- C08. Effects of Methylmercury Exposure on the Growth of Common Loons
- C09. Assessing the Effect of Changing Water Resources on Migratory Bird Health and Management in the Central Flyway—A Harm Reduction Approach
- C10. Selenium Risk to Yuma Ridgway's Rails at the Salton Sea
- C11. Contaminants in Suisun Marsh and the Pacific Flyway
- C12. Avian Influenza Challenge Studies in Migratory Diving Ducks and American Black Ducks
- C13. Avian Influenza Virus and Contaminant Exposure Effects on Body Condition and Movements of Waterfowl
- C14. Avian Influenza Surveillance in Waterfowl—Prevalence and Persistence Locally and Across Flyways
- C15. The Role of Waterfowl in the Transmission, Persistence, and Amplification of Avian Influenza Viruses in North America
- C16. Blue-Winged Teal and Cross Continental Avian Influenza Transmission
- C17. Exposure and Effects of Contaminants on a Model Migratory Bird Species, the Tree Swallow, at Multiple Sites Across the Great Lakes Basin
- C18. Avian Health and Ecology of Wildlife Disease in Alaska and Adjacent Regions
- C19. Dark Epidemiology—Artificial Intelligence to Develop Real-Time Maps of Migratory Bird Movements Using Radar Data for Avian Influenza Risk Assessment
- C20. Seabird Health and Adaptive Management
- C21. Lead Exposure and Effects in Golden Eagles in the Pacific Northwest
- C22. Assessing Occurrence and Effects of Neonicotinoid Pesticides on Loggerhead Shrike Body Condition, Immunocompetence, Survival, and Reproduction
- C23. Role of Gulls in the Dissemination of Antimicrobial Resistant *E. coli*
- C24. Determining and Identifying Anthropogenic Toxins Affecting Birds of Prey
- C25. Can Wetland Water-Management Affect Mercury Bioaccumulation in Songbirds and Ducks at National Wildlife Refuges with Mercury Problems?

Population Dynamics and Distributions

- D01. Use of Remote Sensing Data to Quantify Bird and Bat Distributions and Inform Migratory Bird Conservation Efforts
- D02. Demography of Black-Footed and Laysan Albatross—Kilaua Point and Tern Island Populations
- D03. Population Ecology of Waterfowl and Loons
- D04. Banding Needs Assessment of the Western Gulf Coast Population of Mottled Ducks
- D05. Goose Population Dynamics and Distributions
- D06. Understanding the Contribution of Locations and Paths to the Population Dynamics of Migrating Species
- D07. Ecological Research of Migratory Waterfowl in the Pacific Flyway—Advancing Knowledge for the Management of Breeding, Migrating, and Wintering Ducks and Geese
- D08. Trumpeter Swan Movements and Demography
- D09. Western States Cinnamon Teal Initiative—Understanding the Distribution and Habitat Use of North American Cinnamon Teal
- D10. Understanding Common Loon Distribution and Abundance in Washington
- D11. Population Change and Abundance of Black Ducks and Mallards in Eastern North America
- D12. Tracking Atlantic and Caribbean Seabirds
- D13. Purple Martin Distribution and Habitat Use in Southwestern Oregon
- D14. U.S. Geological Survey and U.S. Fish and Wildlife Science Support and Quick Response Program
- D15. A Rapid Assessment of Geographic Distribution and Habitat Conditions of the Endangered Puerto Rico Plain Pigeon after Hurricane Maria
- D16. Laying the Groundwork for Science-Based Management of Colonial Waterbirds
- D17. Rapid Assessment of Geographic Distribution and Habitat Conditions of the Critically Endangered Puerto Rico Sharp-Shinned Hawk After Hurricane Maria
- D18. Causes of Elevational Patterns in Avian Species Richness
- D19. Waterfowl Distribution in the Chesapeake Bay
- D20. Dispersal Behavior of Yuma Ridgway's Rail
- D21. Population Dynamics, Ecology, and Habitats of North Pacific Shorebirds
- D22. Assessing Distribution and Occupancy Patterns of Riparian Avifauna in the Trans Pecos Region of Texas
- D23. Population Dynamics of Burrowing Owls on Kirtland Air Force Base
- D24. Ecology of Canada Geese in Urban Areas of Iowa
- D25. Population Ecology and Habitats of Alaska Landbirds
- D26. Black Rosy-Finch Distribution, Abundance, and Habitat Selection During the Breeding Season
- D27. Monitoring Avian Productivity and Survival in San Diego County
- D28. Productivity of Black Oystercatchers in Southwest Alaska
- D29. Population Structure and Demography of the Least Bell's Vireo and Southwestern Willow Flycatcher and Use of Restored Riparian Habitat
- D30. Productivity of American Oystercatchers Nesting on Spoil Islands at the Cross Florida Greenway State Recreation and Conservation Area
- D31. Identifying Population Limiting Factors for the Hudsonian Godwit
- D32. Population Demographics of Least Terns and Piping Plovers in Colorado
- D33. Metapopulation Dynamics of Piping Plovers in the Northern Great Plains
- D34. Demographic Analysis of Waterfowl Populations

Effects of Energy Development

- E01. Assessing Risk to Eagles from Wind Turbine Development
- E02. Effects of Wind Energy on Raptors
- E03. Determining Carcass Scavenging and Searcher Efficiency Rates on Major Rivers for Oil Spill Response and Assessment of Wildlife Injury
- E04. Long-Term Louisiana Waterthrush and Avian Community Response to Shale Gas Development in the Central Appalachian Region

- E05. Golden Eagles Near Altamont Pass Wind Resource Area
- E06. Trending Against the Grain—Bird Population Responses to Expanding Energy Portfolios in the Northern Great Plains of the United States
- E07. Changing Arctic Ecosystems—Minimizing Effects of Arctic Energy Development on Wildlife
- E08. Habitat Mitigation for Effects of Energy Facilities on Grassland Birds and Waterfowl Using the Avian-Impact Offset Method
- E09. Understanding the Behavioral Basis of Bird Mortality at Utility-Scale Solar Facilities
- E10. Bird and Bat Environmental Study for the Experimental Wind Facility in Texas
- E11. Reducing Turbine-Related Bird and Bat Mortality Using Weather Radar
- E12. Interactions of Juvenile Swainson's Hawks with Wind Energy Facilities During Dispersal and Migration
- E13. Ecology, Habitat Use, and Effects of Wind Energy on Burrowing Owls
- E14. Effect of Energy Development and Climatic Variability on Sagebrush Songbirds
- E15. Full Life-Cycle Effects of Natural Gas Development on Sagebrush-Obligate Songbirds
- E16. Modeling Bald and Golden Eagle and Other Raptor Populations and Take Rates
- E17. Topographic Drivers of Golden Eagle Flight Altitude in the Mojave Desert, California
- E18. Eastern Brown Pelicans—Dispersal, Seasonal Movements and Monitoring of Polycyclic Aromatic Hydrocarbons and Contaminants in the Northern Gulf of Mexico
- E19. Seabird Ecology for Marine Spatial Planning

Support of Restoration and Species Recovery

- F01. Migration and Wintering Ecology of the Aransas-Wood Buffalo Population of Whooping Cranes
- F02. Demography of Black-Footed and Laysan Albatross—Vital Rates in Support of the Surrogate Species Approach to Strategic Habitat Conservation
- F03. Yellow-Billed Cuckoo Distribution and Habitat Use in Arizona
- F04. Tracking of Colonial Wading Birds and Habitat Use Assessment
- F05. Coordination for Research on California Condors
- F06. Determining Optimal Elevation for Restoration of an Island Used by Rare Colonial Nesting Waterbirds
- F07. Adapting to Climate Change—Trends and Severe Storm Responses by Migratory Landbirds and Their Habitats
- F08. Avian Community Change Across Time, Elevations, and Latitudes
- F09. Wildlife Species of Management Concern in the Arctic
- F10. Gulf of Mexico Marine Assessment Program for Protected Species
- F11. Geographic Information System and Remote Sensing Support—Gulf Coast Joint Venture
- F12. Habitat Selection in an Arctic Shorebird—Implications for Climate Change
- F13. U.S. Geological Survey Alaska Region and Bureau of Ocean Energy Management Outer Continental Shelf Program
- F14. Changes in Avian and Plant Community Composition and Structure After Prescribed Thinning in Pinyon-Juniper Woodlands.
- F15. Decision Support for Restoration and Management of U.S. Fish and Wildlife Service-Owned Native Prairies—Implications for Grassland Bird Communities
- F16. Wisconsin's Wildlife and a Changing Climate
- F17. Restoration of Common Loons in Minnesota
- F18. Conservation of the Kirtland's Warbler
- F19. Investigations of Whooping Crane Colts in the Eastern Migratory Population
- F20. Strategies for Reducing the Vulnerability of Grassland Birds to Climate Change within the Central Flyway
- F21. Diets of Wild and Reintroduced Whooping Cranes
- F23. Barred Owl Effects on Northern Spotted Owls
- F24. Ecology of the Endangered Nordmann's Greenshank
- F25. Birdsbesafe—Is a Novel Cat Collar More Effective at Stopping Domestic Cats from Killing Birds at Higher Latitudes?
- F26. Trophic Consequences of a Recovering Apex Predator
- F27. Restoration of Wetland Invertebrates to Improve Wildlife Habitat in Minnesota
- F28. Using Stakeholder Preferences to Inform Continental-Scale Waterfowl and Wetlands Management for Hunting and Recreation

Conservation Genetics

- G01. Genetic Analysis of Nonbreeding Population Structure of Red Knots
- G02. Population Genetic Analysis of Caribbean and Northeastern Roseate Terns
- G03. Developing and Applying Molecular Tools to Natural Resource Problems in Alaska
- G04. Landscape Genetic Structure of the Western Continental Golden Eagle Population
- G05. An Assessment of the Genetic Structure of an Urban Cooper's Hawk Population

Response to Habitat Change and Management

- H01. A Multiscale Approach to Understanding Migratory Landbird Habitat Use of Functional Stopover Habitat Types and Management Efforts
- H02. Managing Coastal Wetlands for Wildlife and Sustainability in the Face of Sea Level Rise
- H03. Avian Response to Estuarine Habitat Management and Restoration
- H04. Effects of Conifer Range Expansion and Removal on Songbird Abundances and Reproductive Success in High-Elevation Sagebrush of Southwestern Montana
- H05. Prairie Pothole Wetland Condition Assessment
- H06. Cerulean Warbler and Associated Species Response to Silvicultural Operations in the Central Appalachian Region
- H07. Effects of Management on Grassland Birds—Literature Reviews
- H08. Pretreatment and posttreatment Monitoring on Working Lands for Wildlife and Regional Conservation Partnership Program Sites in West Virginia
- H09. Evaluation of Cover Crops for Grassland Nesting Waterfowl in Eastern South Dakota
- H10. Breeding Bird Use of Grasslands Enrolled in the Conservation Reserve Program in the Northern Great Plains
- H11. Red-Headed Woodpecker—Indicators of Oak Savanna Health
- H12. Common Loon Habitat Model
- H13. Effects of Forest Management Practices in the Acadian Northern Hardwood/Conifer Forests of Maine on Forest Bird Communities, with Emphasis on Species of Regional Conservation Priority and Concern
- H14. Oregon Songbird Response to Forest Thinning and Riparian Restoration
- H15. Avian Community Response to Brush Control on the Welder Wildlife Refuge—Phase II
- H16. Fire Effects in Gulf of Mexico Marshes—Historical Perspectives, Management, and Monitoring of Mottled Ducks and Black and Yellow Rails
- H17. Landscape-Scale Management of Grassland Birds in Wisconsin
- H18. Assessing the Importance of Wetlands on Department of Defense Installations for the Persistence of Wetland-Dependent Birds
- H19. Response of Bachman's Sparrow to Habitat Management
- H20. Do Grassland Birds and Beekeepers Select the Same Habitat Patches in the Prairie Pothole Region?
- H21. Identification of Hydrologic Controls on Coastal Marshes and Optimal Hydrologic Conditions for Sustainable Mottled Duck Habitat
- H22. Developing Tools to Assist Natural Resource Managers in Planning for Future Climate Effects on Migratory Waterfowl Habitat
- H23. Supporting the U.S. Fish and Wildlife Service and Prairie Pothole Joint Venture in Monitoring and Management of Migratory Bird Populations
- H24. Effects of Forest Management on Early Successional Avian Species in South Carolina
- H25. Interactions of Consolidation Drainage and Climate on Water-Level Dynamics, Wetland Productivity, and Waterbirds
- H26. Understanding Consequences of Management Strategies for Farmed Wetlands to Ecosystem Services in the Prairie Pothole Region
- H27. Demographic Response of Least Terns and Piping Plovers to the 2011 Missouri River Flood

Monitoring and Population Estimation Techniques

- I01. Partnering with National Aeronautics and Space Administration to Advance Transmitter Technology for Wildlife Tracking
- I02. Evaluating Sea Duck Detectability in the Puget Sound Winter Ambient Monitoring Program
- I03. Estimating the Population Size of North American Landbirds
- I04. Long-Term Seabird Monitoring Data Analysis to Update Channel Islands National Park Seabird Inventory and Monitoring Program and Inform Management and Conservation
- I05. Ecosystems Analytics
- I06. A Meta-Analysis of Secretive Marshbird Habitat Use Across the Full Annual Cycle
- I07. Using Global Positioning System/Global System for Mobile Communications Telemetry to Study Condor Flight
- I08. An Interdisciplinary Approach to Building Data Literacy in Wildlife Survey Technologies
- I09. Improving Monitoring Techniques for Nests of Interior Least Terns and Piping Plovers
- I10. Black Rail Ecology to Inform Effective Survey Design and Support Population Modeling
- I11. Developing Techniques to Census and Monitor American White Pelicans and Other Colonial Waterbirds at Chase Lake National Wildlife Refuge in North Dakota
- I12. An Investigation of Transmitter Effects on Avian Flight
- I13. Design and Analysis of Surveys for Estimating Temporal and Spatial Change in Animal Populations
- I14. Developing Capture Techniques and Monitoring the Movement of Sandhill Cranes Breeding in Iowa
- I15. Advanced Technologies for Waterbird Research
- I16. Analysis of Bird Population Count Data
- I17. North American Breeding Bird Survey
- I18. Integration of Breeding Bird Survey and eBird Data to Improve Estimates of Bird Distribution and Growth Trends at Multiple Spatial Scales.
- I19. Remote Sensing in Support of the U.S. Fish and Wildlife Service Migratory Bird Surveys Branch
- I20. Developing Survey Methods for Spring-Migrating Waterfowl in the Rainwater Basin, Nebraska
- I21. A Novel Wildlife Tag Enabling Weather Radar-Based Animal Tracking
- I22. International Piping Plover Census
- I23. Investigating Roadside Bias in Point-Count Surveys of Grassland Passerines
- I24. Automated Telemetry to Understand Habitat Use, Movement Ecology, and Migratory Departures
- I25. Identifying Important Habitat, Developing Inexpensive Habitat Monitoring, and Developing Habitat-Based Abundance Estimates for Piping Plovers at Wetland Habitats in the Prairie Pothole Region
- I26. Waterfowl Breeding Population Survey Analytical Support

Ferruginous hawk at LaCreek National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.



Project Narratives

Migration and Nonbreeding Ecology

A01. Migration and Wintering Ecology in the San Francisco Bay-Delta and Pacific Flyway

Waterbirds such as shorebirds, waders, and ducks depend on healthy and productive estuaries to “fuel up” for long distance migrations along the Pacific Flyway. Estuarine ecosystems include a mosaic of managed, natural, and restored wetlands and provide critical stopover and wintering areas for federally protected migratory bird species. The purpose of this project is to encompass studies of habitat use, foraging ecology, migratory connectivity, and avian bioenergetics in California’s San Francisco Bay-Delta and across the Pacific Flyway. Components of this project include (1) a multiyear, multispecies study to understand how seasonal habitat use and diet affect body condition, subsequent migration timing, and reproductive potential of diving ducks in the Bay-Delta; (2) studies of winter and spring habitat use, migration phenology, and breeding area affiliations of canvasbacks wintering in the Pacific Flyway; and (3) efforts to determine the susceptibility of North American waterbird species to avian influenza in the Central Valley and Bay-Delta of California and the role of migratory birds in the spread of the virus. Results of these studies will provide information for the conservation of waterbirds throughout their ranges in the Pacific Flyway and across the annual cycle.

Contact: Susan De La Cruz, Western Ecological Research Center, sdelacruz@usgs.gov

Partners: U.S. Fish and Wildlife Service (USFWS)

For more information: <https://www.usgs.gov/centers/werc/science/avian-ecology-and-multi-species-habitat-use-pacific-coast-estuaries>



Surf scoter, a large sea duck that lives on the offshore waters of North America. Photograph by U.S. Geological Survey.

A02. Spring and Fall Stopover Food Resources and Land-Use Patterns for Rocky Mountain Population Sandhill Cranes in the San Luis Valley, Colorado

The Rocky Mountain population and part of the midcontinent population of sandhill cranes use the San Luis Valley in Colorado as an important stopover area during spring and fall migration. Declines in available water for roosting, and in food sources such as barley, could have negative effects on these populations. Assessments of available roost habitat and grain, use of these habitats by cranes, and carrying capacity of the San Luis Valley for cranes are needed to evaluate the future of these populations and to provide information that will help managers make refuge management decisions. Results will be used to build a decision model to assist Monte Vista National Wildlife Refuge (NWR) in making water and grain management decisions.

Contact: William Kendall, Colorado Cooperative Fish and Wildlife Research Unit, wkendall@usgs.gov

Partners: USFWS, Intermountain West Joint Venture, Colorado Parks and Wildlife, Colorado Open Lands

For more information: <https://www1.usgs.gov/coopunits/project/173174986752/William.Kendall>



A03. Body Condition Index of Overwintering Mallards in Arkansas

Many waterfowl species spend winter in the southern United States before migrating north to breeding grounds in spring. During winter, birds maintain or gain weight to successfully attain mates, migrate north, and immediately initiate reproduction. This research effort combines newly collected data with historical data from the 1970s, 1980s, and 1990s to determine how body mass in mallards varies with time and, subsequently, how environmental variables such as precipitation and temperature affect body mass. Results of this project also will determine how management practices affect waterfowl body mass and health by assessing the relation between body mass of hunter-collected ducks with management practices on surrounding lands. Data will be used by management agencies to manage food availability for this economically important species.



Mallards in a flooded bottomland hardwood forest at Cache River National Wildlife Refuge, Arkansas. Photograph by U.S. Fish and Wildlife Service.

Contact: Brett Degregorio, Arkansas Cooperative Fish and Wildlife Research Unit, bdegregorio@usgs.gov

Partners: Arkansas Game and Fish Commission, Ducks Unlimited, Inc.

For more information: <https://www1.usgs.gov/coopunits/project/192960368640/bdegregorio>

A04. Conserving the Flow of Ecosystem Services for Migratory Species

Migratory species such as waterfowl provide valuable ecosystem services, including recreational viewing and hunting opportunities. The value of these services moves as a function of migrational processes from areas where the species biologically originates to areas where captured. For instance, northern pintails are hatched in the Prairie Pothole Region as well as in Alaska but migrate to California and the Gulf Coast; value generated in the breeding grounds is captured by humans in migration and wintering locations. Understanding this movement of value through networks of migrationally linked populations is essential information for delivering conservation and management actions to the areas that are most effective in ensuring continued delivery of these ecosystem services. Our work includes efforts to understand how policy changes affecting one location are expected to lead to ecosystem service outcomes in distant locations connected by migration.



Contact: Wayne Thogmartin, Upper Midwest Environmental Sciences Center, wthogmartin@usgs.gov

Partners: USFWS, USGS Geosciences and Environmental Change Science Center, University of Arizona, Ducks Unlimited, Inc., Colorado State University, University of Natural Resources and Life Sciences (Vienna)

Recent products:

Sources and dynamics of international funding for waterfowl conservation in the Prairie Pothole Region of North America, <https://doi.org/10.1071/WR19100>

A05. Linking Nonbreeding Areas and Reproductive Success of Golden Eagles in Denali National Park and Preserve, Alaska



Golden eagle occupancy and reproduction have been studied at Denali National Park and Preserve for nearly 30 years and, over that time, the number of eagle breeding territories and reproduction at those territories have declined. Further, research indicates that reproductive success of Denali's golden eagles is being affected by conditions away from their breeding grounds. USGS scientists are identifying how survival and reproductive success of Denali's golden eagles are linked to nonbreeding season events and environmental conditions. Scientists are radio tagging eagles to identify migration routes, stopover areas, and wintering ranges of breeding golden eagles and their offspring. Scientists also are studying duration of migrations and conditions at stopovers and wintering areas. Coupled with long-term data collected on golden eagles at Denali, results of this project will provide information about if survival and reproductive success are related to environmental and ecological factors outside breeding areas.

Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: National Park Service (NPS), Alaska Department of Fish and Game, Conservation Science Global, Inc.



Golden eagle at Seedskeadee National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

A06. Evaluating Dynamics of Habitat Resource Availability for Diving Ducks at Pools 13 and 19 of the Mississippi River



USGS scientists are coleading a partnership with Western Illinois University to understand the dynamics of foods for diving ducks at two important migratory stopover areas on the Mississippi River. Navigational Pools 13 and 19 are crucial refueling sites for migratory waterfowl, especially diving ducks, before reaching higher latitudes where food shortages have been documented. Changes in hydrology, traffic, and sedimentation have occurred at Pool 19 since the installation of the Keokuk lock and dam system in 1913. Unlike other navigational pools of the Mississippi River, few aquatic invertebrate and vegetation evaluations have been done on Pool 19 in relation to environmental factors. The purpose of this research is to create a spatial and temporal habitat assessment of Navigational Pools 13 and 19 using historical and recent data. Scientists will use aquatic surveys to characterize distribution and density of vegetation and macroinvertebrates and will use waterfowl aerial survey data to evaluate lesser scaup abundance in relation to habitat factors. Lastly, scientists will perform true metabolizable energy trials using wild-caught scaup to establish energy values for common diet items.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: Western Illinois University, Illinois Department of Natural Resources, USFWS, Illinois Natural History Survey

A lesser scaup fitted with an excrement collection harness during a true metabolizable energy trial. Photograph by Lauren Larson, Western Illinois University.

A07. Avian Food Webs, Prey Resources, and Foraging Ecology

Shorebirds and waterfowl rely on diverse communities of intertidal invertebrates as food to fuel long-distance migrations. Physical and biological factors can affect the type and amount of invertebrates that support fish and waterbird species in coastal estuarine habitats. This project focuses on foraging ecology of migratory birds and factors that affect invertebrate food availability for waterbirds, including effects of habitat restoration on waterbird prey availability. Objectives of this project include (1) examining invertebrate community and food web complexity in tidal wetland restoration sites in major coastal Pacific estuaries such as San Francisco Bay-Delta and Puget Sound, (2) assessing fish and avian responses to changing prey resources in restored habitats, and (3) directing experimental studies to evaluate water regimes on California Central Valley rice fields designed to increase invertebrate prey for endangered salmon and migratory shorebirds. Results of the project will provide information for restoration planning to help improve estuaries' capacity to support diverse fish and bird communities.

Contact: Susan De La Cruz, Western Ecological Research Center, sdelacruz@usgs.gov

Partners: USFWS, California Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Nisqually Indian Tribe, U.S. Army Corps of Engineers (USACE), California State Coastal Conservancy, San Francisco Bay Joint Venture

Recent products:

Impacts of periodic dredging on macroinvertebrate prey availability for benthic foraging fishes in central San Francisco Bay, California, <https://doi.org/10.3133/ofr20201086>

For more information: <https://www.usgs.gov/centers/werc/science/food-web-and-invertebrate-ecology-studies-pacific-coast-estuaries>



U.S. Geological Survey laboratory technicians identifying invertebrate species in samples. Photograph by David Nelson, U.S. Geological Survey.

A08. Spatial Ecology of Brown Pelicans in the South Atlantic Bight

The sparse availability of data for brown pelicans in the southeastern United States has resulted in an incomplete picture of pelican ecology. Understanding of habitat use at sea, population trends, and reproductive success for pelicans is needed to determine the potential for an overlap between use areas of brown pelicans in the marine environment and proposed or existing offshore energy activities. Data will be used to generate distribution maps and movement models showcasing breeding ranges, migratory pathways, wintering locations, and site fidelity. This information will expand knowledge of this charismatic species in the Atlantic and complement prior research on brown pelicans in the Gulf of Mexico.

Contact: Patrick Jodice, South Carolina Cooperative Fish and Wildlife Research Unit, pjodice@usgs.gov

Partners: Bureau of Ocean Energy Management (BOEM), USGS Outer Continental Shelf Program, Texas Parks and Wildlife Department, Louisiana Department of Wildlife and Fisheries, Alabama Department of Conservation and Natural Resources, Florida Fish and Wildlife Conservation Commission

Recent products:

Tropical cyclones alter short-term activity patterns of a coastal seabird, <https://doi.org/10.1186/s40462-019-0178-0>

For more information: <https://www1.usgs.gov/coopunits/project/134854287360/pjodice>



A09. Investigating Postbreeding Movements and Molting Ecology of Gadwall and Mallards in California



The annual wing molt is a critical event in the annual life history of waterfowl, and site selection for the flightless period of molt can play a role in survival through this demanding period. Using newly developed Global Positioning System (GPS)-cellular network telemetry equipment, USGS scientists tracked movements of gadwall and mallard hens that bred in the Suisun Marsh of California to determine postbreeding movements leading to and extending through prebasic (fall) molt. The telemetry technology allowed scientists to precisely evaluate postbreeding movement chronology, evaluate the selection and characteristics of molt sites, and evaluate the molting duration. These data will help to understand better postbreeding ecology of waterfowl in California and Oregon and, importantly, identify migration pathways to molting locations and site selection that will be vital for wetland conservation planning within the southwestern United States.

Contact: Michael Casazza, Western Ecological Research Center, mike_casazza@usgs.gov

Partners: University of California at Davis, California Department of Fish and Wildlife, California Department of Water Resources—Suisun Marsh Branch, California Waterfowl Association, Central Valley Joint Venture, Intermountain West Joint Venture

For more information: <https://www.usgs.gov/centers/werc/science/waterfowl-ecology-california-and-pacific-flyway>

A10. Body Condition of Lesser Snow and Ross's Geese Harvested by Different Methods during the Light Goose Conservation Order



The increase of midcontinent lesser snow and Ross's goose (collectively light geese) populations during the past 30 years and subsequent detrimental effects to Arctic and sub-Arctic habitats have been well documented. However, changes in species composition, sex ratio, and overall condition of light goose populations are uncertain. Scientists will assess body condition of light geese harvested by various methods and determine species, sex, and age composition. The resulting information will be useful for evaluating tradeoffs when considering alternative management scenarios, including potential strategies to reduce light goose populations.

Contact: Lisa Webb, Missouri Cooperative Fish and Wildlife Research Unit, ewebb@usgs.gov

Partners: Nebraska Game and Parks Commission

For more information: <https://www1.usgs.gov/coopunits/project/115038949376/webbli>

A11. Boater Compliance with Efforts to Minimize Disturbance to Waterfowl during Fall Staging on the Upper Mississippi River National Wildlife and Fish Refuge



Recreational boating on the upper Mississippi River has increased during the past three decades; therefore, resource managers and the public are concerned about the effects of this activity on migratory birds and habitat. Lake Onalaska, in Navigation Pool 7 of the Mississippi River, is an important fall staging area for canvasbacks. A voluntary waterfowl avoidance area program was established on Lake Onalaska in 1986 to reduce boating disturbance to migratory waterfowl and has continued annually during a 31-day period in the fall that coincides



U.S. Geological Survey scientist making observations of the Lake Onalaska Voluntary Waterfowl Avoidance Area. Photograph by Kevin Kenow, U.S. Geological Survey.

with peak canvasback use. Boater compliance with the voluntary waterfowl avoidance area program has been monitored throughout the years to assess if compliance was at or below the threshold rate of one major disturbance per day, as outlined in the 2006 Final Environmental Impact Statement and Comprehensive Conservation Plan. The USFWS has recommended that additional administrative protection be implemented for the Lake Onalaska. The Upper Mississippi River National Wildlife and Fish Refuge needs monitoring data before and after implementation of administrative changes to evaluate the effectiveness of these changes with the voluntary waterfowl avoidance area program.

Contact: Luke Fara, Upper Midwest Environmental Sciences Center, lfara@usgs.gov

Partners: USFWS, Upper Mississippi River National Wildlife and Fish Refuge, La Crosse District

A12. Agent-Based Modeling of Movements and Habitat Selection of Midcontinent Mallards



Landscape conservation of waterfowl depends on the evaluation of waterfowl responses to habitat conditions, which may be based on complex and emergent interactions among behavioral, environmental, and anthropogenic factors. Agent-based models offer a spatially and temporally explicit approach to simulate and evaluate the response of waterfowl populations to conservation scenarios. This research project will develop a tool that can be used by managers to test suitability of alternative conservation allotments to sustain and promote mallard populations during the nonbreeding season. These alternatives will consist of different amounts, configurations, and conditions of management units based on a range of management and future environmental conditions.

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Partners: National Resource Conservation Service (NRCS)

For more information: <https://www1.usgs.gov/coopunits/project/203266310144/webbli>

A13. Migration Patterns, Habitat Use, and Food Habits of Long-Tailed Ducks Wintering on Lake Michigan



A sizable population of long-tailed ducks winters on Lake Michigan. During 2015–18, USGS scientists captured and implanted satellite transmitters into long-tailed ducks wintering on Lake Michigan. Marked ducks provided data on wintering habitat use and movements, migratory routes, and presumptive breeding grounds. Scientists also evaluated long-tailed duck diets from hunter-harvested birds. In addition, scientists performed in-person hunter surveys to assess long-tailed duck harvest and hunter participation from a select launch on Lake Michigan. Project results will assist managers in dealing with conservation issues that may affect long-tailed ducks wintering on Lake Michigan, including outbreaks of type-E avian botulism, near-shore and off-shore wind energy development, and assessment of hunting and harvest regulations.

Contact: Luke Fara, Upper Midwest Environmental Sciences Center, lfara@usgs.gov

Partners: Sea Duck Joint Venture, USFWS–Migratory Bird Management, Southern Illinois University–Carbondale, Izaak Walton League of America–Wisconsin Division

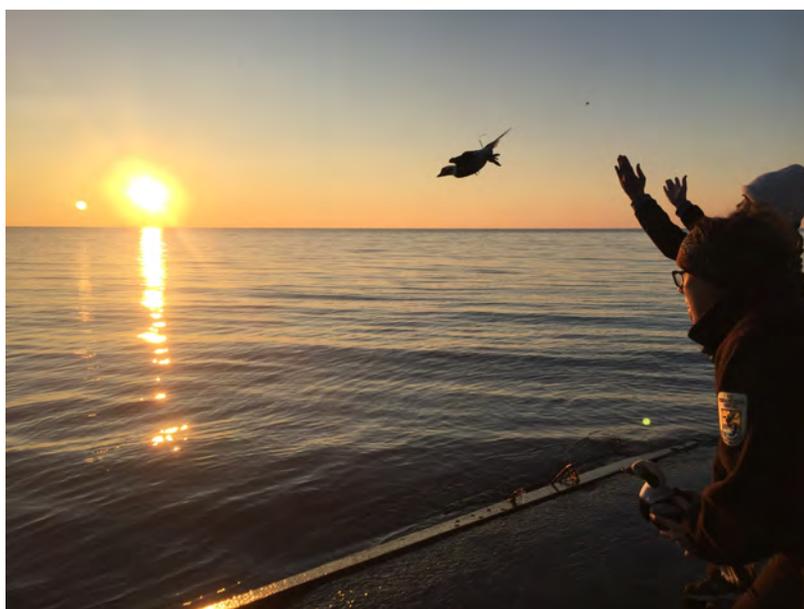
Recent products:

Implanted satellite transmitters affect sea duck movement patterns at short and long timescales, <https://doi.org/10.1093/condor/duaa029>

Assessing year-round habitat use by migratory sea ducks in a multi-species context reveals seasonal variation in habitat selection and partitioning, <https://doi.org/10.1111/ecog.05003>

Spatially explicit network analysis reveals multi-species annual cycle movement patterns of sea ducks, <https://doi.org/10.1002/eap.1919>

Long nights, airplanes, and avian surgery: A tale of working with volunteers to study long-tailed ducks (*Clangula hyemalis*) wintering on Lake Michigan, <https://doi.org/10.1647/2018-418>



Volunteers releasing radio-marked, long-tailed ducks captured from Lake Michigan. Photograph by Kevin Kenow, U.S. Geological Survey.

A14. Ecology of Postbreeding Mallards in North and South Dakota

The behavior and physiology of young mallards during the postfledging period, before fall migration may be unique as the birds learn to fly and navigate, exploit new forage and wetland types, develop settling and social cues, molt, avoid predators, change social status and bonds, and anticipate migration, yet few studies have investigated their ecology during this time. This project intends to use GPS/Global System for Mobile Communications (GSM) implantable transmitters to investigate movements of hatch-year mallards. Because survival of juvenile mallards during autumn is an integral component of recruitment to the breeding population, understanding ecology of hatch-year mallards during this sensitive time will provide information for management decisions, such as habitat acquisition and harvest regulation in North and South Dakota.



Contact: Joshua Stafford, South Dakota Cooperative Fish and Wildlife Research Unit, jstafford@usgs.gov and Aaron Pearse, Northern Prairie Wildlife Research Center, apearse@usgs.gov

Partners: North Dakota Game and Fish Department, South Dakota Game, Fish and Parks

For more information: <https://www1.usgs.gov/coopunits/project/169802889216/joshua.stafford>

A15. Sea Duck Harvest on Lake Michigan

Information collected from waterfowl hunters in Wisconsin has been used to guide managers in making decisions within the State, including information on zone structures and split season frameworks. USGS scientists are expanding hunter surveys to better assess a small, but growing, population of hunters that use open waters of Lake Michigan and Green Bay. Survey results will assist managers by providing species composition of harvested waterfowl, by providing details on what environmental factors (for example, wave height, wind speed, wind direction, and temperature) hunters are likely to engage in hunting activities, and by gathering hunter input regarding regulatory frameworks.



Contact: Luke Fara, Upper Midwest Environmental Sciences Center, lfara@usgs.gov

Partners: Wisconsin Department of Natural Resources, University of Wisconsin-Stevens Point



Long-tailed ducks flying over Lake Michigan near Two Rivers, Wisconsin. Photograph by Luke Fara, U.S. Geological Survey.

A16. Migration Ecology of North American Turkey Vultures Wintering in the Neotropics—Spatial and Population Dynamics

Landscape composition and configuration have been determined to affect the migration of raptors. However, ecological and functional roles played by the landscape and weather in shaping migration strategies of North American turkey vultures are unknown. Furthermore, scant information is available on factors triggering the processes of outbound and return migration of the turkey vulture. This research will analyze and synthesize a database of more than 60 vultures radiomarked with satellite transmitters during the last decade. Results will fill critical knowledge gaps focusing on three North American turkey vulture subpopulations, including information on migration strategies, migratory connectivity, space use, resource selection, and survival of these vulture populations. Results also may provide insight into how multiresolution landscape characteristics, anthropogenic disturbance, and weather conditions play in the life cycle of this species of raptor.



Contact: Francisco Vilella, Mississippi Cooperative Fish and Wildlife Research Unit, fvilella@usgs.gov

Partners: Hawk Mountain Sanctuary, Mississippi State University

For more information: <https://www1.usgs.gov/coopunits/project/193808109568/fvilella>

A17. Distribution and Abundance of Migrating and Wintering Waterbirds on Lake Michigan

The Great Lakes represents an important resource to migrating and wintering waterbirds by providing abundant resting and foraging opportunities. Information on Great Lakes waterbird concentrations during migration and winter is of interest to resource managers as they deal with several priority conservation issues. Assessment of near-shore and off-shore wind turbine placement, characterization of sea duck wintering distribution and population status, and elucidation of factors that affect the outbreak of type-E avian botulism require



U.S. Fish and Wildlife Service biologist during waterbird survey of Lake Michigan. Photograph by Kevin Kenow, U.S. Geological Survey.

better understanding of the distribution, abundance, and temporal use patterns of waterbirds. Systematic waterbird surveys of selected areas of Lake Michigan were completed during 2009–14 in association with multiple studies. These data are being incorporated into a waterbird abundance model, linking the association of selected species to habitat and environmental conditions. Such models could be useful in identifying the total number of birds at risk to botulism poisoning, mortality from wind energy infrastructure, and other disturbances.

Contact: Kevin Kenow, Upper Midwest Environmental Sciences Center, kkenow@usgs.gov

Partners: USFWS, Great Lakes Commission, Alaska Cooperative Fish and Wildlife Research Unit, Institute of Arctic Biology, University of Wisconsin-Stevens Point

Recent products:

A comparative analysis of common methods to identify waterbird hotspots, <https://doi.org/10.1111/2041-210X.13209>

For more information: <https://www.usgs.gov/centers/umesc/science/waterbird-distribution-and-foraging-patterns-great-lakes-respect-avian>



A18. Avian Abundance and Use Patterns in Fields Managed for Mourning Doves—A Multiscale Approach

Dove hunting is a popular outdoor activity in Mississippi and across the United States. Research on mourning doves has been scarce in Mississippi, with recent studies focusing on landscape change around mourning dove call-count routes and banding studies assessing movements and survival. This research will evaluate relations between abundance patterns and multiscale characteristics of managed fields used by mourning doves on Wildlife Management Areas managed by the Mississippi Department of Wildlife, Fisheries, and Parks. Study sites include fields actively managed using dove-attracting crops and were selected based on records of variable hunting pressure and harvest. Results will be used for managing mourning doves and for planning activities such as planting crops on managed lands.

Contact: Francisco Vilella, Mississippi Cooperative Fish and Wildlife Research Unit, fvilella@usgs.gov

Partners: Mississippi Department of Wildlife, Fisheries, and Parks

For more information: <https://www1.usgs.gov/coopunits/project/193962137600/fvilella>



A19. Determining the Relative Importance of Cisco in Diets of Common Loons among Cold-Water Cisco Refuge Lakes in Minnesota

Minnesota lakes with abundant cisco (a deep-water, pelagic fish) populations often have high densities of nonbreeding common loons from midsummer through fall. These loon aggregations generally are present over deep water, where the primary fish species is cisco. The Minnesota Department of Natural Resources directs a substantial conservation effort regarding some of the State's important cisco lakes and is interested in the potential benefits to loons from these efforts. The goal of the project is to determine common loon foraging patterns and the importance of cisco in diets of breeding and nonbreeding common loons among cold-water cisco refuge lakes in Minnesota. The results of this project not only have implications for the cisco lake conservation program, but the results also provide information for common loon restoration efforts associated with the 2016 Deepwater Horizon Oil Spill restoration efforts.

Contact: Kevin Kenow, Upper Midwest Environmental Sciences Center, kkenow@usgs.gov

Partners: Minnesota Department of Natural Resources



Common loon foraging on cisco on Big Trout Lake in Crow Wing County, Minnesota. Photograph by Steve Houdek, U.S. Geological Survey.



A20. Minnesota Trumpeter Swan Migration Ecology and Conservation

The interior population of trumpeter swans was reestablished through reintroduction efforts beginning in the late 1960s. Since that time, the population has exceeded reintroduction goals and currently (2021) numbers more than 25,000 individuals. As this population transitions from rare to abundant across much of the Upper Midwest, a lack of information regarding basic ecology hinders planning for long-term management. This project will mark interior population trumpeter swans with GPS/GSM transmitters to evaluate year-round swan movements, determine if and where trumpeter swans make molt migrations, evaluate year-round habitat use and selection patterns, and evaluate survival rates of trumpeter swans. Additionally, the research will evaluate the genetic structure of this population and assess environmental exposure to lead. Information resulting from this project will help guide future trumpeter swan management across the western Great Lakes region.

Contact: David Andersen, Minnesota Cooperative Fish and Wildlife Research Unit, dea@usgs.gov

Partners: University of Minnesota, USFWS, Canadian Wildlife Service, Manitoba Conservation, Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, Michigan Department of Natural Resources, Iowa Department of Natural Resources, Great Lakes Indian Fish and Wildlife Commission, Trumpeter Swan Society

For more information: <https://www1.usgs.gov/coopunits/project/189724708864/dea>



A21. Identifying Migratory Routes and Wintering Grounds of Burrowing Owls that Breed on Department of Defense Installations in the Western United States

Burrowing owls were once a common breeder in grasslands throughout North America but are now considered a bird of conservation concern in the United States. Burrowing owls are present on many Department of Defense (DoD) installations throughout the western United States. This project will identify wintering grounds and migratory routes of burrowing owls nesting on DoD lands through the use of geolocators. Identifying migratory routes and wintering grounds for burrowing owls that breed on DoD installations will help determine shared management responsibility and allow for the development of cost-effective management plans for recovery. Results will identify priority management needs for this declining species and help reduce conflict with the military mission on DoD installations.

Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

Partners: Arch Coal, USACE, DoD–Legacy, National Science Foundation, Canadian DoD, Canadian Wildlife Service

For more information: <https://www1.usgs.gov/coopunits/project/60295856128/cconway>





Burrowing owl near Las Vegas, Nevada. Photograph by Jeri Krueger, U.S. Fish and Wildlife Service.

A22. Migration Trends for King and Common Eiders and Yellow-Billed Loons Past Point Barrow in a Rapidly Changing Environment

Most king and common eiders and yellow-billed loons nesting in northern Alaska and northwestern Canada migrate twice a year past Point Barrow, Alaska, during northward spring migration and southward fall migration. Historical records from spring and fall counts indicate both eider species have experienced population declines while trends for loons have yet to be assessed. This project will evaluate trends in population estimates of king and common eiders by comparing recently collected data with data from the 1970s, 1990s, and early 2000s. Additionally, the project will evaluate observer error through photographic and radar techniques and obtain estimates of yellow-billed loon populations that can be compared to previous counts. Such data are critically needed to assess conservation needs of these species.

Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: BOEM, Wildlife Conservation Society, North Slope Borough, University of Alaska Fairbanks

Recent products:

Population trends of king and common eiders from spring migration counts at Point Barrow, Alaska between 1994 and 2016, <https://doi.org/10.1007/s00300-019-02581-6>

For more information: <https://www1.usgs.gov/coopunits/project/127299004416/ffanp>



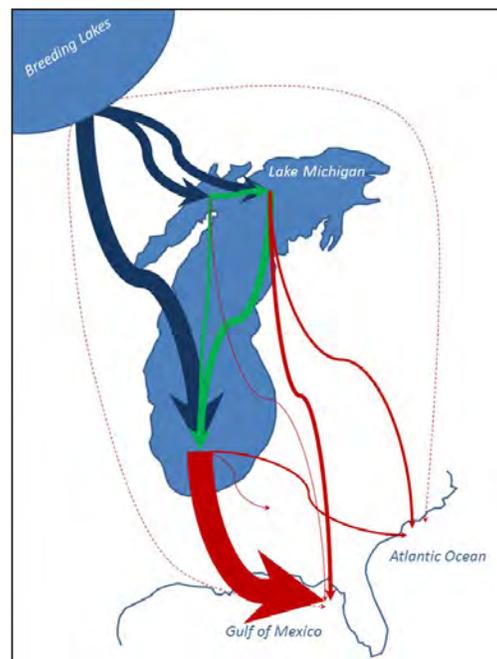
A23. Migration Patterns and Wintering Distribution of Common Loons Breeding in the Upper Midwest

The common loon is considered one of the most vulnerable Minnesota migratory birds from effects of the Deepwater Horizon oil spill. Staff from the Minnesota Department of Natural Resources requested information on migration patterns, wintering distribution of loons breeding in Minnesota, and more detail on winter range and habitat use. The USFWS Species Status Assessment and Conservation Plan for the common loon recommends research to develop geographic linkages among breeding, migratory, and wintering common loon populations. Identifying location and timing of use of migration and wintering sites will inform regional and national conservation planning efforts and compensation of loons lost during marine oil spill events.

Contact: Kevin Kenow, Upper Midwest Environmental Sciences Center, kkenow@usgs.gov

Partners: Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, University of Florida, University of Wisconsin-Madison

For more information: <https://www.usgs.gov/centers/umesc/science/common-loon-migration-study>



Migration patterns of adult common loons breeding in Minnesota, Wisconsin, and the Upper Peninsula of Michigan, with respect to passage through Lake Michigan.

A24. Overwintering Survival of Shorebirds on Florida's Panhandle

The beaches and coastal bayside wetlands along Florida's panhandle are important to migrant and resident shorebirds, including species of conservation concern such as piping plovers and red knots. Human disturbance and development, dredged and hardened inlets, and sea level rise have affected much of the natural beach habitat in this region. The objective of this project is to use existing data and to collect additional field data on nonbreeding shorebirds using public lands along Florida's Panhandle region and, where data on banded birds permits, determine overwintering survival at targeted sites along northwestern Florida beaches. The results will inform managers of potential areas that may need additional protection or alternative management to enhance survival of migrating and overwintering shorebirds.

Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: USFWS, Audubon Society, University of Florida

For more information: <https://www1.usgs.gov/coopunits/project/168485916672/ffanp>



A25. Causes of Differential Migration in Birds

For centuries, the spectacle of animal migration has fascinated the scientific community. Why migration happens is of central importance to the evolution of migratory behavior, and mechanisms governing migratory decisions continue to be an active area of research. One widespread and well-studied migration pattern that has produced insights into why birds migrate is differential migration. Differential migration can be broadly defined as intraspecific variation in migratory behavior, and research has often focused on variation in migration timing, speed, and distance; choice of wintering area; or whether to migrate or not. Whereas differential migration is widespread and well-studied, the underlying causes of this phenomena remain difficult to elucidate. The objectives of this project are to test hypotheses to explain variation in migration distance among individual, remotely tracked, rough-legged hawks. This work also will be broadened and used in a review and analysis of differential migration.

Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

Partners: National Science Foundation, Kidd Biological, University of Idaho

For more information: <https://www1.usgs.gov/coopunits/project/211271225344/cconway>



A26. Movements and Overwinter Survival of Juvenile Red Knots in Southeast United States—Information Needs for Recovery Planning



Tagged red knot along the Atlantic Coast.
Photograph by Gregory Breese, U.S. Fish and Wildlife Service.

Much of the focus of red knot research and conservation during the past 20 years has largely focused on a few sites along the Atlantic Flyway, primarily in the mid-Atlantic region. Scientists do not know the full distribution of juvenile red knots. The primary goals of this project are to identify the main area(s) where juvenile red knots are present during their first 2 years of life and to estimate survival and recruitment rates. Results will be used by biologists to help understand threats to juvenile red knots.

Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: USFWS, Florida Fish and Wildlife Commission, Georgia Department of Natural Resources, South Carolina Department of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/192484032512/ffanp>



A27. Evaluating Wetland-Ecosystem Health Using Real-Time Nutrient Dynamics of Ducks



USGS scientists are leading a collaborative effort, spanning several studies, with the objective of improving techniques to assess quality of spring migration habitat for ducks. Spring is a critical time in the life cycle of migratory ducks because, during migration, ducks experience peak energetic needs at a time when food resources are often scarce. Accordingly, ducks must maximize energy replenishment rates by eating high-lipid forage on spring stopover habitats. This research is focused on assessing the quality of stopover habitats and improving techniques for that assessment. Scientists are using plasma-lipid metabolites of migratory ducks to improve assessments of real-time refueling rates on spring stopover wetland habitats. The results will improve research on spring stopover habitats and allow assessment of wetland ecosystem health on a broad scale to provide information for more efficient conservation efforts.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: South Dakota Cooperative Fish and Wildlife Research Unit, Mississippi Flyway Council, Illinois Department of Natural Resources, South Dakota Game, Fish and Parks, South Dakota State University, Western Illinois University, Ducks Unlimited Canada, Illinois Natural History Survey

Recent products:

Extreme climatic variability during migration invokes physiological and dietary plasticity among spring migrant ducks, <https://doi.org/10.1139/cjz-2018-0075>

Prairie wetlands confer consistent migrant refueling conditions across a gradient of agricultural land use intensities, <https://doi.org/10.1016/j.biocon.2018.11.021>

For more information: <https://www.usgs.gov/centers/npwrc/science/evaluating-wetland-ecosystem-health-using-real-time-nutrient-dynamics-ducks>

A28. Effects of Extreme Disturbances at Wintering Areas on Piping Plover Survival and Migratory Connectivity

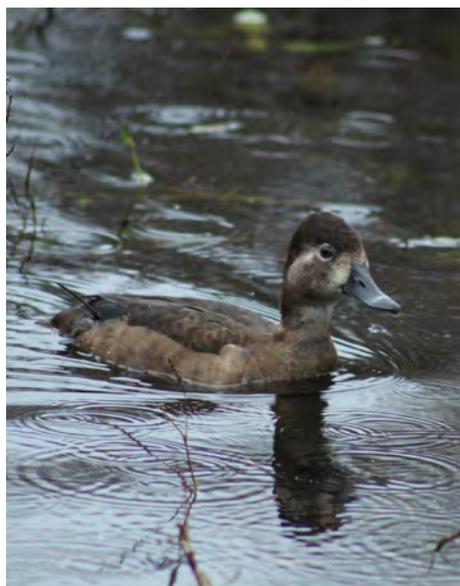


Migratory birds that use coastal habitats may experience extreme disturbances, including oil spills, harmful algal blooms, and hurricanes. Recent research has indicated that certain environmental disturbances are increasing in frequency partially because of climate change. Understanding effects of these disturbances may require a broad spatial and temporal context. Piping plovers are migratory shorebirds that periodically encounter coastal disturbances because their known winter distribution falls along the Atlantic and Gulf coasts of the United States, Mexico, and the Caribbean. The objectives of this project are to (1) evaluate how extreme environmental disturbances affect adult survival, (2) identify potential carry-over effects on survival between seasons, and (3) quantify migratory connectivity for piping plovers breeding within the midcontinent of North America. USGS scientists will analyze mark-resight data on piping plovers collected from 2002 to 2020, by many research teams and community members (primarily in coastal regions). Results will provide seasonal insights into population dynamics of piping plovers and lead to better-informed conservation strategies for the species.

Contact: Kristen Ellis, Northern Prairie Wildlife Research Center, kellis@usgs.gov and Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: Environment and Climate Change Canada, University of Minnesota, Nebraska Game and Parks Commission, Colorado State University, Coastal Bend Bays and Estuaries Program, University of Nebraska–Lincoln

A29. Ring-Necked Duck Wintering and Migration Studies



Female ring-necked duck with an internal transmitter on pond in the Red Hills Region of Florida and Georgia. Photograph by Glenn Olsen, U.S. Geological Survey.

The ring-necked duck breeds and winters across North America and is perhaps the most abundant diving duck harvested. USGS scientists used satellite transmitters to follow female ring-necked ducks marked in the southern Atlantic Flyway during winters of 2017–19.

Regional differences in winter survival in the south Atlantic Flyway have not been determined. Winter survival and harvest variability affect ring-necked duck population dynamics and can affect adaptive harvest management decisions. Migration and winter habitat use also will be studied for these birds in the southeastern United States.

Contact: Glenn Olsen, Eastern Ecological Science Center (formerly Patuxent Wildlife Research Center and Leetown Science Center), golsen@usgs.gov

Partners: University of Georgia, Georgia Department of Natural Resources, Florida Fish and Wildlife Conservation Commission, Delta Waterfowl, 4 Oaks Plantation, Tall Timbers Research Station and Land Conservancy, Virginia Department of Wildlife Resources

Recent products:

Wintering survival of female ring-necked ducks in the southern Atlantic Flyway, <https://doi.org/10.1002/jwmg.21943>



A30. Modeling Avian Migration from First Principles

Migratory waterfowl provide ecosystem services that vary in space and time, such as recreational hunting and viewing, as well as disservices, such as vectoring disease. To understand and predict these movements and resultant consequences to ecosystem service delivery, a continental-scale energetics-based model of waterfowl movement was created. The model moves mallard-like dabbling ducks as a function of caloric gains and losses on a daily time step through the continent, from the breeding grounds through migration across the nonbreeding period. The model approximates energy-expensive movements and energy-gaining stopovers as functions of daily weather, in terms of temperature and frozen precipitation (for example, snow), and the resultant effect on metabolism and body condition. The model is being used to estimate population-level consequences of place-specific perturbations, such as oil spills, to help inform Natural Resource Damage Assessments. Other uses involve evaluating how land and climate change affect waterfowl population dynamics and movement and how the value of harvest provided by waterfowl changes through time and space. Future uses of the model will be to understand the place- and time-specific risk of avian influenza outbreaks; provide real-time, 8-day forecasts of hunter opportunities; identify the magnitude of nonbreeding season weather on breeding body condition; and further evaluate the climate-affected risk for cessation of migration.

Contact: Wayne Thogmartin, Upper Midwest Environmental Sciences Center, wthogmartin@usgs.gov

Partners: USFWS, Colorado Parks and Wildlife, Natural Capital Project, USGS Columbia Environmental Research Center

Recent products:

Modeling the relationship between water level, wild rice abundance, and waterfowl abundance at a central North American wetland, <https://doi.org/10.1007/s13157-018-1025-6>



A31. Ecology and Management of Midcontinent Sandhill Cranes

During breeding, winter, and migration, midcontinent sandhill cranes occupy a large geographic area, including central and western North America and northeastern Asia. Midcontinent sandhill cranes are the focus of a unique convergence of multiple user groups with an interest in the continued health of this population. Tens of thousands of people view hundreds of thousands of cranes during spring staging at the Platte River Valley in Nebraska, and hunters pursue and harvest cranes annually in most of their fall and winter range. The overall goal of this project is to provide information that will improve crane management. This research includes the following multiple objectives: (1) determination of geographic distribution, migration chronology, and spring-staging ecology in the Platte River Valley; (2) evaluation of survey methods; (3) estimation of survival and recruitment; and (4) modeling of population dynamics. Completed research will provide better-informed harvest management strategies, opportunities for increased international conservation collaboration, conservation of crane habitats at multiple spring stopover sites, and insight into long-term monitoring of habitats and cranes.



Contact: Aaron Pearse, Northern Prairie Wildlife Research Center, apearse@usgs.gov

Partners: USFWS, Colorado Parks and Wildlife, Texas Parks and Wildlife Department, Oklahoma Department of Wildlife Conservation, Kansas Department of Wildlife, Parks and Tourism, Nebraska Game and Parks Commission, South Dakota Game, Fish and Parks, North Dakota Game and Fish Department, Wyoming Game and Fish Department, Montana Fish, Wildlife, and Parks, International Crane Foundation, Crane Trust

Recent products:

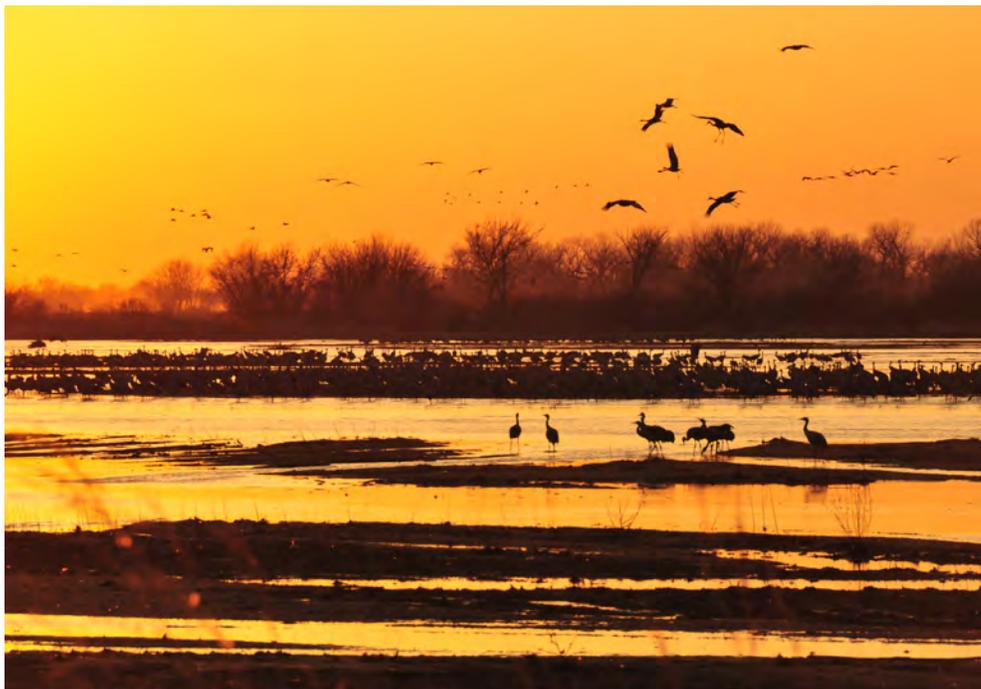
Temporospatial shifts in sandhill crane staging in the central Platte River Valley in response to climatic variation and habitat change, <https://scholarsarchive.byu.edu/mwnan/vol11/iss1/4>

Population and harvest dynamics of midcontinent sandhill cranes, <https://doi.org/10.1002/jwmg.21865>

Roosting habitat use by sandhill cranes and waterfowl on the North and South Platte Rivers in Nebraska, <https://doi.org/10.3996/042019-JFWM-030>

Using morphological measurements to predict subspecies of midcontinent sandhill cranes, <https://doi.org/10.1002/wsb.1020>

For more information: <https://www.usgs.gov/centers/npwrc/science/ecology-and-management-midcontinent-sandhill-cranes>



Sandhill cranes roosting at the Platte River, Nebraska, during spring migration. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

A32. Golden Eagles in Yellowstone National Park and Their Role in the Greater Yellowstone Ecosystem

The status of golden eagles in Yellowstone National Park is not fully known. To address regional and park concerns about golden eagle population status, USGS and NPS scientists are building a framework for a long-term monitoring program for golden eagles within Yellowstone National Park. Scientists are trapping and attaching telemetry units to golden eagles to track movement and demography. The goals are to identify resource use and the environmental drivers associated with reproduction and survival of golden eagles on the northern range of the Park by studying food habits, toxicology, survival, and movement of eagles. This research will help NPS and other Federal and State managers make scientifically informed decisions for management of golden eagles. This research also will help to build an understanding of the species within the greater Yellowstone ecosystem and more broadly within the American West.

Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: NPS



A33. Eagle Movement Response to Environmental Stressors

Recent telemetry studies of golden eagle movements indicate that different types of annual movements, including migrations, are strongly affected by weather. USGS scientists and other researchers are combining existing data on nearly 300 telemetered eagles from many studies across the country to evaluate potential environmental drivers of long-distance movements by eagles and to identify demographic consequences of those movements. Results will aid USFWS biologists in understanding golden eagle long-distance movements in the context of drought and other weather-related variables so they can take appropriate actions to mitigate threats by knowing when, where, and why eagles move. Combining datasets presents a unique opportunity to study eagle movements and model underlying drivers of movements and associated conservation implications.

Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: USFWS

Recent products:

Relevance of individual and environmental drivers of movement of golden eagles, <https://doi.org/10.1111/ibi.12766>



Golden eagle on power pole. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

Breeding Ecology

B01. Waterfowl Breeding and Nesting Ecology in Suisun Marsh and the Pacific Flyway

Suisun Marsh is used by wintering and breeding ducks in California and historically has harbored some of the highest densities of nesting ducks in North America; therefore, Suisun Marsh is an important ecosystem to protect and manage. Many of dabbling duck species that winter in California (for example, mallard and gadwall) nest in upland habitats within the State. Suisun Marsh also is an important site for tidal marsh restoration, which may affect the capacity of the marsh to support waterfowl populations as the birds move from upland nesting sites to nearby wetlands. The purpose of this multiyear study of breeding and nesting ecology in Suisun Marsh is to investigate factors that shape both nest and duckling survival. These two components affect recruitment of new ducks into the population and have a direct effect on California duck hunters' harvest. Components of the project include (1) locating and monitoring duck nests to determine nest abundance and hatching success; (2) assessing how the timing of nesting, vegetation, and habitat management around nesting sites affect nest survival; (3) determining how predators affect nest and duckling



U.S. Geological Survey biological science technician holding a duckling with a lightweight radio transmitter. Photograph by Sarah Peterson, U.S. Geological Survey

survival; and (4) examining the effect of tidal marsh restoration. Results of the research can be used to shape management of upland and wetland habitats for breeding ducks with the goal of improving nesting and brooding success of California waterfowl.

Contact: Josh Ackerman, Western Ecological Research Center, jackerman@usgs.gov

Partners: USFWS, California Department of Water Resources, California Department of Fish and Wildlife, California Waterfowl Association, Ducks Unlimited, Inc., University of California at Davis, Central Valley Joint Venture

Recent products:

Timing, frequency, and duration of incubation recesses in dabbling ducks, <https://doi.org/10.1002/ece3.6078>

Sitting ducklings—Timing of hatch, nest departure, and predation risk for dabbling duck broods, <https://doi.org/10.1002/ece3.5146>

For more information: <https://www.usgs.gov/centers/werc/science/breeding-and-wintering-ecology-waterfowl>



B02. Breeding Ecology of Cinnamon Teal within the San Luis Valley, Colorado

In 2009, the USFWS Regulations Committee requested an assessment of the harvest potential of three North American teal species, including the cinnamon teal. The assessment included five areas of interest, one of which was population dynamics of each species. The cinnamon teal is one of the least studied waterfowl species in North America, and reliable and accurate demographic information, including reproductive parameters, is needed to determine population status and responses to harvest and habitat management. Results will provide baseline demographic data for this population of teal and will provide refuge managers information about the effects of conditions created by refuge management and water availability on cinnamon teal.

Contact: William Kendall, Colorado Cooperative Fish and Wildlife Research Unit, wkendall@usgs.gov

Partners: USFWS, Monte Vista NWR, Colorado Parks and Wildlife



Recent products:

Nest site selection influences cinnamon teal nest survival in Colorado, <https://doi.org/10.1002/jwmg.21818>

Factors influencing cinnamon teal nest attendance patterns, <https://doi.org/10.1111/ibi.12838>

For more information: <https://www1.usgs.gov/coopunits/project/151974021120/William.Kendall>

B03. The Effect of Future Changes in Climate on Breeding Waterfowl Pairs in the Prairie Pothole Region



The Prairie Pothole Region is recognized as one of the most productive areas for waterfowl in North America and is used by an estimated 50–80 percent of the continent’s breeding duck population. The ongoing acquisition program of the USFWS NWR System has conserved approximately 1.3 million hectares of critical breeding-waterfowl habitat. An assumption inherent to the contemporary conservation approach is that past distributions of waterfowl habitat and populations represent future distributions. The project goal is to coproduce novel information for land-management agencies to better plan for future effects of climate change on wetland habitat for breeding waterfowl in the Prairie Pothole Region. USGS scientists will use a mechanistic hydrology model in combination with USFWS multidecadal datasets and predictive breeding waterfowl pair statistical models to simulate wetland-waterfowl responses based on different climate futures. Results will provide USFWS biologists with information about potential climate-driven changes to breeding waterfowl pairs on monitored wetlands.

Contact: Owen McKenna, Northern Prairie Wildlife Research Center, omckenna@usgs.gov

Partners: USFWS–Habitat and Population Evaluation Team, University of Colorado-Boulder

Recent products:

Final report—Climate-driven state shifts in the Prairie Pothole Region—Assessing future impacts relevant to the management of wetland habitats critical to waterfowl, <https://www.sciencebase.gov/catalog/item/5e012601e4b0b207aa033e8d>

For more information: <https://www.usgs.gov/centers/npwrc/science/climate-driven-state-shifts-prairie-pothole-region-assessing-future-impacts>



Northern shoveler breeding pair in a wetland. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

B04. Predator Cascade and Nest Success—Changes in Foraging Patterns as a Function of Grassland Patch Dynamics and Vegetation Composition



Predator-prey interactions affect vital rates, and predation is a primary cause of nest failure of ground-nesting birds (for example, waterfowl). With continued grassland loss associated with conversion to row crop agriculture and changing predator communities (for example, declines in red fox and active coyote control), the goal of this project is to understand how habitat dynamics affect predator-prey interactions and nest success of ground-nesting birds. Results will help improve development of comprehensive management recommendations for remaining grasslands, restoration efforts, and active management programs. The goal of these management recommendations is to modify grassland regimes or predator communities to improve nesting habitat and nest survival.

Contact: Joshua Stafford, South Dakota Cooperative Fish and Wildlife Research Unit, jstafford@usgs.gov and Aaron Pearse, Northern Prairie Wildlife Research Center, apearse@usgs.gov

Partners: South Dakota Game, Fish and Parks, North Dakota Game and Fish Department

For more information: <https://www1.usgs.gov/coopunits/project/169802811392/joshua.stafford>

B05. Understanding Avian Predator Movement Ecology, Habitat Selection, and Effects on Breeding Waterfowl to Inform Habitat and Population Management in Suisun Marsh, California



Predator-prey interactions are important to understanding population dynamics and community structure. Suisun Marsh is an important breeding and wintering location for waterfowl; however, little information is available about how avian predators (northern harriers, great horned owls, red-tailed hawks, and common ravens) use the landscape and interact with waterfowl year round. The goal of this project is to understand basic ecology of avian predators in Suisun Marsh and their role as apex predators, with special attention to northern harriers (a species of special concern in California), in a waterfowl-dominated ecosystem. Specific objectives are as follows: (1) determining migration corridors, stopover locations, and site fidelity using GPS/GSM transmitters; (2) determining habitat selection and distribution in Suisun Marsh; and (3) understanding prey preferences using nest cameras and pellet analysis. This work will help improve waterfowl management strategies; fill knowledge gaps about sensitive species; and contribute to fulfilling the Suisun Marsh Plan, an adaptive and ecosystem-based management approach used by California State, Federal, and private partners to conserve and restore the Suisun Marsh ecosystem.

Contact: Michael Casazza, Western Ecological Research Center, mike_casazza@usgs.gov

Partners: University of California at Davis, California Department of Fish and Wildlife, California Department of Water Resources–Suisun Marsh Branch, Suisun Resource Conservation District, USFWS, Bureau of Reclamation, California Waterfowl, Westervelt Ecological Services

For more information: <https://www.usgs.gov/centers/werc/science/waterfowl-ecology-california-and-pacific-flyway>



Northern harrier migration tracks between Suisun Marsh, California, and breeding areas as far north as Alaska.

B06. Evaluating Avian Use of Cover Crop Fields in the Corn Belt



Fall-seeded cover crops are a re-emerging technology in the upper Midwest that are intended to improve soil health, crop yields, and reduce erosion. Wildlife benefits may be realized from planting of cover crops, but because a cash crop (for example, corn and soybean) is planted and harvested during the avian nesting season, the effect on wildlife and avifauna in particular is unknown. The objectives of this project are to research breeding bird use and nest survival of grassland nesting songbirds in cover crops in Iowa. Results from this research will provide managers with information about avifaunal benefits or detriments of incentivizing fall-seeded cover crops. If this practice becomes an ecological trap for birds, managers can focus on complementary programs to offset cover cropping, which has clear soil health and water-quality implications.

Contact: Joshua Stafford, South Dakota Cooperative Fish and Wildlife Research Unit, jstafford@usgs.gov

Partners: NRCS, Iowa State University

For more information: <https://www1.usgs.gov/coopunits/project/169803001856/joshua.stafford>

B07. Response of Grassland Birds to Habitat Characteristics, Oil Wells, and Roads in the Little Missouri National Grassland in North Dakota

The U.S. Forest Service (USFS) defines sensitive species as species that need special management to maintain and improve their status on National Forests and National Grasslands to prevent a need for listing the species under the Endangered Species Act. The Sprague's pipit and Baird's sparrow are listed as sensitive species in the Northern Region of the USFS. These species require large patches of native grass cover throughout their life cycles. Large-scale losses and degradation of grassland habitat critical for these passerines highlight the importance of appropriate management and conservation measures for remaining native grasslands. The purpose of this project is to evaluate the effects of landscape-level (for example, oil development and roads) and site-specific (for example, vegetation structure and composition) factors on populations of Sprague's pipits, Baird's sparrows, and other declining grassland birds in the Little Missouri National Grassland in western North Dakota. The results will contribute to understanding grassland songbird responses to local and landscape factors and identify specific mechanisms by which conservation measures for declining grassland bird populations can be improved.



Contact: Lawrence Igl, Northern Prairie Wildlife Research Center, ligl@usgs.gov

Partners: USFS, North Dakota State University

For more information: <https://www.usgs.gov/centers/npwrc/science/response-grassland-birds-habitat-characteristics-oil-wells-and-roads-managed>

Male Baird's sparrow singing in a native mixed-grass prairie. Photograph by Rick Bohn.

B08. Ecology of Breeding Canvasbacks in Southwestern Manitoba

Predation is the most common cause of nest failure in waterfowl; however, nearly all studies on the topic have focused on upland nesting ducks. Several species of diving ducks nest overwater and, therefore, cause-specific nest failure of these species is less understood than for upland nesting ducks. Managers who wish to increase nest survival and, hence, diving duck populations, lack information to make management decisions or develop best practices. The goal of this project is to compare nest survival of canvasbacks and other overwater-nesting species between areas where predators have been lethally removed and areas where predators have not been removed. Results of this work will allow managers to understand if predator removal is effective at increasing survival of overwater nests, as well as understand multiple factors influencing nest survival. The role of redhead parasitism on canvasback nests is of additional interest.



Contact: Joshua Stafford, South Dakota Cooperative Fish and Wildlife Research Unit, jstafford@usgs.gov

Partners: Delta Waterfowl Foundation, University of Minnesota, Louisiana State University

For more information: <https://www1.usgs.gov/coopunits/project/192539684864/joshua.stafford>

B09. Least Tern and Common Tern Productivity on Poplar Island Restoration Site

The Poplar Island Environmental Restoration Project is a world class restoration site using clean dredge material to restore remote island habitat in the Chesapeake Bay. Although breeding waterbird populations quickly established on this site after the earliest stages of restoration efforts, some concern has been raised about low productivity of two important tern species—the Maryland State-listed least tern and common tern. Although USGS efforts to understand this population began in 2002, a large scale mark-resight project was initiated in 2013 to improve estimates of hatching and fledging success for these species. Study objectives include improving understanding of (1) the factors influencing nesting and fledging success in least and common tern colonies, (2) how habitat restoration activities have affected breeding bird behaviors and space use at this site, and (3) how new and existing modeling approaches affect estimates of nesting and fledging success. Scientists also are developing a method to collect telemetry data from juvenile and adult birds to gain insight into local and regional movements. The data collected during this project will be used by collaborators of the USFWS to manage the population and mitigate any identified risks and by collaborators of the Maryland Department of Natural Resources to manage populations and habitat at the State level.

Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: USFWS, USACE, Maryland Environmental Service

Recent products:

Promoting change in common tern (*Sterna hirundo*) nest site selection to minimize construction related disturbance, <https://doi.org/10.3368/er.37.3.143>

Eviction notice—Observation of a *Sterna hirundo* (common tern) usurping an active *Sternula antillarum* (least tern) nest, <https://doi.org/10.1656/045.026.0313>

For more information: <https://www.usgs.gov/centers/pwrc/science/productivity-species-concern-least-tern-and-common-tern-poplar-island>



A member of the field crew holds a recently banded least tern chick, displaying both its U.S. Geological Survey Bird Banding Lab metal band and its plastic field readable band. Photograph by U.S. Geological Survey.



B10. Evaluating Nest Site Selection of Arctic Peregrine Falcons in the Colville River Special Area

One-fourth of Alaska's Arctic peregrine falcons, formerly a federally threatened species, nest along the Colville River on Alaska's North Slope. Since recovery and removal of the Colville River Arctic peregrine from the endangered species list, the peregrine population has increased substantially, although considerable variation has been observed in reproductive success and reproduction. USGS scientists used historical survey data and population dynamics models to assess where this population would be most and least susceptible to perturbation. Results of this project will be used to refine management strategies for Colville River Arctic peregrines that minimize potential population changes from anthropogenic factors.

Contact: David Andersen, Minnesota Cooperative Fish and Wildlife Research Unit, dea@usgs.gov

Partners: Bureau of Land Management (BLM), USFWS

For more information: <https://www1.usgs.gov/coopunits/project/150842869760/dea>



B11. Nearshore Marine Ecosystem Research Program



U.S. Geological Survey biologist prepares to release a black oystercatcher in Kachemak Bay, Alaska. Photograph by Brian Robinson, U.S. Geological Survey.

The purpose of the Nearshore Marine Ecosystem Research Program is to research a broad range of marine wildlife, including migratory birds. Avian research is focused particularly on nearshore birds that prey on benthic invertebrates, including black oystercatchers and sea ducks. In addition to directed studies of ecology, USGS scientists are engaged in a long-term marine monitoring program across the Gulf of Alaska. This monitoring program tracks marine bird abundance and community structure and black oystercatcher reproductive performance at several regions of the Gulf of Alaska.



Contact: Dan Esler, Alaska Science Center, desler@usgs.gov and Brian Robinson, Alaska Science Center, brobinson@usgs.gov

Partners: USFWS, NPS, Environment and Climate Change Canada, Simon Fraser University, Alaska Department of Fish and Game

Recent products:

Energy intake rate influences survival of black oystercatcher (*Haemotopus bachmani*) broods, <https://pubs.er.usgs.gov/publication/70208021>

Reliability of external characteristics to age Barrow's goldeneye, <https://doi.org/10.1002/wsb.1123>

Annual winter site fidelity of Pacific Barrow's goldeneyes in the Pacific, <https://doi.org/10.1002/jwmg.21767>

For more information: <https://www.usgs.gov/centers/asc/science/nearshore-marine-ecosystem-research>

B12. Structure and Connectivity of Midcontinental Snowy Plovers

Recent research in the Southern High Plains of Texas has documented continued declines of adult snowy plovers on saline lakes. No reliable estimates of survival, recruitment, connectivity or philopatry exist for any other part of the midcontinental snowy plover population. Approximately 28 percent of snowy plovers are present in the Great Plains emphasis area, with population declines approaching 80 percent in saline lakes of the Southern High Plains of Texas during a 10-year period. Researchers are working to obtain reliable estimates of survival and population connectivity. These data are important to provide decision makers with reliable information with which to evaluate the species status and develop conservation measures if warranted.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: USFWS

For more information: <https://www1.usgs.gov/coopunits/project/134139899904/clint.boal>



B13. Cause of Low Nesting Success and Recruitment of Clark's and Western Grebes in Idaho

Clark's and western grebes are uncommon in North America, and abundances have declined substantially during the past 50 years. No comprehensive surveys of nesting sites exist. Because of their rarity and continued population declines, Clark's grebes were included on a recent list of birds in North America that are most in need of conservation action. The western grebe is a candidate species for listing as threatened or endangered in Washington, and Clark's grebes are a species of concern in Arizona, Montana, and Wyoming. The objectives of this project are to monitor recruitment of these species and explore temporal and spatial variation in recruitment rates.

Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

Partners: USFWS

Recent products:

Drones provide a better method to find nests and estimate nest survival for colonial waterbirds—A demonstration with western grebes, <https://doi.org/10.1007/s11273-020-09743-y>

For more information: <https://www1.usgs.gov/coopunits/project/150218516480/cconway>



Western grebe courtship display at Bear River National Wildlife Refuge, Utah. Photograph by Wayne Watson, U.S. Fish and Wildlife Service.

B14. Nesting Ecology of Songbirds Along an Urban to Rural Gradient

Nest predation is the primary cause of nest failure for most bird species and, thus, plays a crucial role in avian population dynamics. Ornithologists are interested in what choices birds can make when selecting nest sites to reduce predation risk. However, for birds that nest along an urban to rural gradient, the identity of nest predators is likely to change and birds may alter their nest site selections accordingly. Results of this project will determine how nest site selection, predator identity, and predation risk differ for six bird species nesting along an urban to rural gradient. Results will provide information for predator-prey theory and provide practical management applications for managers tasked with recovering birds that nest in human-dominated ecosystems.

Contact: Brett Degregorio, Arkansas Cooperative Fish and Wildlife Research Unit, bdegregorio@usgs.gov

Partners: University of Arkansas Graduate School, Northwest Arkansas Land Trust, City of Fayetteville

For more information: <https://www1.usgs.gov/coopunits/project/192960169984/bdegregorio>



B15. Reconciling Competing Models of Temporospatial Variation in Duck Nest Survival



Conservation planning and management activities for upland-nesting ducks during the breeding season are based on decades of research that have been distilled into several principles used to direct activities. One of the principles relating to drivers of variation in nest survival has been brought into question by recent research that the amount of grassland on the landscape was unrelated to nest survival. To resolve uncertainty of which model best reflects conditions in nest survival across the Prairie Pothole Joint Venture, USGS scientists are comparing two competing models of what drives nest survival using nest fate data from other independent studies. Determining which model, or in which context each model, best performs will give managers an updated and expanded understanding of where to promote conservation actions and which actions would best meet long-standing objectives.

Contact: Aaron Pearse, Northern Prairie Wildlife Research Center, apearse@usgs.gov

Partners: Prairie Pothole Joint Venture, USFWS



A blue-winged teal nest in grassland at the Sand Lake Wetland Management District. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

B16. Nest Ecology of Bluebirds Across Land Cover Types



The eastern bluebird regularly uses nest boxes across much of the eastern United States. However, how this species alters its behavior and ecology depending on the nesting habitat has yet to be determined. Understanding these patterns in behavior and nest survival can provide information to help with management plans for this charismatic songbird and provide valuable information for how a widespread habitat generalist responds to local stressors and pressures. The purpose of this project is to quantify differences in growth, survival, thermal environment, and nest predators for bluebirds nesting in a variety of landscapes across northwest Arkansas. Results will allow stakeholders to use bluebirds as an indicator of ecosystem health.

Contact: Brett Degregorio, Arkansas Cooperative Fish and Wildlife Research Unit, bdegregorio@usgs.gov

Partners: Arkansas Game and Fish Commission, University of Arkansas, Northwest Arkansas Land Trust, City of Fayetteville

For more information: <https://www1.usgs.gov/coopunits/project/192960565248/bdegregorio>

B17. Assessment of Temperate-Breeding Canada Goose Management in Kansas



Pair of Canada geese. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

Resident Canada geese are a wildlife management success story but are exceeding societal thresholds of tolerance in many areas. Management strategies are needed to address this conflict. The goals of this project are to assess translocation as a management strategy for overabundant geese and to resolve conflicts with resident Canada geese by obtaining accurate counts and determining effects of multiple management strategies. Results will be used to improve precision of population estimates and, therefore, improve management plans.

Contact: Beth Ross, South Carolina Cooperative Fish and Wildlife Research Unit, brross@usgs.gov

Partners: Kansas Department of Wildlife, Parks, and Tourism

For more information: <https://www1.usgs.gov/coopunits/project/151826757632/beross>



B18. Climatic Variability and the Productivity of Nongame Sagebrush Birds

Sagebrush habitats have been extensively converted, fragmented, and altered via a wide range of human activities. The consequences of these activities have caused declines of associated wildlife species, including sagebrush-obligate songbirds. Simultaneously, climatic regimes can affect wildlife, especially species that inhabit exposed, arid environments such as the sagebrush steppe. Biologists and managers, however, do not yet have the requisite information with which to assess how weather patterns such as high temperatures and moisture deficits will affect sagebrush songbird populations. Results of this project will address information gaps identified by the Sagebrush Conservation Strategy, will be used to update the Wyoming Comprehensive Wildlife Conservation Strategy, and will contribute to the development of better monitoring and mitigation strategies for sagebrush songbirds most at risk from additional habitat change.

Contact: Anna Chalfoun, Wyoming Cooperative Fish and Wildlife Research Unit, achalfoun@usgs.gov

Partners: Wyoming Game and Fish Department

For more information: <https://www1.usgs.gov/coopunits/project/141411991552/achalfou>



B19. Assessing Shorebird Use of Lagoons in Cape Krusenstern National Monument

Cape Krusenstern National Monument's coastline includes lagoons and estuaries that are important areas for migratory birds breeding and staging activities. Despite the vulnerability of these areas to effects of offshore energy development, little information is available regarding abundance, species composition, distribution, and use of coastal habitats by migrating waterbirds (shorebirds, waterfowl, and seabirds). The purpose of this project is to determine timing of use by postbreeding shorebirds, estimate abundance and diversity of shorebirds, document habitat use around and within the lagoon by shorebirds, and provide a comparison of data collected during this project to historical data for the area. Results from this research will improve understanding of anthropogenic effects to this unique area.

Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: NPS, USFWS, University of Alaska

For more information: <https://www1.usgs.gov/coopunits/project/110306185216/ffanp>



B20. Breeding Ecology and Demographics of Least Terns and Piping Plovers at the Central Platte River, Nebraska



The Platte River Recovery Implementation Program partnered with the USGS to study demographics of listed least terns and piping plovers at the central Platte River in Nebraska. Because of water management and other alterations, riverine habitat for least terns and piping plovers has degraded. Least terns and piping plovers, however, have begun breeding on sandpits adjacent to the river. Scientists marked adults and chicks and resighted them to provide additional data for the Program's monitoring practices. USGS scientists also analyzed data to provide information on dispersal, fidelity, and use of newly constructed or managed habitats that will be useful to make decisions to aid in the conservation and recovery of these species.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: Platte River Recovery Implementation Program, Nebraska Public Power District, Nebraska Game and Parks Commission, Central Platte Natural Resources District, Crane Trust

For more information: <https://www.usgs.gov/centers/npwrc/science/ breeding-ecology-and-demographics-least-terns-and-piping-plovers-central>



U.S. Geological Survey field crew members nest searching for piping plover and least tern nests on a sandpit near the Central Platte River. Photograph by U.S. Geological Survey.

B21. Importance of Wetlands in Intensively Farmed Landscapes to Duck Production



The USGS is collaborating in a partnership to investigate the role of intensively farmed landscapes for production of ducks in the Prairie Pothole Region of the Northern Great Plains. The Prairie Pothole Region annually hosts 50–80 percent of North America's ducks during the breeding season. Accordingly, substantial government and private funds go to conservation for the purposes of improving duck production in the Prairie Pothole Region. The Prairie Pothole Region ecosystem has several stressors, and intensive agriculture is the principal stressor of the ecosystem. The contemporary conservation paradigm focuses on protection of habitat in less-farmed landscapes. However, restoration of habitats in intensively farmed landscapes may prove to be an equally valuable approach because areas that are intensively farmed often have a greater baseline capacity for biological productivity. The objective of this project is to evaluate tradeoffs of baseline productivity with potential negative agricultural effects on duck productivity, while exploring potential avenues to mitigate those negative effects. This project started with a pilot study in Iowa and Minnesota during summer 2018 and expanded into North and South Dakota during 2019 and 2020. Ultimately, this research should provide information for where conservation efforts may be most beneficial to ducks.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: Prairie Pothole Joint Venture, Ducks Unlimited, Inc. (lead agency), Iowa State University, Louisiana State University

For more information: <https://www.usgs.gov/centers/npwrc/science/importance-wetlands-intensively-farmed-landscapes-duck-production>

B22. U.S. Geological Survey Seabird and Forage Fish Program

Alaska's coastal and offshore waters provide foraging habitat for an estimated 100 million birds consisting of more than 90 different species; including seabirds such as murrelets, murres, and puffins that come to shore only to breed. Seabirds depend on the sea to provide a variety of food types, including krill, forage fish, and squid. The availability of nesting habitat and suitable prey are natural factors that regulate the distribution and abundance of marine birds. But seabird populations also are affected by human activities that have direct effects (pollution and bycatch in fishing gear) and indirect effects (global warming alters food availability and algal toxins) on birds and their habitat at sea. The purpose of this project is to determine how forage fish and other factors affect breeding distributions and success of seabird species in Alaska.

Contact: Mayumi Arimitsu, Alaska Science Center, marimitsu@usgs.gov and John Piatt, Alaska Science Center, jpiatt@usgs.gov

Partners: BOEM, USFWS, NPS, National Oceanic and Atmospheric Administration (NOAA)

Recent products:

Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014–2016, <https://doi.org/10.1371/journal.pone.0226087>

For more information: <https://www.usgs.gov/centers/asc/science/seabirds-and-forage-fish-ecology>



Black-legged kittiwake with herring near Gull Island, Cook Inlet Alaska. Photograph by Sarah Schoen, U.S. Geological Survey.



Willet (*Tringa semipalmata*) at Bon Secour National Wildlife Refuge. Photograph by Keenan Adams, U.S. Fish and Wildlife Services.

An American oystercatcher at Cape Romain National Wildlife Refuge, South Carolina. Photograph by Garry Tucker, U.S. Fish and Wildlife Service.



Health, Disease, and Contaminants

C01. Wildlife Health Investigations

The National Wildlife Health Center provides national leadership to safeguard wildlife and ecosystem health through dynamic partnerships and exceptional science. One of the important means by which the National Wildlife Health Center has achieved this mission for more than 40 years is by providing diagnostic and epidemiological services to State, Federal, and Tribal partners to identify, control, and prevent wildlife losses during migratory bird disease events. Through implementation of this event-based, general surveillance for early detection of wildlife pathogens, the National Wildlife Health Center initiates approximately 324 wildlife disease investigation cases per year and receives approximately 787 migratory bird carcasses to be examined in diagnostic laboratories. In addition to laboratory investigations, the National Wildlife Health Center scientists also complete field investigations to further investigate the epidemiology of wildlife disease events in migratory birds where results can benefit the management of the disease or migratory bird populations.



Contact: David Blehert, National Wildlife Health Center, dblehert@usgs.gov

Partners: Arizona Game and Fish Department, Audubon Mississippi Coastal Bird Stewardship Program, Bad River Band of Lake Superior Tribe of Chippewa, NPS, USFWS, California Department of Fish and Wildlife

Recent products:

Detection of Bisgaard taxon 40 in rhinoceros auklets (*Cerorhinca monocerata*) with pneumonia and septicemia from a mortality event in Washington, USA, <https://doi.org/10.7589/2017-12-309>

Multidecade mortality and a homolog of hepatitis C virus in bald eagles (*Haliaeetus leucocephalus*), the national bird of the USA, <https://doi.org/10.1038%2Fs41598-019-50580-8>

Unusual mortality of tufted puffins (*Fratercula cirrhata*) in the eastern Bering Sea, <https://doi.org/10.1371/journal.pone.0216532>

Pathology in practice—Knemidocoptiasis in a pine grosbeak (*Pinicola enucleator*), <https://dpi.wi.gov/sites/default/files/imce/science/Cole-parasitology-publication-Knowles-et-al.pdf>

For more information: <https://www.usgs.gov/centers/nwhc>

C02. Wildlife Disease in the Pacific Basin

Wildlife health plays an integral role in conservation of migratory birds. USGS scientists work with multiple partners to help recover threatened and endangered species by understanding causes of wildlife declines and developing ways to mitigate them. For example, scientists have provided veterinary expertise to translocate and re-establish endangered Laysan ducks to Midway, endangered palilas to the Hawaiian Islands, and endangered Nihoa millerbirds to Laysan Island. The detection of lead poisoning in albatross on Midway helped the USFWS clean up the refuge before the refuge transferred from the Navy to the DOI. The detection of mouse predation on Laysan albatross on Midway Atoll NWR has prompted the USFWS to implement mouse eradication. Scientists are working with USFWS and University of Washington to understand causes of decline in endangered Mariana crows.



Contact: Thierry Work, National Wildlife Health Center, Thierry_work@usgs.gov

Partners: USFWS–Pacific Islands Remote Refuges, NPS, State of Hawaii Department of Land and Natural Resources, Kaneohe Marine Corps Base Hawaii, Guam Department of Marine and Wildlife, Commonwealth of the Northern Marianas Department of Marine and Wildlife, American Samoa Department of Marine and Wildlife



Laysan albatross on Midway Atoll National Wildlife Refuge with signs of mouse predation. Photograph by Thierry Work, U.S. Geological Survey.

For more information: <https://www.usgs.gov/centers/nwhc/science/avian-diseases>

C03. Microcystin Toxin Exposure

Although detections of harmful algal blooms have increased globally, harmful algal toxins have been rarely directly implicated as the cause of wild bird mortality events. Few data on toxin residence time in tissues and tissue lesions associated with toxin exposure exist; thus, in most cases wild bird mortality events are only linked circumstantially to the presence of these toxins in tissues or to the surrounding environment. The purpose of this project is to investigate how harmful algal toxins affect migratory birds. Therefore, USGS scientists are doing experimental studies using mallards to determine how exposure to these toxins leads to acute, sub-acute, and chronic effects. Scientists also are identifying biomarkers of algal toxin exposure in these birds. These results will help scientists to better understand when algal toxins may have played a role in wild bird mortality events.

Contact: Robert Dusek, National Wildlife Health Center, rdusek@usgs.gov

Partners: USFWS, U.S. Food and Drug Administration



C04. Characterization of Avian Hazards After Chlorophacinone Use for Prairie Dog Control

Black-tailed prairie dog are important prey for several raptor species during fall migration and winter. Additionally, prairie dog colonies provide important habitat for many songbird species. However, prairie dogs are considered a pest species by many in the agricultural community and are subjected to eradication attempts that include applications of Rozol Prairie Dog Bait rodenticide (hereafter Rozol, 0.005 percent active ingredient chlorophacinone). The study objective is to characterize Rozol's hazards to migratory birds. USGS scientists documented Rozol's lethal and sublethal hazards to free-ranging raptors and songbirds. Scientists have gathered data on avian behavior that increases the risks of exposure and on Rozol's adverse effects on avian behavior, physiology, and survival.

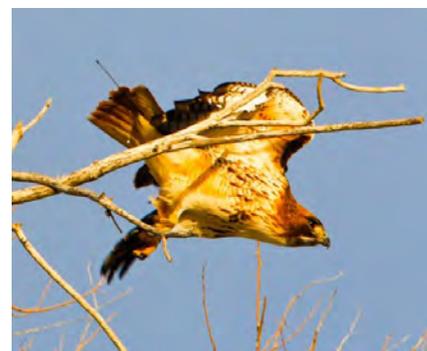
Contact: Nimish Vyas, Eastern Ecological Science Center, nvyas@usgs.gov

Partners: USFWS, U.S. Department of Agriculture (USDA)

Recent products:

Quantifying source and sink habitats and pathways in spatially structured populations—A generalized modelling approach, <https://doi.org/10.1016/j.ecolmodel.2019.06.003>

For more information: <https://www.usgs.gov/centers/pwrc/science/characterization-avian-hazards-following-chlorophacinone-use-prairie-dog>



Red-tailed hawk that had fed on Rozol-exposed prairie dogs. Photograph by M.J. Lockhart.



C05. Understanding Spatiotemporal Dynamics of Avian Influenza in Migratory Waterfowl Populations and Risk of Transmission to Domestic Livestock

Avian influenza virus has caused several billions of dollars in damages to poultry farms in the United States. Tracking spatial distributions and related disease dynamics of migratory waterfowl at high frequency can provide critical information for understanding risk of avian influenza virus transmission among waterfowl and to other species including domestic livestock. USGS scientists partnered with academic, private, and government stakeholders to leverage the program's high-resolution (less than 10 meters) and frequent (several times daily) waterfowl telemetry data and to model, in near real time, spatiotemporal distributions of multiple duck and goose species in the Pacific Flyway in relation with poultry farms. Additionally, scientists are providing the necessary tools and expertise to sample waterfowl, water, and soil for avian influenza virus. This research will culminate in the development and deployment of a web application that poultry farmers, veterinarians, and regulators (USDA–Animal and Plant Health Inspection Service and State agriculture departments) can use as a tool to assess and manage risk of avian influenza virus transmission to poultry.

Contact: Michael Casazza, Western Ecological Research Center, mike_casazza@usgs.gov



Partners: University of California at Davis, University of Delaware, U.S. Department of Food and Agriculture–National Institute of Food and Agriculture, Department of Water Resources, Suisun Resource Conservation District, Pacific Egg and Poultry Association, California Poultry Federation, USDA–Animal and Plant Health Inspection Service, California Department of Food and Agriculture, Central Valley Joint Venture

Recent Products:

Limited detection of antibodies to clade 2.3.4.4 A/Goose/Guangdong/1/1996 lineage highly pathogenic H5 avian influenza virus in North American waterfowl, <https://doi.org/10.7589/2019-01-003>

For more information: <https://www.usgs.gov/centers/werc/science/waterfowl-ecology-california-and-pacific-flyway>

C06. Changing Arctic Ecosystems—Algal Toxins in the Arctic

The Changing Arctic Ecosystems Initiative began in 2010 with a primary objective to understand the rapid physical changes, such as increasing temperature and reduced sea ice, taking place in the Arctic and to quantify and forecast how Arctic wildlife and habitats are responding to these changes. Results of this project will develop rapid response and laboratory support for investigation of algal toxins in Alaska seabirds, assess the effects of saxitoxin ingestion by common murres, quantify the biogeography of biotoxins in seabirds across Alaska, and assess biotoxin accumulation and transfer through pelagic food webs in Alaska.

Contact: John Pearce, Alaska Science Center, jpearce@usgs.gov

Partners: USFWS, NOAA, Alaska Migratory Bird Co-Management Council

Recent products:

Algal toxins in Alaskan seabirds—Evaluating the role of saxitoxin and domoic acid in a large-scale die-off of common murres, <https://doi.org/10.1016/j.hal.2019.101730>

Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014–2016, <https://doi.org/10.1371/journal.pone.0226087>

For more information: <https://www.usgs.gov/center-news/usgs-alaska-science-center-develops-new-5-year-arctic-research-plan>



A common murre near its colony on the water in Kachemak Bay, Alaska. Photograph by Sarah Schoen, U.S. Geological Survey.

C07. Immune Components in Eggs of New World Blackbirds



Candling a red-winged blackbird egg to determine incubation stage. Photograph by Lawrence Igl, U.S. Geological Survey.

Interest in immune systems of wild birds has increased as public health authorities have recognized that many emerging infectious diseases of wildlife can be transmitted to humans. Eco-immunology is an emerging field that characterizes how immune adaptations of wild species differs as a result of evolution in different habitats and niches. Understanding of the effect of life-history traits and habitats on wild bird immune investment is rudimentary, and few studies have compared multiple immunological parameters of related wild bird species. The purpose of this project is for USGS scientists to compare passive immune components in eggs of six songbird species in a single taxonomic family, New World blackbirds. Information from this research is used to evaluate how differences in immune components of different species may be related to divergence in life-history traits and ecological niches. This approach provides a baseline for the degree of between-species variability. This research also provides information for broader questions related to the effectiveness of immune systems in resisting infection in species of conservation concern and closely related nonthreatened taxa.



Contact: Lawrence Igl, Northern Prairie Wildlife Research Center, lign@usgs.gov

Partners: Creighton University, Departamento de Recursos Naturales y Ambientales de Puerto Rico

Recent products:

Do life history traits influence patterns of maternal immune elements in New World blackbirds (Icteridae)? <https://doi.org/10.1093/iob/oby011>

For more information: <https://www.usgs.gov/centers/npwrc/science/immune-components-eggs-new-world-blackbirds>

C08. Effects of Methylmercury Exposure on the Growth of Common Loons

Assessing the ecological risk of mercury exposure to piscivorous wildlife is a priority issue for Federal and State resource management agencies and industry. However, the wildlife-mercury risk assessment model used by these projects is compromised by a lack of relevant toxicological data from the laboratory and the field, resulting in many uncertainties. To develop a scientifically defensible ecological risk assessment of mercury to wildlife, based on an at-risk species, USGS scientists led laboratory and field studies of common loons. Common loons are thought to be sensitive to toxic effects of mercury and, because loons are high trophic level, long-lived, obligate piscivores, loons are at great risk of mercury exposure among wildlife species on inland (nonmarine) North American aquatic systems. Information previously reported also is updated regarding effects of chronic dietary methylmercury exposure on growth, food consumption, and survival of loon chicks reared from hatch to 105 days.



Contact: Kevin Kenow, Upper Midwest Environmental Sciences Center, kkenow@usgs.gov

Partners: Wisconsin Department of Natural Resources, University of Wisconsin-Madison

For more information: <https://www.usgs.gov/centers/umesc/science/waterbird-distribution-and-foraging-patterns-great-lakes-respect-avian>

C09. Assessing the Effect of Changing Water Resources on Migratory Bird Health and Management in the Central Flyway—A Harm Reduction Approach

The 1998 NWR Administration Act mandates that the NWR System conserve fish, wildlife, and plants and facilitate recreational uses for the public. Fulfillment of these statutes depends on the health of wildlife populations that, historically, has been defined as the absence of disease. More recently, health is being understood as a cumulative outcome of many diverse biotic, abiotic, and social factors, some of which are negatively affected by a changing climate. In the southcentral United States, changing hydrologic patterns in USFWS NWRs and State wildlife refuges have put pressure on migratory birds that depend upon the refuges for seasonal habitat and are critical components of the refuges' conservation and recreation goals. The purpose of this project is to determine how migratory bird health is broadly defined and measured by managers, how migratory bird health may be affected by changes to water regimes, and how managers can mitigate those water-related health risks via management actions.



Contact: Katrina Alger, National Wildlife Health Center, kalger@usgs.gov

Partners: South Central Climate Adaptation Science Center, University of Oklahoma, USFWS, Louisiana Department of Wildlife and Fisheries

C10. Selenium Risk to Yuma Ridgway's Rails at the Salton Sea

The federally endangered Yuma Ridgway's rail inhabits emergent marshes throughout the Lower Colorado River Basin and around the Salton Sea in California. Emergent marshes of the Salton Sea support one of the largest remaining populations of Yuma Ridgway's rails in the United States. Much of the rail habitat at the Salton Sea is managed by the USFWS (Sonny Bono Salton Sea NWR) and California Department of Fish and Wildlife (Wister Wildlife Management Area). Unmanaged marshes have appeared at agricultural drainage outlets around the Salton Sea and are becoming more common as sea levels recede. Marshbird survey results indicate Yuma Ridgway's rails are moving away from managed wetlands into newer unmanaged marshes around agricultural drainages. These unmanaged marshes receive agricultural drainage water with varying concentrations of selenium, whereas managed marshes receive Colorado River water with low concentrations of selenium. Crucially, selenium concentrations exceed U.S. Environmental Protection Agency (EPA) water-quality standards in agricultural drains feeding unmanaged marshes inhabited by Yuma Ridgway's rails. As such, rails within unmanaged marshes may be at risk from elevated selenium concentrations.



Managers and policy makers need to know whether these new unmanaged marshes are benefiting or hindering recovery of the species. Results of this research will help evaluate the habitat suitability of unmanaged marshes for Yuma Ridgway's rails and assess the risk that selenium concentrations in these unmanaged marshes may pose to the birds. Such information will help guide conservation efforts locally and throughout the entire range of this federally endangered rail.

Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

Partners: USFWS, Bureau of Reclamation

For more information: <https://www1.usgs.gov/coopunits/project/211363391488/cconway>

C11. Contaminants in Suisun Marsh and the Pacific Flyway

California's Central Valley and San Francisco Bay Estuary have a history of mercury contamination from past mercury mining and gold extraction. Waterbirds are particularly susceptible to mercury because of their use of wetland habitats where methylmercury (the most toxic and biologically form of mercury available) is produced and because low methylmercury exposure can reduce reproductive success. The purpose of this project is to research several aspects of methylmercury contamination in migratory birds throughout the western United States, including: (1) factors affecting bioaccumulation of contaminants and effects on bird health and reproduction; (2) pathways of contaminant uptake and bioaccumulation in waterfowl and endemic marsh birds using Pacific Coast habitats; (3) diving duck winter foraging ecology and relations among foraging patterns, body condition, and high contaminant concentrations in the San Francisco Bay Estuary; (4) the role of benthic prey and disturbances to waterbird foraging activity and energy-based carrying capacity for benthic-foraging waterfowl species; and (5) potential combined effects of contaminants and avian influenza on body condition of migratory waterfowl. Results from this project can provide information to wetland and wildlife management in California's Central Valley and the San Francisco Bay Estuary.



Contact: Josh Ackerman, Western Ecological Research Center, jackerman@usgs.gov and Susan De La Cruz, Western Ecological Research Center, sdelacruz@usgs.gov

Recent products:

Synthesis of maternal transfer of mercury in birds—Implications for altered toxicity risk, <https://doi.org/10.1021/acs.est.9b06119>

Avian eggshell thickness in relation to egg morphometrics, embryonic development, and mercury contamination, <https://doi.org/10.1002/ece3.6570>

Wetland water-management may influence mercury bioaccumulation in songbirds and ducks at a mercury hotspot, <https://doi.org/10.1007/s10646-019-02143-w>

Mercury contamination in resident and migrant songbirds and potential effects on body condition, <https://doi.org/10.1016/j.envpol.2018.11.060>

Disentangling the effects of habitat biogeochemistry, food web structure, and diet composition on mercury bioaccumulation in a wetland bird, <https://doi.org/10.1016/j.envpol.2019.113280>

Methylmercury exposure in wildlife—A review of the ecological and physiological processes affecting contaminant concentrations and their interpretation, <https://doi.org/10.1016/j.scitotenv.2019.135117>

For more information: <https://www.usgs.gov/centers/werc/science/contaminants-waterbirds-and-effects-avian-reproduction>



Tree swallows perched on an artificial nest box at Cosumnes River Preserve, in California's Central Valley. Photograph by U.S. Geological Survey.

C12. Avian Influenza Challenge Studies in Migratory Diving Ducks and American Black Ducks

The susceptibility and pathogenesis of the highly pathogenic avian influenza virus has not been characterized in many waterfowl species, particularly diving ducks, despite the established role wild waterfowl serve as reservoirs of low pathogenicity avian influenza and potential vectors for highly pathogenic avian influenza. The captive breeding colony of sea ducks at the USGS provides a unique opportunity to address this important information gap. Captive breeding research allows USGS scientists to challenge studies on multiple diving and dabbling duck species (ruddy ducks, lesser scaup, surf scoters, and American black ducks). USGS scientists have evaluated the pathogenesis, minimum infectious dose, asymptomatic period, and transmissibility of relevant avian influenza virus strains and species of interest. Information from this research will continue to fill an important gap in the state of knowledge on the avian influenza virus in wild birds and will produce data that can serve as input factors for disease transmission risk models.

Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: USDA–Southeast Poultry Research Lab

Recent products:

The pathogenesis of a North American H5N2 clade 2.3.4.4 group A highly pathogenic avian influenza virus in surf scoters (*Melanitta perspicillata*), <https://doi.org/10.1186/s12917-020-02579-x>

The pathogenesis of H7 highly pathogenic avian influenza viruses in lesser scaup (*Aythya affinis*), <https://doi.org/10.1637/11909-060118-ResNote.1>

Clade 2.3.4.4 H5 North American highly pathogenic avian influenza viruses infect, but do not cause clinical signs in American black ducks (*Anas rubripes*), <https://doi.org/10.1637/11950-081418-ResNote.1>

For more information: <https://www.usgs.gov/centers/pwrc/science/highly-pathogenic-avian-influenza-seaduck-challenge-study>



Collaborative studies investigate pathogenicity and shedding of avian influenza virus in understudied lesser scaup (pictured) and other diving duck species. Photograph by U.S. Geological Survey.

C13. Avian Influenza Virus and Contaminant Exposure Effects on Body Condition and Movements of Waterfowl



Northern pintail sampled for contaminant, disease, and movement studies. Photograph by U.S. Geological Survey.

During the past decade, research has dramatically improved the understanding of the role wild birds play in the ecology of avian influenza; however, few studies have determined factors that affect an individual's risk of becoming infected after exposure. Not only is the relation between avian influenza infection and body condition still not fully understood, the relation between avian influenza and additional confounding factors such as heavy metal contamination, which is known to affect body condition and immune response, remain unstudied. The purpose of this project is to explore interactions among body condition, avian influenza infection status, and heavy metal contamination (mercury as initial model). Related studies aim to investigate effects of pathogen exposure on migratory movements.

Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: University of California at Davis



C14. Avian Influenza Surveillance in Waterfowl—Prevalence and Persistence Locally and Across Flyways



In December 2014, a novel strain of highly pathogenic avian influenza caused an outbreak in poultry on the west coast of the United States. The virus progressed steadily eastward, causing \$3.3 billion in economic losses in addition to 50 million chickens or turkeys dying or being depopulated. Although the primary mode of spread seemed to be via the poultry system, wild birds have been detected with asymptomatic infection, indicating the potential for virus spread via wild populations. For this project, waterfowl of several target species were sampled throughout the Atlantic Flyway, primarily in Maine and Maryland. Samples were collected to test for infection and viral antibodies indicating past infections. USGS scientists are interested in all avian influenza viruses to determine prevalence by species, season, flyway, sex, and age. The scientists also will track movement and development of viruses throughout North America. Understanding prevalence, transmission among birds, and movement of these viruses throughout the United States is imperative for mitigating negative effects. Additionally, scientists have sought to improve understanding of viral persistence in the environment via a unique field and laboratory-based study.

Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: University of Georgia, University of California at Davis, USDA–National Poultry Research Center, Memorial University of Newfoundland, Louisiana Department of Wildlife and Fisheries, Environment and Climate Change Canada, Maryland Department of Natural Resources

Recent products:

Influenza A viruses remain infectious for more than seven months in northern wetlands of North America, <https://doi.org/10.1098/rspb.2020.1680>

For more information: <https://www.usgs.gov/centers/pwrc/science/avian-influenza-surveillance-waterfowl-atlantic-flyway>

C15. The Role of Waterfowl in the Transmission, Persistence, and Amplification of Avian Influenza Viruses in North America



Though avian influenza has been of considerable concern in Asia where the disease has caused mass mortality events in wild waterfowl and several outbreaks in humans, the United States also has been confronted with avian influenza in wild birds and domestic poultry. Highly pathogenic avian influenza viruses have been detected in three of the Nation's four wild bird flyways. The purpose of the project is to understand the role of wild waterfowl in the spread, persistence, and amplification of avian influenza across North America. Results include high-resolution species distribution maps that reflect seasonal movements of waterfowl, and scientists are engaged in efforts to combine this information with data regarding domestic poultry distribution and factors influencing initial introduction events to create spatial-temporal nationwide transmission risk models. Additional broader level studies include improving understanding of wild migratory waterfowl and their role in avian influenza spread across North America.

Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: USDA–Center for Epidemiology and Animal Health, University of Maryland, Colorado State University, Michigan State University, University of Georgia

Recent products:

Seasonal occurrence and abundance of the dabbling ducks across the continental United States—Joint spatio-temporal modeling for genus *Anas*, <https://doi.org/10.1111/ddi.12960>

Limited detection of antibodies to clade 2.3.4.4 A/Goose/Guangdong/1/1996 lineage highly pathogenic H5 avian influenza virus in North American waterfowl, <https://doi.org/10.7589/2019-01-003>

For more information: <https://www.pwrc.usgs.gov/ai/>

C16. Blue-Winged Teal and Cross Continental Avian Influenza Transmission



USGS scientists and collaborators recently identified that blue-winged teal may play a critical role in the transmission of blood-borne parasites between the United States and the Neotropics. Researchers also have identified a variety of avian influenza viruses when sampling migratory blue-winged teal. Despite the known ability of this species to carry avian influenza and the potential role this species may serve in cross continental disease transmission, little research has been done to study the migratory ecology of blue-winged teal and their spatiotemporal overlap with domestic poultry. This research has focused on understanding the following three key factors: (1) the migration and stopover ecology of blue-winged teal, (2) the exposure of these birds to domestic poultry during migration, and (3) the spatiotemporal association of blue-winged teal migration with avian influenza outbreaks. Scientists have started to analyze paired telemetry and disease sampling datasets using advanced statistical approaches. This work will test hypotheses relating transmission potential and stopover duration.

Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: University of Maryland, Louisiana Department of Wildlife and Fisheries, USFWS, Environment and Climate Change Canada

Recent products:

Waterfowl occurrence and residence time as indicators of H5 and H7 avian influenza in North American poultry, <https://doi.org/10.1038/s41598-020-59077-1>

For more information: <https://www.usgs.gov/centers/pwrc/science/blue-winged-teal-and-cross-continental-avian-influenza-transmission>

C17. Exposure and Effects of Contaminants on a Model Migratory Bird Species, the Tree Swallow, at Multiple Sites Across the Great Lakes Basin



The Great Lakes Water Quality Agreement designated 31 areas of concern across the Great Lakes for which information is needed to assess how human activities might affect migratory bird use. USGS scientists are providing information to assist States and the EPA to assess beneficial use impairments, principally the “Bird or Animal Deformities or Reproductive Problems” beneficial use impairment. Scientists are collecting reproductive data in the field and comparing with normal reproductive rates in areas similar to those of concern and comparing tissue concentrations to background and known reproductive effect levels from field and laboratory studies. Tree swallows are useful in this context because there exists a wealth of exposure and effects data for several chemical classes from locations across the United States and Canada. Tree swallows can be attracted to nest boxes placed in specific areas of interest, feed on aquatic insects that reside in the contaminated sediments, and can be consistently sampled at all Great Lakes areas of concern, something that has been lacking for vertebrates. Legacy contaminants and trace elements (for example, polychlorinated biphenyls, dioxins, cadmium, lead, and mercury) and contaminants of emerging concern (for example, perfluorinated substances, polybrominated diphenyl ethers, and the polycyclic aromatic hydrocarbons) are being sampled for this project. Information has been collected at more than 90 sites across all Great Lakes.

Contact: Christine Custer, Upper Midwest Environmental Sciences Center, ccuster@usgs.gov

Partners: EPA, NOAA, USACE, USFWS, Bureau of Indian Affairs, Minnesota Pollution Control Agency, Wisconsin Department of Natural Resources, Indiana Department of Natural Resources

Recent products:

Element concentrations in tree swallows (*Tachycineta bicolor*) from the U.S. and binational Great Lakes Areas of Concern, <https://doi.org/10.1007/s00244-019-00601-4>

Perfluoroalkyl contaminant exposure in and effects in tree swallows nesting at Clarks Marsh, Oscoda, Michigan, USA, <https://doi.org/10.1007/s00244-019-00620-1>

For more information: www.usgs.gov/centers/umesc/science-topics/wildlife-toxicology

C18. Avian Health and Ecology of Wildlife Disease in Alaska and Adjacent Regions



Environmental health is defined by connections among the physical environment, ecological health, and human health. Research within USGS recognizes the importance of this integrated research philosophy, which includes study of disease and pollutants as they pertain to wildlife and humans. Because Alaska is in a key geographic location and has substantial wildlife resources, Alaska is a critical area for study of environmental health. Within USGS, the Emerging Wildlife Disease project is a funding opportunity for USGS scientists nationwide to address diseases of high concern to the United States. This project focuses on important wildlife disease topics such as avian influenza, harmful algal toxins, bacterial and parasitic infections in wildlife, avian keratin disorder in landbirds, and responds to new topics.

Contact: Andy Ramey, Alaska Science Center, cvanhemert@usgs.gov and Caroline Van Hemert, Alaska Science Center, aramey@usgs.gov

Partners: USFWS, NPS, Alaska Department of Fish and Game, USDA, Alaska Department of Environmental Conservation, Alaska Department of Health and Social Services

Recent products:

Influenza A viruses remain infectious for more than seven months in northern wetlands of North America, <https://doi.org/10.1098/rspb.2020.1680>

Algal toxins in Alaskan seabirds—Evaluating the role of saxitoxin and domoic acid in a large-scale die-off of common murres, <https://doi.org/10.1016/j.hal.2019.101730>

Field-based method for assessing duration of infectivity for influenza A viruses in the environment, <https://doi.org/10.1016/j.jviromet.2020.113818>

Limited detection of antibodies to clade 2.3.4.4 A/Goose/Guangdong/1/1996 lineage highly pathogenic H5 avian influenza virus in North American waterfowl, <https://doi.org/10.7589/2019-01-003>

Waterfowl occurrence and residence time as indicators of H5 and H7 avian influenza in North American poultry, <https://doi.org/10.1038/s41598-020-59077-1>

Ecology of influenza A viruses in wild birds and wetlands of Alaska, <https://doi.org/10.1637/0005-2086-64.2.109>

Influenza A prevalence and subtype diversity in migrating teal sampled along the United States Gulf Coast, <https://doi.org/10.1637/11850-041918-Reg.1>

Emperor geese (*Anser canagicus*) are exposed to a diversity of influenza A viruses, are infected during the non-breeding period and contribute to intercontinental viral dispersal, <https://doi.org/10.1111/tbed.13226>

Confronting models with data—The challenges of estimating disease spillover, <https://doi.org/10.1098/rstb.2018.0435>

Prevalence and diversity of avian blood parasites in a resident northern passerine, <https://doi.org/10.1186/s13071-019-3545-1>

Evidence of *Culiseta* mosquitoes as vectors for *Plasmodium* parasites in Alaska, <https://doi.org/10.1111/jvec.12330>

For more information: <https://www.usgs.gov/centers/asc/science/wildlife-disease-and-environmental-health-alaska>



U.S. Geological Survey technician swabbing hunter-harvested ducks in western Alaska as part of U.S. Geological Survey research to investigate the persistence of avian influenza viruses in North American wetlands. Photograph by Andrew Reeves, U.S. Geological Survey.

C19. Dark Epidemiology—Artificial Intelligence to Develop Real-Time Maps of Migratory Bird Movements Using Radar Data for Avian Influenza Risk Assessment



Biosecurity measures implemented by individual livestock producers are effective for minimizing risk of avian influenza transmission at the wildlife-livestock interface; however, maintaining high levels of biosecurity is often not economically feasible. Therefore, poultry producers need a tool to evaluate avian influenza transmission risk associated with migratory bird movements that will scale biosecurity according to real-time distribution of migratory flocks. USGS scientists address this need using machine learning approaches to integrate Doppler radar information with citizen science observations to create near real-time maps of migratory bird locations that can be easily accessed via a web visualization tool and be used to ascertain the movements of migratory birds in relation to a producer's location. The real-time nature of these maps will permit the creation of dynamic personalized avian influenza risk assessments, which will help overcome problems of biosecurity fatigue and, most importantly, allow producers to take proactive biosecurity measures to protect the Nation's food supply.

Contact: Daniel Walsh, National Wildlife Health Center, dwalsh@usgs.gov

Partners: Cornell University, USDA

C20. Seabird Health and Adaptive Management



Seabirds are vulnerable to a variety of threats both at sea, where they spend most of their lives, and on land, where they nest. Of primary importance is the need to understand basic population parameters and ecological requirements, including attendance patterns at colonies, diet, reproductive success, and baseline health parameters that affect species during the breeding season and survival of adults overwinter. The objectives of this project are as follows: (1) to quantify abundance patterns and behaviors associated with habitats at sea and on land, including population assessments of seabirds such as the Hawaiian petrel, ash storm-petrel, and marbled and Kittlitz's murrelet; (2) to complete a comprehensive ocean-ecosystem study to determine seabird population responses to a changing marine ecosystem; and (3) to analyze the efficacy of conservation practices intended to benefit the preservation and recovery of threatened seabird populations. Overall, these assessments support adaptive management for seabirds at sea and on land.

Contact: Josh Adams, Western Ecological Research Center, josh_adams@usgs.gov

Partners: NPS, USFWS, BLM, BOEM, Hawaii Department of Land and Natural Resources, Oregon State University, University of Akron, Hawai'i Pacific University, BirdLife International, Universidad Católica del Norte

Recent products:

Genetic diversity, population structure, and historical demography of a highly vagile and human-impacted seabird in the Pacific Ocean—The red-tailed tropicbird, *Phaethon rubricauda*, <https://doi.org/10.1002/aqc.3471>

Genetic analysis of the diet of red-footed boobies (*Sula sula*) provisioning chicks at Ulupa'u Crater, O'ahu, <https://doi.org/10.1002/aqc.3470>

Post-release survival of fallout Newell's shearwater fledglings from a rescue and rehabilitation program on Kaua'i, Hawai'i, <https://doi.org/10.3354/esr01051>

Trends in mammalian predator control trapping events intended to protect ground-nesting, endangered birds at Haleakalā National Park, Hawai'i, 2000–14, <https://doi.org/10.3133/ofr20191122>

For more information: <https://www.usgs.gov/centers/werc/science/seabird-health-and-adaptive-management>



U.S. Geological Survey biologists surveying for marbled murrelets off the central California Coast. Photograph by U.S. Geological Survey.

C21. Lead Exposure and Effects in Golden Eagles in the Pacific Northwest

Lead is a threat to raptors, such as golden eagles that scavenge on remains of animals killed with lead ammunition. Lead poisoning can impair flight coordination, increasing the likelihood of eagle fatality from collisions with structures such as wind turbines. Using golden eagle blood samples, researchers evaluated lead exposure and potential effects on nestling golden eagles in central and eastern Oregon, western Idaho, and northern California. The results will help identify if additional studies are warranted for evaluating the interaction between lead exposure and traumas such as wind turbine strikes. Results also will be useful for mitigating golden eagle risk associated with trauma at wind energy sites, because the wind industry is striving to better understand how lead abatement in the region may help compensate for golden eagle take associated with turbine collisions.

Contact: Collin Eagles-Smith, Forest and Rangeland Ecosystem Science Center, ceagles-smith@usgs.gov

Partners: USFWS

Recent products:

The lead (Pb) lining of agriculture-related subsidies: Enhanced golden eagle growth rates tempered by Pb exposure, <https://doi.org/10.1002/ecs2.3006>



C22. Assessing Occurrence and Effects of Neonicotinoid Pesticides on Loggerhead Shrike Body Condition, Immunocompetence, Survival, and Reproduction

The loggerhead shrike is a grassland-associated avian species that is one of the fastest declining passerines in Arkansas and North America. Despite the dramatic decline, why these populations continue to trend down precipitously is not clear. One hypothesis that has yet to be evaluated is the effect of agricultural chemicals on the health and reproductive behavior of the loggerhead shrike. The purpose of this project is to evaluate the occurrence and effect of neonicotinoid pesticides on individuals to help conserve this species. USGS scientists and collaborators are capturing shrikes and collecting blood and fecal samples from adult and nestlings that inhabit a variety of row-crop habitats and more natural grassland and pasture habitat. Scientists also are capturing adult birds across seasons in these same habitat types to assess how pesticide concentrations and potential effects differ between growing and nongrowing seasons. These results will provide State and Federal agencies information on how to conserve shrikes in human-modified habitats and, therefore, possibly elucidate one of the primary threats to population viability.

Contact: Brett DeGregorio, Arkansas Cooperative Fish and Wildlife Research Unit, bdegregorio@usgs.gov

Partners: Arkansas State University, Arkansas Game and Fish Commission

For more information: <https://www1.usgs.gov/coopunits/project/192958248960/bdegregorio>



C23. Role of Gulls in the Dissemination of Antimicrobial Resistant *E. coli*

The role of gulls in Alaska in the dissemination of antimicrobial resistant *E. coli* was initiated after the State of Alaska determined that high fecal coliform bacterial levels in the Kenai River were attributed to birds. The objectives of this project by the USGS are as follows: (1) identify the specific ecological pathways by which gulls acquire antibiotic resistance to provide information for the design of potential mitigation strategies; (2) determine movement patterns of large gulls inhabiting Alaska to identify potential dispersal pathways; and (3) quantify levels of risk at local, national, and international scales for the spread of antibiotic resistance via environmental pathways.

Contact: Andy Ramey, Alaska Science Center, aramey@usgs.gov and Christina Ahlstrom, Alaska Science Center, cahlstrom@usgs.gov

Partners: USDA, USFWS, Alaska Department of Health and Social Services

Recent products:

Antibiotic resistant bacteria in wildlife—Perspectives on trends, acquisition and dissemination, data gaps, and future directions, <https://doi.org/10.7589/2019-04-099>



Early emergence of *mcr-1*-positive Enterobacteriaceae in gulls from Spain and Portugal, <https://doi.org/10.1111/1758-2229.12779>

Gulls as sources of environmental contamination by colistin-resistant bacteria, <https://doi.org/10.1038/s41598-020-61318-2>

Satellite tracking of gulls and genomic characterization of faecal bacteria reveals environmentally mediated acquisition and dispersal of antimicrobial-resistant *Escherichia coli* on the Kenai Peninsula, Alaska, <https://doi.org/10.1111/mec.15101>

Repeated detection of carbapenemase-producing *Escherichia coli* in gulls inhabiting Alaska, <https://doi.org/10.1128/AAC.00758-19>

For more information: <https://www.usgs.gov/centers/asc/science/antibiotic-resistant-bacteria-migratory-birds>



U.S. Geological Survey biologist prepares to release a gull with a satellite transmitter. Photograph by U.S. Geological Survey.

C24. Determining and Identifying Anthropogenic Toxins Affecting Birds of Prey

Wildlife of many species are threatened by poisoning from anthropogenically derived lead and anticoagulant rodenticides. Anticoagulant rodenticides are commonly used to control rodents; however, poisoning nontarget species is a risk, especially predatory and scavenging birds. USGS scientists are determining how birds are exposed to lead and from what sources. Research on lead exposure includes using blood and liver samples from raptors (from across North America), such as golden and bald eagles, ferruginous hawks, red-shouldered hawks, red-tailed hawks, black and turkey vultures, and osprey. The scientists also are testing commercially available measurement devices to determine suitability for detecting potential anticoagulant rodenticides exposure in birds of prey. Results from this research provide insight into how birds are exposed to anthropogenic toxins and how wildlife managers can determine exposure.



Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: The Peregrine Fund, State of Idaho

Recent products:

Evaluating a rapid field assessment system for anticoagulant rodenticide exposure of raptors, <https://doi.org/10.1007/s00244-020-00763-6>

High frequency of lead exposure in the population of an endangered Australian top predator, the Tasmanian wedge-tailed eagle (*Aquila audax fleayi*), <https://doi.org/10.1002/etc.4914>

Feeding ecology drives lead exposure of facultative and obligate avian scavengers in the eastern United States, <https://doi.org/10.1002/etc.4680>

Lead exposure of red-shouldered hawks during the breeding season in the central Appalachians, USA, <https://doi.org/10.1007/s00128-019-02732-9>

Lead in piscivorous raptors during breeding season in the Chesapeake Bay region of Maryland and Virginia, USA, <https://doi.org/10.1002/etc.4376>

C25. Can Wetland Water-Management Affect Mercury Bioaccumulation in Songbirds and Ducks at National Wildlife Refuges with Mercury Problems?

During summer 2017, the USGS initiated a collaborative research study focused on understanding if water-level management of wetlands at refuges can affect mercury bioaccumulation in wetland-dependent migratory birds. Birds are susceptible to effects of mercury and can serve as indicators of contamination in ecosystems. USGS scientists investigated mercury concentrations of songbirds and waterfowl using seven different management units at Kelly's Slough NWR near Grand Forks, North Dakota. A mercury hotspot had previously been reported in this area. This research is designed to investigate if four different water-management regimes potentially can affect



mercury bioaccumulation. Preliminary analysis indicates that a wetland’s management regime has profound implications for mercury bioaccumulation in migratory birds. This research serves as a case study that can be replicated in other public lands where mercury contamination is a concern. Ultimately, this research could have implications for water-level management of wetlands on public lands in areas where mercury may be a concern.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USGS Upper Midwest Environmental Sciences Center, USGS Western Ecological Research Center, National Wildlife Health Program, USFWS, Benedictine College

Recent Products:

Wetland water-management may influence mercury bioaccumulation in songbirds and ducks at a mercury hotspot, <https://doi.org/10.1007/s10646-019-02143-w>

For more information: <https://www.usgs.gov/centers/npwrc/science/can-wetland-water-management-influence-mercury-bioaccumulation-songbirds-and>



Graduate student from Benedictine College holding a common yellowthroat. Photograph by Michael Anteau, U.S. Geological Survey.

Waterfowl on LaCreek National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.



Population Dynamics and Distributions

D01. Use of Remote Sensing Data to Quantify Bird and Bat Distributions and Inform Migratory Bird Conservation Efforts



Millions of landbirds migrate through the Gulf of Mexico region each spring and autumn stopping in habitats along the way to rest and forage for the food needed to fuel their journey. Knowing the location where peak numbers of birds consistently stopover is critical for conservation planning, particularly when habitat continues to be lost or degraded. The Columbia Bottomlands, a coastal live oak forest along the upper Texas coast, supports an estimated 29 million migrants each year. Although once extensive, the Columbia Bottomlands today (2021) consists of hundreds of forest patches some of which are on the Texas Mid-Coast NWR Complex. The goal of this project is to use weather radar data to determine the stopover distribution of migratory birds along the upper Texas coast and within the Texas Mid-Coast NWR Complex. Data collected during this project will provide managers with information needed to make habitat conservation decisions.

Contact: Wylie Barrow, Wetland and Aquatic Research Center, barroww@usgs.gov and Lori Randall, Wetland and Aquatic Research Center, randalll@usgs.gov

Partners: USFWS

For more information: <https://www.usgs.gov/centers/wetland-and-aquatic-research-center-warc/science/use-remote-sensing-data-quantify-bird-and>

D02. Demography of Black-Footed and Laysan Albatross—Kilauea Point and Tern Island Populations



Black-footed and Laysan albatrosses are long-lived seabirds of conservation concern to the USFWS, and a petition to list the black-footed albatross under the Endangered Species Act has been submitted to USFWS. Furthermore, more than 65 percent of the world population of these albatross species nest on remote low island refuges in the Pacific and in smaller numbers on Hawaiian Islands. Little information is available about the life history, survival, and breeding frequency of Northern Hemisphere albatross species, including comparisons among islands. A model of annual survival and breeding probability for albatross will be developed for Kilauea Point NWR and Tern Island, allowing these processes to be connected with threats such as overlap with long-line fishing and other environmental factors. A vetted banding database will be provided for future analyses and recommendations for monitoring intensity also will be provided to Refuge personnel.

Contact: William Kendall, Colorado Cooperative Fish and Wildlife Research Unit, wkendall@usgs.gov

Partners: USFWS, Marine National Monuments of the Pacific, USGS Bird Banding Laboratory

For more information: <https://www1.usgs.gov/coopunits/project/168550574080/William.Kendall>

D03. Population Ecology of Waterfowl and Loons



This project includes a variety of research directions and methods that will provide information to partners. The following are research objectives for 2020–21: (1) quantify shifts in abundance and distribution of waterbird species in northern Alaska; (2) determine response of waterbird species to shifts in climate, such as warmer ocean water temperatures, declines in sea ice, and earlier spring phenology; (3) perform demographic analyses and trends for species of management concern, such as spectacled eiders, snow geese, black brant, and emperor geese; and (4) complete surveys and assessments of eelgrass and seaweeds of western Alaska that are important food and ecosystem components for migratory birds.

Contact: Paul Flint, Alaska Science Center, pflint@usgs.gov and John Pearce, Alaska Science Center, jpearce@usgs.gov

Partners: USFWS, BLM, BOEM

Recent products:

Ecosystem-scale loss of grazing habitat impacted by abundance of dominant herbivores, <https://doi.org/10.1002/ecs2.2767>

Monitoring annual trends in abundance of eelgrass (*Zostera marina*) at Izembek National Wildlife Refuge, Alaska, 2018, <https://doi.org/10.3133/ofr20191042>

Serologic evidence for influenza A virus exposure in three loon species breeding in Alaska, USA, <https://doi.org/10.7589/2018-06-165>

For more information: <https://www.usgs.gov/centers/asc/science/antibiotic-resistant-bacteria-migratory-birds>



Pacific loon taking off from a lake in northern Alaska. Photograph by Ryan Askren, U.S. Geological Survey.

D04. Banding Needs Assessment of the Western Gulf Coast Population of Mottled Ducks

The mottled duck is a sedentary waterfowl species dependent on coastal marsh and other habitats along the Gulf Coast and, therefore, is especially subject to effects of development and habitat loss. Several monitoring programs are in place to assess the status of this species and to provide information for harvest and habitat management decisions. A banding needs assessment is desired to evaluate the experimental banding done since the 1990s; to design an operational banding program that accounts for harvest rates, survival rates, and movements among States; and to integrate with the other monitoring programs for this population. Banding data, along with abundance surveys and harvest surveys, will be integrated in a population model that will provide information for future monitoring and mottled duck management decisions.

Contact: William Kendall, Colorado Cooperative Fish and Wildlife Research Unit, wkendall@usgs.gov

Partners: Rocky Mountain Cooperative Ecosystem Studies Unit, USFWS, Texas Parks and Wildlife, Louisiana Department of Fisheries and Wildlife

For more information:
<https://www1.usgs.gov/coopunits/project/192531943424/William.Kendall>



Mottled duck hen and brood at Anahuac National Wildlife Refuge, Texas. Photograph by William Powell, U.S. Fish and Wildlife Service.

D05. Goose Population Dynamics and Distributions

Because suitable habitat for waterfowl continues to decline, the population status of several waterfowl species within California's Central Valley are becoming more of a concern. Whereas most duck species struggle to reach population targets established by the Central Valley Joint Venture and conservation partners, snow and Ross's geese have far exceeded their targets. This project focuses on the implications of exponentially increasing populations of geese for the conservation of waterfowl on wintering areas as well as for migration and breeding areas. Through the use of newly developed telemetry technology that uses GPS and the cellular phone network, USGS scientists will study population dynamics and wintering area distributions of Pacific greater white-fronted geese, Tule greater white-fronted geese, snow geese, and Ross's geese. This information will be linked to food supply, energetic demands, and distributions of California's waterfowl populations, and therefore, provide information to Federal, State, and private stakeholders for conservation and management of habitats.



Contact: Mike Casazza, Western Ecological Research Center, mike_casazza@usgs.gov

Partners: Central Valley Joint Venture, Ducks Unlimited, Inc., Ducks Unlimited Canada, Inc., California Department of Fish and Wildlife, USFWS, California Department of Water Resources, Suisun Resource Conservation District, University of California at Davis, California Waterfowl Association, Washington Department of Wildlife, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, Alaska Department of Fish and Game, Canadian Wildlife Service, Russian Ministry of Environmental Protection and Natural Resources

For more information: <https://www.usgs.gov/centers/werc/science/goose-population-dynamics-california-central-valley-and-pacific-flyway>

D06. Understanding the Contribution of Locations and Paths to the Population Dynamics of Migrating Species

Migratory species, such as northern pintails, rely on habitat distributed across multiple locations. Understanding the contributions of locations and the pathways connecting them is critical information for efficient and effective management. Diverse approaches have been used to quantify the importance of habitats and pathways in a spatial network; however, these approaches have been limited by a lack of general applicability across life histories and movement strategies. The purpose of this project is to develop a generalizable and broadly applicable approach to modeling the spatiotemporal dynamics of species and to develop metrics for estimating the location- and pathway-specific per capita contributions of locations to the dynamics of populations. This research will determine if consequences at one location percolate via migrational processes through the network to be felt in far-distant locations. Understanding these place-specific contributions can identify pinch points in the migrational process and the whole-population consequences of place-specific management or perturbations. Remaining areas of interest are to better understand the sensitivity of these per-capita contribution calculations and to apply these network-derived insights to continuously distributed migratory species.



Contact: Wayne Thogmartin, Upper Midwest Environmental Sciences Center, wthogmartin@usgs.gov

Partners: National Institute for Mathematical and Biological Synthesis, Emmanuel College, University of Redlands, University of Natural Resources and Life Sciences

Recent products:

Quantifying the contribution of habitats and pathways to a spatially structured population facing environmental change, <https://doi.org/10.1086/709009>

Quantifying source and sink habitats and pathways in spatially structured populations—A generalized modelling approach, <https://doi.org/10.1016/j.ecolmodel.2019.06.003>

D07. Ecological Research of Migratory Waterfowl in the Pacific Flyway—Advancing Knowledge for the Management of Breeding, Migrating, and Wintering Ducks and Geese



Understanding migratory waterfowl ecology throughout all life history stages is critical to informing management, improving habitat, and creating resilient populations. During this project, USGS scientists tracked multiple Pacific Flyway duck and goose species with GPS telemetry, using these fine-scale spatiotemporal data to better understand movement and habitat use patterns. Future research will investigate the importance and distribution of sanctuaries across the landscape for migratory waterfowl and how successes in public/private conservation have created resiliency in the Pacific Flyway.

Contact: Mike Casazza, Western Ecological Research Center, mike_casazza@usgs.gov

Partners: Central Valley Joint Venture, Intermountain West Joint Venture, Ducks Unlimited, Inc., California Waterfowl Association, Ducks Unlimited Canada, Inc., USFWS, California Department of Water Resources, Suisun Resource Conservation District, University of California at Davis, State wildlife agencies of California, Oregon, Washington, Idaho, Nevada, Utah, and Colorado

Recent products:

Good prospects—High-resolution telemetry data suggests novel brood site selection behaviour in waterfowl, <https://doi.org/10.1016/j.anbehav.2020.04.013>

GPS tracking data reveals daily spatio-temporal movement patterns of waterfowl, <https://doi.org/10.1186/s40462-019-0146-8>

Moving at the speed of flight—Dabbling duck-movement rates and the relationship with electronic tracking interval, <https://doi.org/10.1071/WR19028>

For more information: <https://www.usgs.gov/centers/werc/science/waterfowl-ecology-california-and-pacific-flyway>



Northern pintails in flight. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

D08. Trumpeter Swan Movements and Demography

Populations of trumpeter swans have fluctuated dramatically during the past century and recovery of trumpeter swans has been inconsistent across their range. In particular, recovery of the U.S. breeding segment of Rocky Mountain Population of trumpeter swans, primarily present in and around the Greater Yellowstone Ecosystem, has lagged behind that of the Canadian breeding segment and the two other populations (Pacific Coast and Interior). The USGS is assessing the movements and demography of the Rocky Mountain Population of trumpeter swans. This information is necessary to make decisions about the annual establishment of hunting regulations that are consistent with the long-term conservation needs of the Rocky Mountain Population of trumpeter swans.

Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: USFWS



D09. Western States Cinnamon Teal Initiative—Understanding the Distribution and Habitat Use of North American Cinnamon Teal

Cinnamon teal are one of the least studied dabbling duck species in North America. Information on cinnamon teal distribution typically has been obtained from temporally and spatially limited survey methods (for example, band returns and aerial surveys), and data on cinnamon teal are frequently grouped



with blue-winged teal. The goal is to use GPS-cellular network telemetry technology to build upon traditional survey methods and further understand the spatial ecology and habitat selection of cinnamon teal in western North America. Habitat availability during migration may strongly affect body condition, survival, and subsequent reproductive success, especially in arid regions of the western United States. By tracking cinnamon teal throughout the annual cycle, scientists can begin to link habitat selection and population dynamics to habitat available through the year. To support efforts by Federal, State, and private partners to sustain cinnamon teal populations, USGS is mapping important migration routes and stopover habitat for migrating cinnamon teal to understand how climatic and anthropogenic changes to natural resources may affect populations.

Contact: Michael Casazza, Western Ecological Research Center, mike_casazza@usgs.gov

Partners: USFWS, State wildlife agencies of California, Oregon, Washington, Idaho, Nevada, Utah, Colorado, California Department of Water Resources, California Waterfowl Association, Intermountain West Joint Venture, Central Valley Joint Venture, University of California at Davis

For more information: <https://www.usgs.gov/centers/werc/science/western-states-cinnamon-teal-initiative>



Cinnamon teal at Seedskadee National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Refuge.

D10. Understanding Common Loon Distribution and Abundance in Washington

The common loon is a State species of concern in Washington. The species was once thought to be common in eastern and western Washington, but likely declined in the early decades of the 20th Century. Planning conservation efforts for the common loon is complicated because information is limited on the abundance and distribution of this species in Washington. The purpose of this project is to provide the State of Washington with information necessary to perform effective, efficient, and affordable surveys for the species in the State. The project will involve the following three components: (1) understanding factors influencing site occupancy of loons in the State, based on existing State survey data as well as citizen science (eBird) data; (2) pilot testing a drone-based sampling method to determine detection probabilities as a function of effort; and (3) using information from components 1 and 2 to design a sampling strategy and carry out a simulation study that will describe expected precision in occupancy estimates as a function of sampling effort and spatial coverage.



Contact: Sarah Converse, Washington Cooperative Fish and Wildlife Research Unit, sconverse@usgs.gov

Partners: Washington Department of Fish and Wildlife

For more information: <https://www1.usgs.gov/coopunits/project/150906406912/sconverse>

D11. Population Change and Abundance of Black Ducks and Mallards in Eastern North America



This project involves research into survey design and analysis and is a vehicle for USGS support for the USFWS and the Black Duck Joint Venture. The purpose of this project is to develop an analysis method used for estimation of population change for waterfowl in the Eastern Survey Region of the Waterfowl Breeding Population and Habitat Survey, led by the USFWS, which is the primary data source for waterfowl management in North America. The ongoing role includes yearly consultation and review of waterfowl survey analyses, review and development of survey methods, and participation in technical reviews and meetings of the Black Duck Joint Venture Technical Committee. Future plans include implementation of a model set and model selection for analysis of survey data.

Contact: John Sauer, Eastern Ecological Science Center, jrsauer@usgs.gov

Partners: USFWS Division of Migratory Bird Management, Black Duck Joint Venture

D12. Tracking Atlantic and Caribbean Seabirds



During some portion of the annual cycle, many species of seabirds breeding in the Caribbean occupy coastal waters of the Atlantic and Gulf of Mexico. As marine spatial planning becomes a pressing issue in the region, data are needed to enhance understanding of the seabird community in the South Atlantic Bight and the Gulf of Mexico. Ship-based and aerial surveys are the standard methods used to measure abundance and distribution of birds at sea; however, each survey is a population-based survey that provides information without regard to individual variability or colony of origin. Researchers are deploying tracking devices to measure movement patterns of seabirds in the Caribbean, Gulf of Mexico, and western north Atlantic. Data from individual tracking efforts will allow assessment of variability in movements and use patterns; fidelity to specific marine locations; and relations among marine use areas, breeding locations, and population trends.

Contact: Patrick Jodice, South Carolina Cooperative Fish and Wildlife Research Unit, pjodice@usgs.gov

Partners: Clemson University Institute for Parks, USFWS, Neotropical Bird Club

Recent products:

High spatial fidelity among foraging trips of masked boobies from Pedro Cays, Jamaica, <https://doi.org/10.1371/journal.pone.0231654>

Dynamic oceanography determines fine scale foraging behavior of masked boobies in the Gulf of Mexico, <https://doi.org/10.1371/journal.pone.0178318>

Habitat modelling locates nesting areas of the endangered black-capped petrel *Pterodroma hasitata* on Hispaniola and identifies habitat loss, <https://doi.org/10.1017/S0959270920000490>

A preliminary report of ongoing research of the ecology of black-capped petrel (*Pterodroma hasitata*) in Sierra de Bahoruco, Dominican Republic—I—GPS tracking of breeding adults, <https://www.sciencebase.gov/catalog/item/5d8b64fee4b0c4f70d0b0af5>

For more information: <https://www1.usgs.gov/coopunits/project/170835681280/pjodice>

D13. Purple Martin Distribution and Habitat Use in Southwestern Oregon

Availability of nest sites in suitable habitat is a limiting factor for western purple martin populations, a bird that uses natural cavities in standing live and dead trees for nesting. This species prefers to nest in open, postdisturbance forest, including clear-cuts with legacy trees and snags. To determine purple martin distribution and habitat use, researchers are surveying forested sites in southwestern Oregon to estimate the population of purple martins nesting in snags. Researchers also are examining habitat features at occupied sites to determine factors associated with habitat selection. The results will provide information for forest habitat restoration efforts for purple martins and help develop a habitat suitability model for purple martins in this region that can be used to map potential habitat on Federal forest lands based on a range of disturbance and management alternatives.

Contact: Joan Hagar, Forest and Rangeland Ecosystem Science Center, joan_hagar@usgs.gov

Partners: USFS, BLM

Recent products:

The snag's the limit—Habitat selection modeling for the western purple martin in a managed forest landscape, <https://doi.org/10.1016/j.foreco.2020.118689>



Western purple martins facing each other on a snag. Photograph by Lorelle Sherman, U.S. Forest Service.

D14. U.S. Geological Survey and U.S. Fish and Wildlife Science Support and Quick Response Program



Rock sandpiper flock on the mudflats near Kasilof, Alaska, in the winter. Photograph by Daniel Ruthrauff, U.S. Geological Survey.

This project is a nationwide annual collaborative program in which USGS scientists address priority research needs identified by the USFWS. The USFWS priorities for these funds change annually. In 2020–22, the final USGS Alaska Science Center migratory bird projects chosen by the USFWS Alaska and Pacific Regions for funding are as follows: Assessing the population status of two rare taxa endemic to the central Bering Sea, Alaska—McKay's bunting and Pribilof rock sandpiper; Status assessment of spectacled eider populations on the Yukon-Kuskokwim Delta; and Investigating hybridization between the declining gray-headed chickadee and a recent colonizer, the boreal chickadee.

Contact: John Pearce, Alaska Science Center, jpearce@usgs.gov

Partners: USFWS

For more information: <https://www.usgs.gov/centers/asc/science/collaborative-science-priority-information-needs>



D15. A Rapid Assessment of Geographic Distribution and Habitat Conditions of the Endangered Puerto Rico Plain Pigeon after Hurricane Maria

The plain pigeon is a large arboreal columbid of open woodlands of the Greater Antilles. The plain pigeon subspecies in Puerto Rico is considered rare and is listed as endangered. Hurricane Maria moved across the island of Puerto Rico and across the center of the region occupied by plain pigeon. The purpose of this project is to use a spatial modeling approach to assess hurricane effects to plain pigeon habitat and quantify damage to forest cover, including defoliation and loss of canopy. Plain pigeon numbers were likely negatively affected by hurricane Maria. Damage to plain pigeon habitat in municipalities encompassing the study area were expected to be widespread, with differing intensity depending on particular sectors in each municipality. Project results will be instrumental for informing the next phase of research on posthurricane geographic distribution, movement, and dispersal to fully assess the effects of hurricane Maria to the long-term recovery of the plain pigeon.



Contact: Francisco Vilella, Mississippi Cooperative Fish and Wildlife Research Unit, fvilella@usgs.gov

Partners: Federal Emergency Management Agency, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/169599744000/fvilella>

D16. Laying the Groundwork for Science-Based Management of Colonial Waterbirds

Colonial nesting seabirds and long-legged wading birds of the eastern United States span geographic boundaries and jurisdictions of conservation agencies in 19 States, as well as adjacent provinces in maritime Canada. Despite many management concerns for colonial nesting waterbirds, broad, coordinated annual surveys similar to those for waterfowl, American woodcock, and sandhill cranes do not exist, and colonial seabirds are recognized as poorly sampled by the Breeding Bird Survey. The purpose of this project is to increase knowledge on surveying limitations and associated data storage needs for colonial waterbirds in the Atlantic and Gulf Coast; and to understand the distributions, population trends, and threats to these species. In addition, the project aims to resurrect the Colonial Waterbirds Database for improving data archiving and accessibility. Scientists will evaluate contents of the USGS-managed Colonial Waterbirds Database and update with data collected within the eastern United States. Scientists also will display species trends for select focal species graphically and evaluate trends and conservation goals.



Contact: Cynthia Loftin, Maine Cooperative Fish and Wildlife Research Unit, cindy_loftin@usgs.gov

Partners: University of Maine, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/169546725376/cynthia.loftin>

D17. Rapid Assessment of Geographic Distribution and Habitat Conditions of the Critically Endangered Puerto Rico Sharp-Shinned Hawk After Hurricane Maria

The Puerto Rican sharp-shinned hawk is an endangered woodland raptor of Puerto Rico. Individual populations are small and mostly known to be present on montane forest reserves on the island. Information is lacking on Puerto Rican sharp-shinned hawk population status and use of private lands, particularly the coffee-growing regions of the Cordillera Central. In 2017, Hurricane Maria hit Puerto Rico and caused extensive damage and alteration of forest structure, including loss of tree branches (for example, nesting structures), the opening of the forest canopy (approximately 90 percent of canopy loss), and a consequent increase in understory and midstory cover. Consequently, posthurricane forest conditions resulted in less available suitable habitat for the Puerto Rican sharp-shinned hawk. This rapid assessment project quantifies and documents initial damage to the vegetation structure of the Maricao, Guilarte, and Toro Negro Forests. As a result of the documented physical and structural damage, many basic ecological processes such as microclimates, rainfall patterns, nutrient cycling, and litter fall will be altered. Because of precarious situation of this endangered island raptor, results will be critical for identifying Puerto Rican sharp-shinned hawk survival and movements after hurricane Maria to avoid the extinction of this critically endangered species.



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Partners: Federal Emergency Management Agency, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/169607780352/fvilella>

D18. Causes of Elevational Patterns in Avian Species Richness

Anticipating and mitigating the effects of climate change on species diversity in montane ecosystems requires a mechanistic understanding of drivers of patterns of diversity. Scientists will document elevational gradients in avian species richness and test mechanistic hypotheses to explain those patterns. Although much attention has been given to the role of abiotic factors, particularly temperature, in limiting species' ranges, the goal of this project is to determine if other processes also affect gradients in species richness and if the importance of temperature differs across taxa.



Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

For more information: <https://www1.usgs.gov/coopunits/project/115871064064/cconway>

D19. Waterfowl Distribution in the Chesapeake Bay

Though large numbers of waterfowl migrate through the Chesapeake Bay region every winter, they do not use the landscape homogeneously. Instead, certain habitats are critical to the maintenance of these migratory birds, providing shelter and food during this energetically demanding period. To guide study site selection for projects investigating the effects of climate change on waterbird habitat, scientists must identify areas of importance among waterfowl in general and to specific species. The goal of this project is to combine scientific surveys (for example, midwinter waterfowl survey) and citizen science data (for example, eBird) to produce hotspot maps of waterfowl distribution across the Chesapeake Bay region. This information can then be used to identify sites for further research into how climate change drivers and shifting habitat availability may affect waterfowl species.



Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: Maryland Department of Natural Resources, Virginia Department of Game and Inland Fisheries

D20. Dispersal Behavior of Yuma Ridgway's Rail

Since 2005, the number of Yuma Ridgway's rail detected through standardized surveys has decreased substantially. Most of this decline has happened at managed wetlands near the Salton Sea, California, and reasons for the decline are unclear. The species is restricted to small patches of emergent wetland vegetation affected by multiyear drought and disconnected by large expanses of agricultural lands and open desert. Solar facilities in the immediate region possibly attract dispersing individuals that mistake the reflection from the solar arrays as water. The purpose of this project is to determine the dispersal distances, dispersal direction, and dispersal behavior of juvenile Yuma Ridgway's rails via individual tracking. The results will provide information for monitoring strategies of fatalities at renewable energy facilities to evaluate potential effects to rails and other species.



Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

Partners: BLM, First Solar, National Fish and Wildlife Foundation, NPS

For more information: <https://www1.usgs.gov/coopunits/project/125369903104/cconway>

D21. Population Dynamics, Ecology, and Habitats of North Pacific Shorebirds

Alaska, with its vast size and geographic position at the northern end of several migration pathways, is a critically important site for the world's shorebirds. Thirty-seven shorebird species regularly breed in Alaska. Most of these species complete epically long migrations to take advantage of Alaska's abundant food resources and breeding habitat, making Alaska a global resource for shorebirds. The purpose of the project is to improve knowledge of shorebirds and address key questions for management agencies about distribution and abundances of these species.



Contact: Dan Ruthrauff, Alaska Science Center, druthrauff@usgs.gov and Lee Tibbitts, Alaska Science Center, ltibbitts@usgs.gov

Partners: USFWS, BLM, NPS

Recent products:

Shorebird research at the U.S. Geological Survey Alaska Science Center, <https://doi.org/10.3133/fs20203056>

Factors promoting the recolonization of Oahu, Hawaii, by bristle-thighed curlews, <https://doi.org/10.1016/j.gecco.2019.e00785>

Flexible timing of annual movements across consistently used sites by marbled godwits breeding in Alaska, <https://doi.org/10.1093/auk/uky007>

Survival of bristle-thighed curlews equipped with externally mounted transmitters, <https://doi.org/10.18194/ws.00145>

Shorebird subsistence harvest and indigenous knowledge in Alaska—Informing harvest management and engaging users in shorebird conservation, <https://doi.org/10.1093/condor/duz023>

Alaska Shorebird Conservation Plan, Version III, <https://pubs.er.usgs.gov/publication/70203041>

For more information: <https://www.usgs.gov/centers/asc/science/shorebird-research>



Semipalmated sandpiper on the Arctic Coastal Plain, Alaska. Photograph by Daniel Ruthrauff, U.S. Geological Survey.

D22. Assessing Distribution and Occupancy Patterns of Riparian Avifauna in the Trans Pecos Region of Texas

Riparian areas in the Chihuahuan Desert Ecoregion are identified as a priority for conservation in the Trans Pecos region of Texas. Desert riparian systems are distinct narrow drainages that provide conditions for vegetation and wildlife species dependent on permanent or ephemeral surface and subsurface water. An objective of the Texas Parks and Wildlife Department is to work toward the recovery of threatened, endangered, and high-priority species associated with riparian systems. However, few quantitative data are available for riparian obligate birds in the region. The purpose of the project is to assess the distribution, site occupancy, and community structure of avifauna among different riparian systems of the Trans Pecos region and estimate nesting abundance and productivity of three State threatened raptor species. Results will help the Texas Parks and Wildlife Department make informed decisions for identification of priority areas for conservation and restoration, and for assessing species of concern status.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: Texas Parks and Wildlife Department

For more information: <https://www1.usgs.gov/coopunits/project/170220144640/clint.boal>



D23. Population Dynamics of Burrowing Owls on Kirtland Air Force Base

Burrowing owls were once a common breeder in grasslands and deserts throughout the western United States and Canada. Burrowing owl populations have declined, and the species has been extirpated from areas on the western, northern, and eastern periphery of their breeding range. Burrowing owls are now federally endangered in Canada and are listed by the USFWS as a species of conservation concern in the United States. Improved monitoring, research, and proactive management of this species on DoD lands is vital to supporting the military mission. These actions will help identify the management role of DoD for conserving burrowing owls nesting in the region, potentially help prevent further listing efforts, and provide information on risk and frequency of bird strike hazards. As a declining species on Kirtland Air Force Base, examining the local status, distribution, abundance, breeding behavior, and foraging habits of burrowing owls will facilitate successful mitigation and relocation efforts that may be needed to balance natural resource management with military readiness.

Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

Partners: DoD

For more information: <https://www1.usgs.gov/coopunits/project/211363440640/cconway>



Burrowing owl on fence post. Photograph by Peter Eades, U.S. Fish and Wildlife Service.

D24. Ecology of Canada Geese in Urban Areas of Iowa

Iowa's Canada goose population has gone from near zero to spring population estimates that occasionally are greater than 100,000. Concurrently, Iowans' perception of Canada geese has evolved from an uncommon and charismatic bird to a widespread species that is occasionally viewed as a nuisance. The purpose of this project is to determine movements of urban geese to quantify their susceptibility to hunting and to estimate annual harvest and survival rates of Canada geese captured in urban areas. Results will be used to ensure that monitoring and management keep pace with the changes population abundance and status.

Contact: Bob Klaver, Iowa Cooperative Fish and Wildlife Research Unit, bklaver@usgs.gov

Partners: Iowa Department of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/170162558976/bklaver>



D25. Population Ecology and Habitats of Alaska Landbirds

This program coordinates a cooperative, regional effort to monitor population trends of landbirds breeding in northern ecoregions, to investigate population dynamics of landbirds and relations between the distribution of breeding landbirds and terrestrial habitats at the landscape level. Objectives of this project are as follows: (1) a continuing investigation of viral factors related to the emerging epizootic of avian keratin disorder in forest birds of Alaska and other bird species across the globe; (2) using statistical methods to assess factors responsible for species detectability during point count surveys; (3) summarizing population trends and habitat associations of breeding landbird populations in Alaska by compiling information through Boreal Partners in Flight, on lands within the NPS southwestern Alaska region, and from the Alaska Landbird Monitoring Survey, (4) identifying limiting factors, key habitats, and migratory connectivity throughout the annual cycles and ranges of declining and rare species of high continental concern; and (5) assessing the vulnerability and adaptive potential of landbird populations to rapid climate change.

Contact: Colleen Handel, Alaska Science Center, chandel@usgs.gov and Steve Matsuoka, Alaska Science Center, smatsuoka@usgs.gov

Partners: USGS Eastern Ecological Science Center, USGS Nebraska Cooperative Fish and Wildlife Unit, USFWS, BLM, NPS, DoD, USFS, Alaska Department of Fish and Game, Environment and Climate Change Canada, University of Alaska Anchorage, University of Alaska Fairbanks, University of Alberta, Utah State University, Audubon Society, Biodiversity Research Institute, International Rusty Blackbird Working Group, Partners in Flight

Recent products:

Monitoring boreal avian populations—How can we estimate trends and trajectories from noisy data?, <https://doi.org/10.5751/ACE-01397-140208>

Lessons learned from comparing spatially explicit models and the Partners in Flight approach to estimate population sizes of boreal birds in Alberta, Canada, <https://doi.org/10.1093/condor/duaa007>

Climate-change refugia in boreal North America—What, where, and for how long?, <https://doi.org/10.1002/fee.2188>

For more information: <https://www.usgs.gov/centers/asc/science/landbird-research-alaska>



A bluethroat perching in northwestern Alaska. Photograph by Rachael Richardson, U.S. Geological Survey.



D26. Black Rosy-Finch Distribution, Abundance, and Habitat Selection During the Breeding Season

The black rosy-finch has a restricted geographic range within the intermountain west and is one of the most understudied species in North America. The black rosy-finch has been designated a Species of Greatest Conservation Need in Wyoming, reflecting the lack of information available on this species. Because the black rosy-finch is a high elevation-obligate nester, range contraction and habitat changes resulting from warming weather trends could lead to local extirpation of the species. The purpose of this project is to collect data that are lacking on breeding habitat selection and requirements and identify key characteristics of summer breeding habitat to build a predictive model. This project addresses conservation actions as identified in the State Wildlife Action Plan, including the establishment of optimal long-term monitoring sites that could be used for tracking population trends and changes in habitat use resulting from changing weather conditions in the alpine.

Contact: Anna Chalfoun, Wyoming Cooperative Fish and Wildlife Research Unit, achalfoun@usgs.gov

Partners: Wyoming Game and Fish Department

For more information: <https://www1.usgs.gov/coopunits/project/115046264832/achalfou>



D27. Monitoring Avian Productivity and Survival in San Diego County



U.S. Geological Survey scientists collect field information at a Monitoring Avian Production station. Photograph by Barbara Kus, U.S. Geological Survey.

Long-term data from the North American Breeding Bird Survey and other sources indicate that many neotropical migratory species are declining, prompting development of coordinated monitoring and research for neotropical birds. The Monitoring Avian Productivity and Survivorship program uses capture and banding data to compile basic demographic parameters of migratory species, many of which are imperiled regionally and even globally. Monitoring at San Diego County sites provides long-term demographic data for use in evaluating population trends of neotropical migrants and other species of concern in riparian, oak woodland, and coastal sage scrub habitats. The long-term Monitoring Avian Productivity and Survivorship data may be used to assess threats to habitat and associated birds, such as drought and the invasive shot hole borer.



Contact: Barbara Kus, Western Ecological Research Center, barbara_kus@usgs.gov

Partners: USFWS, U.S. Marine Corps, USACE, San Diego State University

For more information: <https://www.usgs.gov/centers/werc/science/monitoring-avian-productivity-and-survivorship-maps>

D28. Productivity of Black Oystercatchers in Southwest Alaska

The black oystercatcher plays an important role in structuring nearshore systems and is highly susceptible to human disturbance. Inventory and monitoring efforts may not adequately address information needs for estimating long-term trends for this species. To address these issues, researchers of this project will investigate black oystercatcher nests, diet, and chick provisioning to ensure robust interpretation of trends observed in long-term monitoring data. Operational and alternative methods for monitoring black oystercatcher reproductive success will be evaluated and recommendations for management of the species will be produced.



Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: NPS, Natural Resources Preservation Program, University of Alaska

Recent products:

Energy intake rate influences survival rates of black oystercatcher (*Haematopus bachmani*) broods, <http://marineornithology.org/content/get.cgi?rn=1329>

For more information: <https://www1.usgs.gov/coopunits/project/110306279424/ffanp>

Sora at Trempealeau National Wildlife Refuge. Photograph by Larry Palmer, U.S. Fish and Wildlife Service.



D29. Population Structure and Demography of the Least Bell's Vireo and Southwestern Willow Flycatcher and Use of Restored Riparian Habitat

Riparian woodlands are highly productive ecosystems that support a disproportionately high percentage of regional biodiversity. The woodlands also are one of the most endangered terrestrial systems in temperate North America and have been reduced to just 5 percent of their former extent in California and throughout the American southwest. These losses have been accompanied by steep declines in many plant and animal species, including the federally endangered least Bell's vireo and southwestern willow flycatcher, which are considered flagship species for riparian conservation. This project focuses on the ecology of the least Bell's vireo and southwestern willow flycatcher, including their genetic population structures, habitat requirements, nesting ecology, and demography. The project also provides insight on the effectiveness of restoration as a means for replacing lost natural habitat and associated animal communities.

Contact: Barbara Kus, Western Ecological Research Center, barbara_kus@usgs.gov

Partners: USFWS, U.S. Marine Corps, USACE, San Diego State University

Recent products:

Recovery planning in a dynamic system—Integrating uncertainty into a decision support tool for an endangered songbird, <https://doi.org/10.5751/ES-11169-240411>

For more information: <https://usgs.gov/centers/werc/science/population-structure-and-demography-least-bell-s-vireo-and-southwestern-willow>

Female southwestern willow flycatcher with colorful bands on the upper San Luis Rey River. Photograph by Scarlett Howell, U.S. Geological Survey.



D30. Productivity of American Oystercatchers Nesting on Spoil Islands at the Cross Florida Greenway State Recreation and Conservation Area

Within Florida, American oystercatchers breed at approximately 50 sites, although 90 percent of the population is concentrated on the Gulf Coast. The Cross Florida Greenway State Recreation and Conservation Area spoil islands along the Gulf Coast support a large concentration of nesting oystercatchers. The objectives of this project are to use existing data and collect additional field data to determine causes of mortality and disturbance and to estimate annual productivity and responses to disturbance, predators, and food supply. Results will be used to develop management actions to increase annual productivity of oystercatchers nesting on spoil islands in the Cross Florida Greenway State Recreation and Conservation Area.

Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: University of Florida, Nature Coast Biological Station

For more information: <https://www1.usgs.gov/coopunits/project/127299174400/ffanp>



D31. Identifying Population Limiting Factors for the Hudsonian Godwit

Because of the immense scale of movements by migratory bird species, analyses are needed throughout the annual cycle to identify population limiting factors. The purpose of this project is to provide answers that are relevant to a model species—the Hudsonian godwit—and to migratory species generally. Objectives include (1) determining how choices throughout the annual cycle affect survival, condition, and performance of individuals; (2) determining how density-dependent heterospecific interactions and phenological mismatches affect populations; and (3) identifying climatic effects on the network of migratory



stopover sites. Results will provide information to help partners make conservation decisions throughout the annual cycle and to identify conservation priorities related to changes in climatic conditions, habitat quality, and species interactions.

Contact: Rose Swift, Northern Prairie Wildlife Research Center, rswift@usgs.gov

Partners: University of South Carolina, USFWS, Cornell Lab of Ornithology

Recent products:

Seasonal survival and reversible state effects in a long-distance migratory shorebird, <https://doi.org/10.1111/1365-2656.13246>

D32. Population Demographics of Least Terns and Piping Plovers in Colorado

The USGS is helping to improve monitoring of federally listed least terns and piping plovers by the USACE at John Martin Reservoir in southeastern Colorado. Scientists are providing information to the USACE to improve habitat management and productivity monitoring. The purpose of this project is to provide the capability to mark adults and chicks with alphanumeric color bands during a 5-year period that began in 2017. The USACE's monitoring program will benefit from having the population of least terns and piping plovers that use this area uniquely marked because the information will help to estimate recruitment and fidelity to breeding areas. Monitoring of marked birds at John Martin Reservoir as well as birds marked elsewhere will answer broader questions about how isolated these populations are from other breeding areas.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USACE, Colorado Parks and Wildlife

For more information: <https://www.usgs.gov/centers/npwrc/science/population-demographics-least-terns-and-piping-plovers-colorado>



Least tern and piping plover monitoring staff and U.S. Army Corps of Engineers staff observe piping plover nest on John Martin Reservoir. Photograph by Dustin Toy, U.S. Geological Survey.

D33. Metapopulation Dynamics of Piping Plovers in the Northern Great Plains

USGS scientists are leading a multiagency regional study to understand metapopulation dynamics of piping plovers in the Northern Great Plains. Piping plovers are a federally listed species that nests on riverine sandbars and shorelines of wetlands and reservoirs. These habitats are dynamic in response to climate and water-management regimes of the Missouri River. The USACE manages the Missouri River for hydropower, recreation, water supply, navigation, flood control, and fish and wildlife. This multiple use management strategy puts piping plovers in jeopardy. Accordingly, the USACE is preparing to spend more than \$10 million a year for the foreseeable future to create breeding habitat for plovers on the Missouri River. Additionally, the other key areas where plovers breed, wetlands in the Prairie Pothole Region, are threatened by changing climate and land-use practices. Results of this project will provide population demographic and dispersal information to help managers make decisions regarding management, conservation, and recovery of this species, as well as provide information regarding management of the Missouri River.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USACE, Missouri River Recovery Implementation Committee, USFWS, The Nature Conservancy

Recent products:

Asymmetric benefits of a heterospecific breeding association vary with habitat, conspecific abundance and breeding stage, <https://doi.org/10.1111/oik.07256>

Low renesting propensity and reproductive success make renesting unproductive for the threatened piping plover (*Charadrius melodus*), <https://doi.org/10.1093/condor/duz066>

For more information: <https://www.usgs.gov/centers/npwrc/science/metapopulation-dynamics-piping-plovers-northern-great-plains>



D34. Demographic Analysis of Waterfowl Populations

The USGS has a history of broad-scale demographic analyses using available data on waterfowl. Efforts are collaborative with a variety of partners. Studies include (1) analysis of midcontinent waterfowl harvest information to identify predictable drivers of recruitment and (2) evaluation of the North American Breeding Population and Habitat Survey for sources of changing bias in survey methods. The USGS recognizes the cultural and socioeconomic importance of waterfowl in North America, and results of each of these analyses provide information for pressing conservation decisions that are made by partners.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USFWS–Habitat and Population Evaluation Team, North Dakota Game and Fish Department, Duke University

For more information: <https://www.usgs.gov/centers/npwrc/science/demographic-analysis-waterfowl-populations>



The annual economic footprint of waterfowl hunting is more than \$3 billion. Photograph by Glen Sargeant, U.S. Geological Survey.

2021



Brown pelican. Photograph by Mike Morel, U.S. Fish and Wildlife Services.

American avocet at Seedskadee National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.



Effects of Energy Development

E01. Assessing Risk to Eagles from Wind Turbine Development

The central United States is an important focus area for development of wind facilities because of low human densities and high wind speeds. Rapid expansion of wind energy is forecasted for this area, prompting a need to predict risk to golden eagles and other raptors from turbines and to suggest approaches to bird-friendly wind energy development. Although effects of wind power on eagles have been extensively studied in the eastern and western United States, almost no research has been completed in the central United States. Therefore, making sound management recommendations and decisions is a challenge. The USGS is leading several studies that use GPS/GSM telemetry to track birds, such as bald and golden eagles, to acquire information for spatially explicit risk models that identify areas good for turbine placement and at lower risk to eagles. The research also collects information on topography, weather, and land cover to understand how environmental conditions affect eagles and may put them at risk from collisions with wind turbines. These new models will predict possible turbine locations that pose low and high potential risk to eagles, and the models can be used to suggest alternatives to high-risk sites.



Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: Oklahoma Department of Wildlife Conservation, Enel Green Power, BLM, National Fish and Wildlife Foundation, Conservation Science Global, Inc., USFWS, Winona State University, University of Tasmania

Recent products:

Use of upland and riparian areas by wintering bald eagles and implications for wind energy, <https://doi.org/10.1002/jwmg.21927>

Evaluating contributions of recent tracking-based animal movement ecology to conservation management, <https://doi.org/10.3389/fevo.2019.00519>

Wind energy—An ecological challenge, <https://doi.org/10.1126/science.aaz9989>

Roost- and perch-site selection by golden eagles (*Aquila chrysaetos*) in eastern North America, <https://doi.org/10.1676/18-38>

E02. Effects of Wind Energy on Raptors

A central challenge in applied ecology is understanding the effect of anthropogenic fatalities on wildlife populations and predicting which populations may be particularly vulnerable and in greatest need of management attention. Scientists are studying 14 raptor species for potential of population-level effects from wind turbine collisions. Preliminary analysis indicates that some raptor populations may be more vulnerable than others to wind turbine collisions. The goal of this project is to support species management by identifying which species may benefit from research that identifies tools to avoid or reduce raptor collisions with turbines.



Contact: Wayne Thogmartin, Upper Midwest Environmental Sciences Center, wthogmartin@usgs.gov

Partners: University of Wisconsin-Stout, Oklahoma State University

Recent products:

Strategic plan for the North American Breeding Bird Survey, 2020–30, <https://doi.org/10.3133/cir1466>

E03. Determining Carcass Scavenging and Searcher Efficiency Rates on Major Rivers for Oil Spill Response and Assessment of Wildlife Injury



The USFWS's Natural Resource Damage Assessment and Restoration process is used to quantify an oil spill's effects on natural resource injuries and apply the appropriate restoration. Measures of carcass persistence and searcher efficiency can reduce uncertainty associated with estimates of the magnitude of avian harm after an oil spill. The objective of this project is to establish predisaster carcass persistence and searcher efficiency rates for high-risk segments of the Yellowstone River and the Missouri River. Results will generate baselines for assessing the magnitude of avian injury after potential future inland oil spills and provide a template for generating predisaster estimators for other riverine locations.

Contact: Nimish Vyas, Eastern Ecological Science Center, nvyas@usgs.gov

Partners: USFWS, USACE, EPA, NPS, Nebraska Game and Parks Commission, South Dakota Game, Fish and Parks

For more information: <https://www.usgs.gov/centers/pwrc/science/determining-carcass-scavenging-rates-major-rivers-oil-spill-response-and-nrdar>



Canada geese on an island after an oil spill in the Yellowstone River. Photograph by D. Rouse, U.S. Fish and Wildlife Service.

E04. Long-Term Louisiana Waterthrush and Avian Community Response to Shale Gas Development in the Central Appalachian Region



Shale gas development in the central Appalachian region has increased exponentially in recent years leading to concerns related to fragmentation of the region's forests and to effects on water resources, particularly forested headwater streams. The purpose of this 6-year project is to evaluate multiple measures of avian population response to a changing landscape from shale gas development activities. Measures include avian community changes, Louisiana waterthrush demographic response, and benthic community changes. Results will better define ecosystem level responses across the terrestrial-aquatic interface.

Contact: Petra Wood, West Virginia Cooperative Fish and Wildlife Research Unit, pbwood@usgs.gov

Partners: Appalachian Stewardship Foundation, National Aviary, U.S. Department of Energy, West Virginia University, West Virginia Department of Natural Resources

Recent products:

Demographic characteristics of an avian predator, Louisiana waterthrush (*Parkesia motacilla*) in response to its aquatic prey in a Central Appalachian USA watershed impacted by shale gas development, <https://doi.org/10.1371/journal.pone.0206077>

Louisiana waterthrush (*Parkesia motacilla*) survival and site fidelity in an area undergoing shale gas development, <https://doi.org/10.1676/18-6>

Epigenetic response of Louisiana waterthrush *Parkesia motacilla* to shale gas development, <https://doi.org/10.1111/ibi.12833>

For more information: <https://www1.usgs.gov/coopunits/project/115062364160/pbwood>

E05. Golden Eagles Near Altamont Pass Wind Resource Area



The Altamont Pass Wind Farm in northern California. Photograph by Todd Katzner, U.S. Geological Survey.

Collisions with wind turbines at the Altamont Pass Wind Resource Area have been identified as a primary cause of death for golden eagles in the region. The purpose of this project is to determine if the local population of golden eagles surrounding Altamont, California, has the demographic resiliency to sustain such mortality. The USGS and partners are using historical and new data to investigate patterns of territory occupancy, breeding success, ranging behavior, and habitat use of golden eagles near Altamont. This information is being used to develop demographic models that can help predict how the local population of golden eagles may respond to estimated levels of fatalities related to wind turbines. Researchers will also evaluate factors that affect detection rates of breeding golden eagles and their nests during surveys. These results will help improve survey and monitoring tools for golden eagles across the wide range of environmental conditions in the western United States.



Contact: Dave Wiens, Forest and Rangeland Ecosystem Science Center, jwiens@usgs.gov

Partners: East Bay Regional Park, USFWS

Recent products:

Distribution and abundance of *Aquila chrysaetos* (golden eagles) in the East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan Area, California <https://doi.org/10.3133/ofr20201107>

E06. Trending Against the Grain—Bird Population Responses to Expanding Energy Portfolios in the Northern Great Plains of the United States

Heightened demand for global energy is likely to be met through increased extraction of unconventional fossil fuels and production of renewable energy such as biofuels. Renewable energy is often proposed as an environmentally friendly alternative to fossil fuels; however, effects of these energy sources on wildlife populations have rarely been evaluated in working landscapes. Scientists used North American Breeding Bird Survey data to estimate the joint effects of unconventional oil and gas and biofuel crop production on population trends of three grassland bird species (bobolink, grasshopper sparrow, and western meadowlark) in North Dakota, a State experiencing rapid growth in both energy sectors. Results of this project will allow managers to determine the relative effect of agricultural expansion to energy development on grassland bird communities.



Contact: Max Post van der Burg, Northern Prairie Wildlife Research Center, maxpostvanderburg@usgs.gov

E07. Changing Arctic Ecosystems—Minimizing Effects of Arctic Energy Development on Wildlife



The USGS Changing Arctic Ecosystems Initiative began in 2010 with a primary objective to understand rapid physical changes, such as increasing temperature and reduced sea ice, taking place in the Arctic and to quantify and forecast how Arctic wildlife and habitats are responding to these changes. The Changing Arctic Ecosystems program has developed a 5-year plan that includes research projects on migratory birds. USGS scientist will assess helicopter-induced disturbance on molting black brant in the National Petroleum Reserve—Alaska.

Contact: Brandt Meixell, Alaska Science Center, bmeixell@usgs.gov and Paul Flint, Alaska Science Center, pflint@usgs.gov

Partners: BLM, USFWS

For more information: <https://www.usgs.gov/center-news/usgs-alaska-science-center-develops-new-5-year-arctic-research-plan>



A greater white-fronted goose flies over a nesting area near Point Lonely, Alaska. Photograph by Brandt Meixell, U.S. Geological Survey.

E08. Habitat Mitigation for Effects of Energy Facilities on Grassland Birds and Waterfowl Using the Avian-Impact Offset Method



Compensatory mitigation is increasingly being used to offset effects from anthropogenic disturbances such as energy development and building of roads. Previous studies have documented behavioral avoidance and, thus, reduced use of habitat by grassland birds near wind infrastructure. To quantify and compensate for this loss in value of breeding habitat, USGS and USFWS scientists developed the Avian-Impact Offset Method. The Avian-Impact Offset Method is a tool that estimates the amount of grasslands and wetlands needed to support displaced pairs of grassland birds and waterfowl, and is applicable to displacement by wind, oil, gas, and transportation infrastructure. The Avian-Impact Offset Method tool provides the following four products: (1) avian displacement rates; (2) a demonstration of the Avian-Impact Offset Method for wind and oil infrastructure; (3) a worksheet for Avian-Impact Offset Method users to apply to their own projects; and (4) a geospatial decision support tool that automates geographic information system processes for identifying biologically equivalent habitats for mitigation fulfillment, as well as for forecasting mitigation costs of proposed developments.

Contact: Jill Shaffer, Northern Prairie Wildlife Research Center, jshaffer@usgs.gov

Partners: USFWS, NextEra Energy Resources

Recent products:

Estimating offsets for avian displacement effects of anthropogenic impacts, <https://doi.org/10.1002/eap.1983>

For more information: <https://www.usgs.gov/centers/npwrc/science-topics/wind-energy>

E09. Understanding the Behavioral Basis of Bird Mortality at Utility-Scale Solar Facilities

A growing concern surrounds avian mortality at utility-scale photovoltaic solar facilities, especially because of the projected growth of solar energy as a renewable energy source. How and why solar facilities are associated with differing degrees of avian mortality remains a mystery. Therefore, researchers are interested in determining if these facilities attract birds and, thereby, potentially contribute to avian mortality. The goal of this project is to address some of the following uncertainties associated with solar energy-related bird mortality: (1) what cues associated with large solar fields might serve to attract birds; (2) how are birds responding while in flight; (3) how might this attraction differ among different taxonomic groups; and (4) do the properties of solar facilities—their size, isolation, or geographic location—predict levels of mortality? Answers to these and other uncertainties may affect the future design and siting of utility-scale solar facilities in ways that minimize effects to birds while remaining a viable alternative to more traditional sources of energy.

Contact: Robb Diehl, Northern Rocky Mountain Science Center, rhdiehl@usgs.gov

Partners: Bard College, WEST Inc., Humboldt State University, California Energy Commission, Avian Solar Work Group, BLM



Portable radar monitoring the movements of birds and other flying animals near a solar facility in the desert southwest. Photograph by Robb Diehl, U.S. Geological Survey.

E10. Bird and Bat Environmental Study for the Experimental Wind Facility in Texas

Wind energy is a clean form of energy, but the negative effects on birds through direct mortality or habitat displacement, or both, in the southern Great Plains are not well understood. Research and monitoring of the local avian community near a wind energy facility is necessary to assess immediate and long-term effects of the facility. The purpose of this project is to assess direct mortality of volant species caused by wind turbines at the Scaled Wind Farm Technology facility in Lubbock, Texas. For this project, scientists also will evaluate long-term trends in occupancy and, for select species, survival and productivity of resident and migrant grassland bird species.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: Sandia National Laboratory, U.S. Department of Energy, Texas Tech University

For more information: <https://www1.usgs.gov/coopunits/project/170225694720/clint.boal>

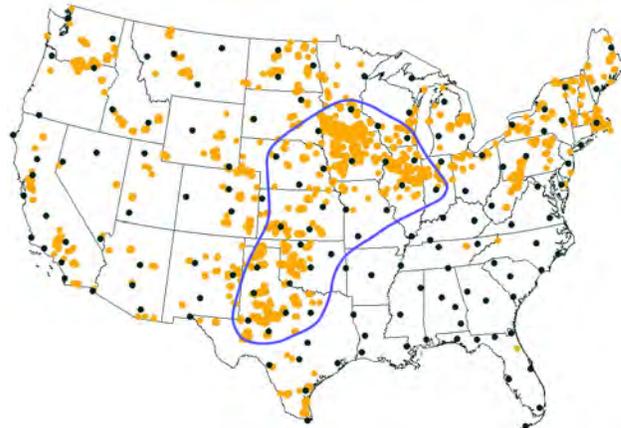


E11. Reducing Turbine-Related Bird and Bat Mortality Using Weather Radar

Remote sensing methods designed to supervise curtailment of wind turbine operation or dissuade birds and bats from approaching operating turbines, will require widespread deployment of new sensor networks that may add considerable complexity and cost because of the extent and build-out forecasts for wind energy in the United States. Therefore, the best solutions will be easy to deploy, inexpensive to operate, highly reliable, require little maintenance, and minimize energy generation losses. The purpose of this project is to explore the use of the existing U.S. weather radar network to help provide information regarding siting or turbine curtailment in the presence of flying animals. A critical issue to such applications, in addition to discriminating radar target types, concerns these radars' limited range to directly monitor bird and bat densities at rotor-swept heights. Researchers will apply recent advances in machine learning-based biological target discrimination and explore if radar-determined bird/bat density profiles accurately reflect abundances and height distributions beyond the immediate coverage area.

Contact: Robb Diehl, Northern Rocky Mountain Science Center, rhdiehl@usgs.gov

Partners: U.S. Department of Energy, National Renewable Energy Laboratory



Coverage of weather radars (black dots) overlaps the distribution of wind energy facilities (orange dots) throughout the United States. The study area outlined in blue includes 28 radars and some of the highest concentrations of wind turbines.



E12. Interactions of Juvenile Swainson's Hawks with Wind Energy Facilities During Dispersal and Migration

Swainson's hawks breed in the prairies and steppes of North America and migrate to the grasslands of Argentina; both areas have experienced high wind energy development. Wind energy facilities have been demonstrated to pose threats to avian species through direct mortality and habitat loss. The objectives of this study are to provide survival estimates, movement data, and habitat use data for juvenile Swainson's hawks throughout their migrations from Texas to Argentina and back. These results will provide important data with which to evaluate hemispheric level risks to the species and other similar long-distance migrant birds.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: U.S. Department of Energy

For more information: <https://www1.usgs.gov/coopunits/project/170226511872/clint.boal>



E13. Ecology, Habitat Use, and Effects of Wind Energy on Burrowing Owls

Burrowing owls are of substantial conservation concern across their breeding distribution in the prairies and steppes of North America; both are areas of high wind energy development. Wind energy development is increasing at a rapid pace throughout much of the world, and wind energy facilities have been demonstrated to pose threats to avian species, including direct mortality of burrowing owls. The purpose of this project is to provide comparison data between burrowing owl breeding pair site occupancy, productivity, and habitat use in areas with and without wind energy development. These data will allow assessments of burrowing owl response to wind energy development and the potential direct and indirect effects of associated structures. Results of this project will provide important information with which to understand and evaluate risks and determine the need for conservation actions in response to wind energy development.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: U.S. Department of Energy, Consolidated Nuclear Security—Pantex

For more information: <https://www1.usgs.gov/coopunits/project/193181759488/clint.boal>



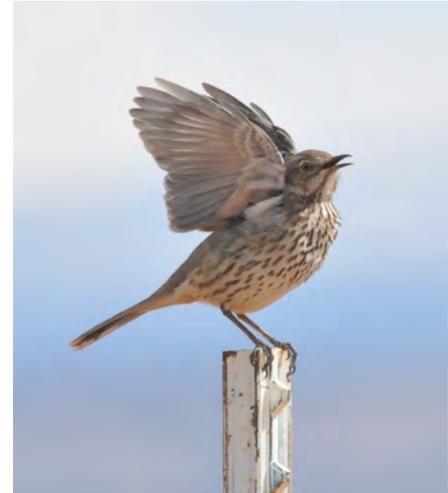
E14. Effect of Energy Development and Climatic Variability on Sagebrush Songbirds

Changing temperature and precipitation regimes, especially within arid systems such as the sagebrush steppe, are broad-scale factors that will affect landscapes in addition to other forms of physical habitat loss and fragmentation. The combined, and potentially interactive, effects of climatic conditions and habitat loss on wildlife species of concern, however, are unknown. Simultaneously, three species of songbirds (Brewer's sparrow, sagebrush sparrow, sage thrasher) that nest almost exclusively within North American sagebrush habitats have been exhibiting population declines, at least partly because of habitat changes on breeding grounds. The purpose of this project is to use a large, multiyear nesting dataset of sagebrush songbirds and remotely sensed weather data to investigate the joint effects of climatic conditions and energy development on the reproductive success of sagebrush songbirds within the Wyoming Landscape Conservation Initiative area. Information generated by the research will be used to update the Wyoming Comprehensive Wildlife Conservation Strategy and Wyoming State Wildlife Action Plan, provide information for Climate Vulnerability Assessments, and address information needs articulated by the multiagency Sagebrush Conservation Initiative.

Contact: Anna Chalfoun, Wyoming Cooperative Fish and Wildlife Research Unit, achalfoun@usgs.gov

Partners: University of Wyoming, Western Association of Fish and Wildlife Agencies, Wyoming Wildlife–The Foundation, Wyoming Landscape Conservation Initiative, USFWS, Wyoming Game and Fish Department

For more information: <https://www1.usgs.gov/coopunits/project/143177771008/achalfou>



Sage thrasher in Mesa, Colorado.
Photograph by Scott Somershoe, U.S. Fish and Wildlife Service.

E15. Full Life-Cycle Effects of Natural Gas Development on Sagebrush-Obligate Songbirds

A primary challenge for management of sagebrush habitats and wildlife is the conversion and fragmentation of habitat related to energy extraction. Three species of sagebrush-obligate songbirds (Brewer sparrow, sagebrush sparrow, sage thrasher) are declining and are species of concern for many State and Federal agencies. Gaps in understanding remain about how development affects key life stages outside of the nesting period, including the postfledging period and annual survival, and the extent to which the fidelity of birds to breeding sites may affect trends in abundance. Moreover, migratory routes and overwintering locations for sagebrush songbirds remain unknown, which precludes the ability to assess which life stages may be most limiting. The purpose of this project is to address vital informational gaps necessary to update species conservation plans and to provide information for future sighting decisions.

Contact: Anna Chalfoun, Wyoming Cooperative Fish and Wildlife Research Unit, achalfoun@usgs.gov

Partners: Wyoming Game and Fish Department, Wyoming Landscape Conservation Initiative

For more information: <https://www1.usgs.gov/coopunits/project/203279378432/achalfou>



E16. Modeling Bald and Golden Eagle and Other Raptor Populations and Take Rates

Eagle collisions with turbines at wind energy facilities are common in some areas of the United States. If wind turbine collision-related mortality rates are sufficiently high, population growth rates and persistence could be compromised. The purpose of this project is to complete a demographic analysis using a collision risk model. Results will aid in the issuance of incidental take permits to operators of wind energy facilities, improve models used to predict fatalities, and formally update the overall modeling process. Covariates that might affect eagle exposure or collision risk also will be incorporated into a collision risk model to improve its accuracy.

Contact: James Cain, New Mexico Cooperative Fish and Wildlife Research Unit, jwcain@usgs.gov

Partners: USFWS

For more information: <https://www1.usgs.gov/coopunits/project/193849700352/jwcain>



E17. Topographic Drivers of Golden Eagle Flight Altitude in the Mojave Desert, California

Risk of golden eagle collisions with wind turbines is affected by the altitude at which birds fly. Topographic features drive eagle flight because lift is dependent on the slope, aspect, and cover type. The USGS is leading an evaluation of the relation between topography and eagle flight altitude to infer risk to eagles from turbine development in the Mojave Desert, California. Using existing GPS telemetry data that includes information on flight altitude, scientists are performing an analysis to compare flight height among different landforms and to evaluate how flight altitude varies with slope, aspect, and ground cover. Scientists also are evaluating eagle use of sites with and without winds suitable for wind energy development. Results will help identify characteristics of wind development sites in the Mojave that may be risky to golden eagles and will aid in development of eagle-safe management plans.

Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: BLM, Conservation Science Global, Inc., Boise State University

Recent products:

Topographic drivers of flight altitude over large spatial and temporal scales, <https://doi.org/10.1093/auk/ukz002>



Golden eagle in flight. Photograph by Michael Lanzone.

E18. Eastern Brown Pelicans—Dispersal, Seasonal Movements and Monitoring of Polycyclic Aromatic Hydrocarbons and Contaminants in the Northern Gulf of Mexico

The Gulf of Mexico contains a high density of oil and gas infrastructure and coastal development. The region also is of year-round importance to seabirds, including local breeding populations and birds from distant locations that are present within the Gulf throughout the year. A species of conservation concern in the region is the brown pelican. Despite a history of focus on conservation and restoration efforts, much of the information required to understand pelican population dynamics, habitat requirements, or responses to environmental stress remains unknown or is poorly understood. This project relies on collaboration with many partners to extensively explore brown pelican nesting and movement ecology. Results will provide information regarding restoration activities in the Gulf, and the information will play a role in the establishment of guidelines for the development of long-term monitoring plans for seabirds in the region. Results also will provide information to agency partners for the development of spill response plans, assessment activities, and marine spatial planning.

Contact: Patrick Jodice, South Carolina Cooperative Fish and Wildlife Research Unit, pjodice@usgs.gov

Partners: BOEM, Texas Parks and Wildlife Department, Louisiana Department of Wildlife and Fisheries, Alabama Department of Conservation and Natural Resources, Florida Fish and Wildlife Conservation Commission

Recent products:

Seasonal variation in environmental and behavioral drivers of annual-cycle habitat selection in a nearshore seabird, <https://doi.org/10.1111/ddi.13015>

Ecological drivers of brown pelican movement patterns, health, and reproductive success in the Gulf of Mexico, https://espis.boem.gov/final%20reports/BOEM_2020-036.pdf

For more information: <https://www1.usgs.gov/coopunits/project/59365425152/pjodice>



E19. Seabird Ecology for Marine Spatial Planning

Oceanic waters of the United States provide habitat for many migratory, resident, and breeding species of seabirds. Recent technology has made offshore wind energy development a possibility for the deep waters offshore of the U.S. west coast and the Hawaiian Islands. Minimizing negative interactions of offshore wind energy infrastructure with marine species is a step towards a sustainable offshore energy future. Scientists from USGS and BOEM will provide information for marine planning by evaluating the vulnerability of seabirds to potential offshore energy infrastructure. Objectives of this project are as follows: (1) mapping seabird colonies on land, (2) evaluating and quantifying seabird vulnerabilities at sea, (3) developing new technologies and machine learning analytics for seabird and marine mammal surveys, (4) high-resolution tracking of individual seabirds to determine habitat use, and (5) sophisticated modeling of species distributions at sea.



Contact: Josh Adams, Western Ecological Research Center, josh_adams@usgs.gov

Partners: American Bird Conservancy, BOEM, Pacific Outer Continental Shelf Region, Hawaii Department of Land and Natural Resources, Hawai'i Pacific University, Kalaupapa National Historical Park, Kaua'i Endangered Seabird Recovery Project, Maui Nui Seabird Recovery Project, Marine Corps Base Hawaii, Moloka'i Land Trust, The Nature Conservancy, Oikonos Ecosystem Knowledge, Pacific Rim Conservation, University of Hawai'i, NOAA National Centers for Coastal Ocean Science, University of Washington

Recent products:

Spatial and temporal diving behavior of non-breeding common murrelets during two summers of contrasting ocean conditions, <https://doi.org/10.1016/j.jembe.2019.05.009>

Diving behavior of pink-footed shearwaters *Ardenna creatopus* rearing chicks on Isla Mocha, Chile, <http://www.marineornithology.org/content/get.cgi?rn=1286>

Does perspective matter? A case study comparing Eulerian and Lagrangian estimates of common murre (*Uria aalge*) distributions, <https://doi.org/10.1002/ece3.5083>

Overlap of pink-footed shearwaters and central Chilean purse-seine fisheries—Implications for bycatch risk, <https://doi.org/10.1093/condor/duz026>

Eastern Pacific migration strategies of pink-footed shearwaters *Ardenna creatopus*—Implications for fisheries interactions and international conservation, <https://doi.org/10.3354/esr00969>

For more information: <https://www.usgs.gov/centers/werc/science/seabird-ecology-and-marine-planning>

Waterfowl on LaCreek National Wildlife
Refuge. Photograph by Tom Koerner,
U.S. Fish and Wildlife Service.





Mallards in flight at twilight. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

Support of Restoration and Species Recovery

F01. Migration and Wintering Ecology of the Aransas-Wood Buffalo Population of Whooping Cranes



The only self-sustaining population of endangered whooping cranes nests within and near Wood Buffalo National Park, Canada, migrates through the Great Plains and winters primarily along the Texas Gulf Coast. The objectives of this collaborative project are to address the annual life cycle of this species by advancing knowledge of breeding, wintering, and migration ecology, including threats to survival and population persistence. Results will allow researchers to identify potential barriers to species recovery. To complete this research, scientists have deployed and monitored more than 100 GPS-enabled satellite transmitters during 2010–20. Scientists are characterizing stopover sites used by whooping cranes and documenting surrounding habitat characteristics and land-management practices to better define habitat criteria required by the species at stopover sites (for example, the Platte River). Results will provide information for recovery and management of whooping cranes into the foreseeable future.

Contact: Aaron Pearse, Northern Prairie Wildlife Research Center, apearse@usgs.gov

Partners: USFWS, Canadian Wildlife Service, Crane Trust, International Crane Foundation, Parks Canada

Recent products:

Whooping crane use of riverine stopover sites, <https://doi.org/10.1371/journal.pone.0209612>

Diurnal habitat selection of migrating whooping cranes in the Great Plains, <http://www.ace-eco.org/vol14/iss1/art6/>

Identifying sustainable winter habitat for whooping cranes, <https://doi.org/10.1016/j.jnc.2020.125892>

Heterogeneity in migration strategies of whooping cranes, <https://doi.org/10.1093/condor/duz056>

For more information: <https://www.usgs.gov/centers/npwrc/science/migration-and-winter-ecology-aransas-wood-buffalo-population-whooping-cranes>



A pair of whooping cranes walking along the edge of a wetland in central Kansas. The lead crane was marked with a satellite transmitter that collects multiple locations per day. Photograph by Travis Wooten, U.S. Geological Survey.

F02. Demography of Black-Footed and Laysan Albatross—Vital Rates in Support of the Surrogate Species Approach to Strategic Habitat Conservation



The black-footed and Laysan albatrosses are long-lived seabirds of conservation concern to the USFWS, and a petition to list the black-footed albatross under the Endangered Species Act has been submitted to USFWS. Furthermore, more than 65 percent of the world population of these albatross species nest on remote low islands in the Pacific and in smaller numbers in the main Hawaiian Islands. A model for annual survival and breeding probability for albatross will be developed for Midway Atoll and Laysan Island, allowing demographic processes to be connected with threats such as overlap with long-line fishing and other environmental factors.

Contact: William Kendall, Colorado Cooperative Fish and Wildlife Research Unit, wkendall@usgs.gov

Partners: USFWS, Marine National Monuments of the Pacific

For more information: <https://www1.usgs.gov/coopunits/project/129373782016/William.Kendall>

F03. Yellow-Billed Cuckoo Distribution and Habitat Use in Arizona

Yellow-billed cuckoo populations have declined across their North American range, with the western population segment experiencing the most severe losses. Remaining populations in the West are primarily in the southernmost part of the range, in southern Arizona, southern California, and New Mexico. Although western cuckoo populations are typically associated with riparian forests, breeding season use of upland habitats also are reported in the Southwest, ranging from desert scrub habitats to oak woodlands. Better understanding of cuckoo use of these upland habitats is essential for a more complete assessment of population size of western yellow-billed cuckoos and for management and protection of the populations in these areas, primarily on USFS lands. Surveys indicate that substantial numbers of yellow-billed cuckoos breed in these upland sites in southern Arizona, and the purpose of this project is to evaluate the relation of these upland populations to the overall distribution and pattern of decline of this threatened species.

Contact: Charles Drost, Southwest Biological Science Center, charles_drost@usgs.gov

Partners: USFWS, NPS, Saguaro National Park, USFS, Coronado National Forest, Arizona Game and Fish Department, Northern Arizona University, National Audubon Society



Yellow-billed cuckoo near nest in northern Santa Rita Mountains, Coronado National Forest, Arizona. Photograph by Harold Greeney.

F04. Tracking of Colonial Wading Birds and Habitat Use Assessment

Restoration of habitats along the Gulf Coast for colonial wading birds has been a focus of mitigation actions after the Deepwater Horizon Oil Spill. Such actions require, however, a detailed understanding of habitat use and movement patterns of focal species. The purpose of this project is to determine the extent to which declines in colonial nesting wading bird populations result from habitat limitation versus other potential population-limiting factors and, in turn, which restoration approaches and techniques are most appropriate to effectively target and restore wading bird populations. Results will provide information to enhance future restoration planning for key colonial nesting wading bird species along the Gulf Coast.

Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: Alabama Trustee Implementation Group, USFWS, Alabama Department of Conservation and Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/192480180224/ffanp>



American white pelican migration.
Photograph by Larry Palmer,
U.S. Fish and Wildlife Service.



F05. Coordination for Research on California Condors

California condors are one of the world's most endangered and intensively managed birds. Although many research studies have been completed on the California condor, new research needs are becoming apparent as wild condor populations grow and expand their ranges. The California condor research is done by approximately 50 independent scientists, and communication among these scientists is irregular and poorly coordinated among the larger group. Because of the limited funds available for research, this group should avoid overlap, miscommunication, false starts, and duplication of research efforts. The USGS is assisting the USFWS in an effort to coordinate California condor research efforts by organizing and maintaining a master list of California condor research projects, coordinating existing research on condors, planning next steps in research on condors, and organizing frameworks for communication.

Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: USFWS



Perched California condor. Photograph by Todd Katzner, U.S. Geological Survey.



F06. Determining Optimal Elevation for Restoration of an Island Used by Rare Colonial Nesting Waterbirds

Several rare species of colonial nesting waterbirds nest at Rabbit Island, Louisiana. However, the island floods frequently and causes nest failure. Restoration of the island is being considered and, therefore, data are needed on the optimal target elevation for restoration that minimizes flood risk and occupancy of the islands by mammalian predators. Data will be used to minimize costs of island restoration and to maximize benefits by optimizing island height to minimize nest failure because of flooding and mammalian predation.

Contact: Sammy King, Louisiana Cooperative Fish and Wildlife Research Unit, sking@usgs.gov

Partners: Louisiana Department of Wildlife and Fisheries, Louisiana State University School of Renewable Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/151264489472/sking16>



F07. Adapting to Climate Change—Trends and Severe Storm Responses by Migratory Landbirds and Their Habitats

Predicted habitat loss from sea level rise and extreme weather events coupled with mismatches between the timing of peak bird migration and peak food abundance may limit the availability and quality of stopover habitats, creating urgency for the conservation of areas to support migrating landbirds. The objective of this project is to determine how stopover habitat use by migrating landbirds changes in response to climate change, land cover change, and weather events. Scientists are analyzing data from 25 years of weather surveillance radar observations of birds departing stopover habitats to measure the responses of migrants to climate change. Scientists will predict bird responses based on multiple climate scenarios and provide maps to visualize where birds stopover and how their stopover distributions change in response to past and future habitat changes. Mapped landbird stopover distributions across Texas and Louisiana will provide information for habitat acquisition, restoration, and conservation efforts.

Contact: Theodore Zenzal, Jr., Wetland and Aquatic Research Center, tzenzal@usgs.gov

Partners: University of Delaware, USFWS, Lower Mississippi Valley Joint Venture, Oaks and Prairies Joint Venture, Gulf Coast Joint Venture, National Audubon Society, Louisiana Department of Wildlife and Fisheries, Texas Parks and Wildlife, Gulf Coast Bird Observatory, The Nature Conservancy

For more information: <https://www.usgs.gov/centers/wetland-and-aquatic-research-center-warc/science/adapting-climate-change-trends-and-severe>



F08. Avian Community Change Across Time, Elevations, and Latitudes

Changing environmental conditions because of global climate change can have substantial consequences for regional bird populations and communities throughout time, particularly along elevational and latitudinal gradients. For instance, populations of high-elevation species may decline and low-elevation species may begin to expand into higher elevations in response to increasing temperatures, with rates potentially differing across latitudes. Thus, research is needed to investigate effects of climate change on long-term community dynamics while incorporating elevational variability and latitudinal ranges. The purpose of this project is to improve understanding of the extent and causes of avian community change throughout time and across elevational and latitudinal gradients within the Appalachian Mountains. This project lays the foundation for future research focused on climate change effects of birds in high-elevation habitats and mountain ranges, an important focus for emerging investigations of climate refugia.



Contact: Petra Wood, West Virginia Cooperative Fish and Wildlife Research Unit, pbwood@usgs.gov

Partners: USFS

For more information: <https://www1.usgs.gov/coopunits/project/203558156288/pbwood>

F09. Wildlife Species of Management Concern in the Arctic

The USGS Changing Arctic Ecosystems Initiative began in 2010 with a primary objective to understand the rapid physical changes, such as increasing temperature and reduced sea ice, taking place in the Arctic and to quantify and forecast how Arctic wildlife and habitats are responding to these changes. The purpose of this project is to continue monitoring the growing number of snow geese in northern Alaska and potential effects to other bird species and nesting habitats, to examine the genomic capacity of threatened eiders in a rapidly changing environment, to assess possible drivers of red-throated loon productivity in the Beaufort Sea, and to assess the population status of two rare taxa endemic to the central Bering Sea, Alaska—McKay's bunting and Pribilof rock sandpiper.



Contact: John Pearce, Alaska Science Center, jpearce@usgs.gov

Partners: USFWS, NPS, BLM, BOEM, NOAA, North Slope Borough comanagement councils

Recent products:

Does habitat partitioning by sympatric plovers affect nest survival? <https://doi.org/10.1093/auk/ukaa018>

Temporal variation in genetic structure within the threatened spectacled eider, <https://doi.org/10.1007/s10592-019-01234-9>

Spatio-temporal population change of Arctic-breeding waterbirds on the Arctic Coastal Plain of Alaska, <https://doi.org/10.5751/ACE-01383-140118>

Movements and habitat use of loons for assessment of conservation buffer zones in the Arctic Coastal Plain of northern Alaska, <https://doi.org/10.1016/j.gecco.2020.e00980>

The influence of chick production on territory retention in Arctic-breeding Pacific and yellow-billed loons, <https://doi.org/10.1093/condor/duy021>

For more information: <https://www.usgs.gov/center-news/usgs-alaska-science-center-develops-new-5-year-arctic-research-plan>



Snow geese and black brant fight over nesting territories in northern Alaska. Photograph by Ryan Askren, U.S. Geological Survey.

F10. Gulf of Mexico Marine Assessment Program for Protected Species

Seabirds are one of the most threatened groups of birds globally yet are understudied in many regions of the United States. For example, little information is available regarding species composition, distribution, and abundance of seabirds using nearshore and offshore waters of the Gulf of Mexico. This region also supports some of the highest densities of oil and gas development in marine ecosystems in the world. Sparse data available on distribution and abundance of seabirds in the Gulf combined with the extent of oil and gas activity hinders the understanding of seabird ecology and the ability to plan for or respond to data needs during oil and gas activities. The goal of this project is to execute vessel-based surveys for pelagic seabirds in the northern Gulf. USGS scientists will combine seabird data with similar data collected on marine mammals and sea turtles and, collectively, these data will permit spatially explicit modeling of abundance and distribution of marine vertebrates across the Gulf. Models will provide stakeholders with tools to predict occurrence and potential effects with respect to marine spatial planning and future spills.



Contact: Patrick Jodice, South Carolina Cooperative Fish and Wildlife Research Unit, pjodice@usgs.gov

Partners: USFWS, BOEM, NOAA, Michigan State University

For more information: <https://www1.usgs.gov/coopunits/project/149055883264/pjodice>

F11. Geographic Information System and Remote Sensing Support—Gulf Coast Joint Venture

The western U.S. Gulf of Mexico coast provides important habitat for migrant and wintering waterfowl and shorebirds. The Gulf Coast Joint Venture partnership is focused on advancing conservation of priority bird habitats in this region. Gulf Coast Joint Venture scientists use bioenergetic models (for example, models that incorporate species-specific population abundance objectives, temporal residency, daily energy demand of birds, and foraging energy values of habitats) to translate regional avian population targets into quantitative habitat objectives that are expected to represent landscape conditions needed to support populations at desired levels. Across this region, USGS and Gulf Coast Joint Venture scientists use remote sensing to estimate the amount of avian habitat in seasonally flooded wetlands and agricultural lands. Results from these assessments provide a metric for evaluating avian habitat abundance relative to habitat objectives but are also useful for gauging the contribution of conservation delivery efforts toward regional habitat objectives.



Contact: Nicholas Enwright, Wetland and Aquatic Research Center, enwrightn@usgs.gov

Partners: Alabama Department of Conservation and Natural Resources, Louisiana Coastal Protection and Restoration Authority, Louisiana Department of Wildlife and Fisheries, Texas Parks and Wildlife Department, The Nature Conservancy

For more information: <https://www.usgs.gov/centers/wetland-and-aquatic-research-center-warc/science/geographic-information-system-and-remote>

F12. Habitat Selection in an Arctic Shorebird—Implications for Climate Change

Climate change is projected to have its greatest effect in Arctic regions where temperature increases are forecasted to cause rapid changes to ecosystems and to the wildlife dependent on those ecosystems. These changes range from phenological mismatches to altered habitats where warmer climates favor successional changes in plant communities. The semipalmated sandpiper is an Arctic shorebird likely to be affected by climate change and is undergoing a decline in population size. The objective of this project is to investigate the habitat selection by semipalmated sandpipers in the Colville River Delta, Alaska, by modeling nest site selection. Results will be used to predict how climate change will affect the habitat and population size of semipalmated sandpipers.



Contact: Mark Henderson, California Cooperative Fish and Wildlife Research Unit, mhenderson@usgs.gov

For more information: <https://www1.usgs.gov/coopunits/project/114953869312/mhenderson>

F13. U.S. Geological Survey Alaska Region and Bureau of Ocean Energy Management Outer Continental Shelf Program

The USGS Ecosystems Mission Area supports the BOEM's science information requirements through this collaborative partnership that leverages the expertise of scientists from both agencies to provide scientific information for BOEM decision makers. Results of these projects address issues relevant to BOEM's information requirements in the areas of biologic, oceanographic, social, economic, and cultural research. Projects are focused on the effect of marine fish communities on red-throated loon population trend on the North Slope of Alaska and monitoring recovery of seabirds and forage fish in Lower Cook Inlet, Alaska.

Contact: John Pearce, Alaska Science Center, jpearce@usgs.gov

Partners: BOEM, USFWS

For more information: <https://www.usgs.gov/centers/asc/science/collaborative-science-priority-information-needs>



F14. Changes in Avian and Plant Community Composition and Structure After Prescribed Thinning in Pinyon-Juniper Woodlands.

Pinyon-juniper woodlands are an extensive and biologically important vegetation community across the western United States. A history of overgrazing and fire suppression has resulted in pinyon-juniper woodlands expanding beyond their historical distribution and encroaching into predominantly grassland vegetation communities. This issue has led to efforts to reduce pinyon-juniper as part of grassland restoration, despite a reduction in avian diversity and abundance resulting from pinyon-juniper thinning and removal. Reducing pinyon-juniper is of concern because these habitats have the highest diversity of birds, highest density of nesting birds, and the highest number of bird species throughout the year compared to other upland habitats in the west. Of concern is how thinning practices may affect pinyon-juniper obligate species, especially the juniper titmouse and the pinyon jay. Specifically, scientists are assessing avian community structure in pinyon-juniper areas in thinned and unthinned plots and, before and after thinning, to acquire data that support decisions for landscape level management.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: BLM, First Solar, National Fish and Wildlife Foundation, NPS

For more information: <https://www1.usgs.gov/coopunits/project/151370121216/clint.boal>



F15. Decision Support for Restoration and Management of U.S. Fish and Wildlife Service-Owned Native Prairies—Implications for Grassland Bird Communities

Native grasslands in the Prairie Pothole Region have been degraded by fragmentation, encroachment by woody and exotic plants, and suppression or misapplication of grazing and fire. Although prairies evolved with grazing and fire, management of USFWS grasslands often has been passive, involving extended periods of rest. These rest periods threaten grassland quality for grassland birds, many of which have exhibited widespread population declines. In 2008, the USGS and USFWS initiated a collaborative effort, the Native Prairie Adaptive Management program. This program uses the principles of adaptive management to evaluate and improve management practices that address invasive plant issues and restoration efforts on USFWS grasslands. USGS scientists initiated a companion study to develop models for the response of grassland birds to adaptive management treatments. The objectives of this study were to assess the response of grassland birds to management treatments (rest, fire, and grazing) that were implemented to restore vegetation composition and to explore the effects of vegetation structure and composition as mechanisms for triggering grassland bird responses to management.

Contact: Lawrence Igl, Northern Prairie Wildlife Research Center, ligl@usgs.gov

Partners: USFWS

For more information: <https://www.usgs.gov/centers/npwrc/science/decision-support-restoration-and-management-service-owned-native-prairies>



Male grasshopper sparrow singing from an elevated perch in a grassland. Photograph by David O. Lambeth.

F16. Wisconsin's Wildlife and a Changing Climate

Grassland ecosystems originally dominated central North America, but prairies in general and tall-grass prairies in particular, are one of the most extensively human-altered ecosystems and one of the most vulnerable to a changing climate. Grassland bird conservation focuses on habitat restoration, but scientists have little understanding of how effects of changing climate on grassland birds might be mitigated by management actions. Understanding if habitat microclimates might help nesting grassland birds avoid some of the effects from events such as drought and heat waves will help provide information for the development of new habitat management strategies for grassland birds. The purpose of this project is to document the importance of habitat microclimates for grassland bird productivity and provide results to natural resource managers in Wisconsin.

Contact: Christine Ribic, Wisconsin Cooperative Wildlife Research Unit, caribic@usgs.gov

Partners: Northeast Climate Adaptation Science Center, University of Wisconsin-Madison, USFWS, Wisconsin Department of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/27130720256/caribic>



F17. Restoration of Common Loons in Minnesota

On April 20, 2010, the Deepwater Horizon mobile drilling unit exploded, resulting in a massive release of oil from the British Petroleum Exploration and Production Inc., Macondo well. The oil spill caused loss of life and extensive natural resource injuries. Common loons on their winter range in the Gulf were injured as a result of the spill. The purpose of this project is to directly restore common loon numbers by facilitating increases in adult and chick survivorship and reproduction at their breeding locations in Minnesota. Habitat loss and degradation in nesting areas are primary threats to common loons. Other threats include human disturbance (particularly from water-based recreational activities and water management practices) and toxicosis from ingested lead fishing tackle (for example, sinkers and jig heads). This project includes components (for example, land acquisition, loon nesting habitat enhancement and lake stewardship, and the reduction in the exposure to lead fishing tackle) intended to reduce each of these threats, thereby enhancing loon survival and reproduction.

Contact: Kevin Kenow, Upper Midwest Environmental Sciences Center, kkenow@usgs.gov

Partners: USFWS, Minnesota Department of Natural Resources, Minnesota Pollution Control Agency



Adult common loon with chick on a northern Minnesota lake. Photograph by Luke Fara, U.S. Geological Survey.



F18. Conservation of the Kirtland's Warbler

The population of the federally endangered Kirtland's warbler has stabilized during the last 5 years (2015–20) at nearly double the population goal in the 1976 Recovery Plan. As a result of this biological recovery, the species has expanded into new breeding areas and USFWS scientists are compiling information for potential delisting of this species. However, evaluating how the species is using these new habitats and assessing how climate change might affect conservation of Kirtland's warbler has not been done. A population viability assessment will be developed by linking how Kirtland's warbler survivorship and productivity may be altered from changing climate conditions (for example, drought) and changing habitat availability and distribution.

Contact: Christine Ribic, Wisconsin Cooperative Wildlife Research Unit, caribic@usgs.gov

Partners: USFWS, USFS, USDA–McIntire-Stennis Program

For more information: <https://www1.usgs.gov/coopunits/project/168672137216/caribic>



F19. Investigations of Whooping Crane Colts in the Eastern Migratory Population

In late 2015, the USFWS directed that the ultralight aircraft-led reintroductions of whooping cranes cease and that more natural rearing techniques be used for released birds in the Eastern Migratory Population. Based on the 3-year pilot study of parent-reared releases of whooping crane colts, scientists from the USGS and cooperating agencies began releasing larger numbers of parent-reared whooping cranes in 2016 and 2017. The program was successful in reintroducing whooping cranes to Wisconsin and getting whooping cranes to migrate to other States as far south as Alabama. Some of the cranes have started to nest in Wisconsin. Scientists are continuing to monitor the released whooping cranes to determine if recovery goals are being met.

Contact: Glenn Olsen, Eastern Ecological Science Center, golsen@usgs.gov

Partners: Whooping Crane Eastern Partnership, USFWS, USGS National Wildlife Health Center, International Crane Foundation, Wisconsin Wildlife Federation, Wisconsin Department of Natural Resources

For more information: <https://www.bringbackthecranes.org>



A whooping crane colt being parent reared. Photograph by Glenn Olsen, U.S. Geological Survey.

F20. Strategies for Reducing the Vulnerability of Grassland Birds to Climate Change within the Central Flyway

The management and conservation of grassland birds often focuses on habitat protection and restoration, but the recognition that grassland birds are sensitive to climate variability such as drought, heat waves, and flooding is becoming more apparent. A synthesis of climate change vulnerability for grassland birds is needed in the Central Flyway to identify information gaps and management strategies useful for developing climate adaptation plans for grassland birds and their habitats. The objective of this project is to develop a report that documents adaptation strategies and information gaps needed for implementing those strategies. The report will provide information to managers in the Central Flyway.

Contact: Christine Ribic, Wisconsin Cooperative Wildlife Research Unit, caribic@usgs.gov

Partners: USFWS

For more information: <https://www1.usgs.gov/coopunits/project/192619653120/caribic>



F21. Diets of Wild and Reintroduced Whooping Cranes

The whooping crane is the most endangered crane species in the world. In an effort to recover the species, scientists from the USGS and cooperating agencies developed a program to reintroduce a migratory whooping crane flock into eastern North America using several methods, each depending on captive reared chicks. The objective of this project is to compare food items consumed by wild and reintroduced whooping cranes. Diets will be compared by collecting and identifying contents from proventriculus and ventriculus of dead birds collected from the Eastern Migratory Population and the wild Aransas-Wood Buffalo population.

Contact: Glenn Olsen, Eastern Ecological Science Center, golsen@usgs.gov

Partners: Whooping Crane Eastern Partnership, USFWS, Wisconsin Department of Natural Resources



Two reintroduced whooping cranes in the Eastern Migratory Population foraging at Necedah National Wildlife Refuge. Photograph by Glenn Olsen, U.S. Geological Survey.

F22. Effects of Translocation on a Cooperatively Breeding Bird in Ocala National Forest

Translocation has been considered as a conservation tool to increase abundance of Florida scrub-jays, especially in areas that have been recently restored and where small, isolated populations reside and are unlikely to increase naturally through dispersal. Most translocation research has focused on the success at recipient sites, whereas effects associated with the donor population have not been monitored. The objective of this project is to determine the effects that translocation could place on a donor population through monitoring of nesting success and productivity. Monitoring nests in groups with and without helpers will increase the understanding of how this cooperative breeder benefits from the presence of nonbreeding individuals. If data indicate that helpers do not increase productivity or nest success, then future translocations can focus on removing helpers as opposed to entire family groups.

Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: Florida Fish and Wildlife Conservation Commission

For more information: <https://www1.usgs.gov/coopunits/project/168514195456/ffanp>



F23. Barred Owl Effects on Northern Spotted Owls

In collaboration with six other Federal and State agencies, USGS scientists documented that high densities of newly colonizing barred owls seemed to be outcompeting native northern spotted owls for space, habitat, and food. This study and others prompted the decision by USFWS scientists to initiate limited removal of barred owls from test areas in the Pacific Northwest as an experiment to recover threatened northern spotted owls. USGS scientists are collaborating with USFWS scientists to determine if removing barred owls affects site occupancy, reproduction, survival, and population trends of spotted owls relative to control areas without barred owl removal. Outcomes of the study will help USFWS provide future management guidance for the recovery of northern spotted owls.

Contact: David Wiens, Forest and Rangeland Ecosystem Science Center, jwiens@usgs.gov

Partners: USFWS, USFS, BLM, Oregon State University, Colorado State University, Hoopa Valley Tribe, California Academy of Sciences

Recent products:

Effects of barred owl (*Strix varia*) removal on population demography of northern spotted owls (*Strix occidentalis caurina*) in Washington and Oregon—2019 annual report, <https://doi.org/10.3133/ofr20201089>

Effects of experimental removal of barred owls on population demography of northern spotted owls in Washington and Oregon—2018 progress report, <https://doi.org/10.3133/ofr20191074>

Anticoagulant rodenticides in *Strix* owls indicate widespread exposure in west coast forests, <https://doi.org/10.1016/j.biocon.2019.108238>

Social status, forest disturbance, and barred owls shape long-term trends in breeding dispersal distance of northern spotted owls, <https://doi.org/10.1093/condor/duz055>

Three-dimensional partitioning of resources by congeneric forest predators with recent sympatry, <https://doi.org/10.1038/s41598-019-42426-0>

Anticoagulant rodenticide exposure in barred owls (*Strix varia*) collected in Washington and Oregon 2015–2017, <https://doi.org/10.5066/P9S51J9K>

For more information: <https://www.usgs.gov/centers/fresc/science/effects-experimental-removal-barred-owls-population-demography-northern>



Spotted owl at Mount Rainier National Park, Washington. Photograph by Emily Brouwer, National Park Service.

F24. Ecology of the Endangered Nordmann's Greenshank

The Nordmann's greenshank is a critically endangered shorebird that breeds in far eastern Russia and migrates through and overwinters in east and southeast Asia. Little information is available about this species. USGS scientists are working with Russian collaborators and others to locate and describe breeding areas and to capture and mark birds. In 2019, the first Nordmann's Greenshank nest was found since the 1970s. Information on basic life history of the species can assist in making management decisions that will protect important breeding areas. Resightings of marked birds can assist in determining migratory pathways and overwintering areas in the East Asian–Australasian Flyway.



Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: Florida Fish and Wildlife Conservation Commission, Wildlife Conservation Society

For more information: <https://www1.usgs.gov/coopunits/project/193778483200/ffanp>

F25. Birdsafe—Is a Novel Cat Collar More Effective at Stopping Domestic Cats from Killing Birds at Higher Latitudes?

As many as 4 billion birds are killed annually in the United States alone by domestic cats. The purpose of this project is to investigate a novel conservation tool that has the potential to be effective at keeping domestic cats from killing songbirds—the Birdsafe cat collar cover. Research will determine if the Birdsafe cat collar cover is differentially effective at multiple latitudes. Because birds at higher latitude have a shorter breeding season and a concurrent higher spike in testosterone than birds at lower latitudes, the assumption is that the more distracted breeding birds in the northern latitudes will experience a higher magnitude difference in predation by cats with and without the Birdsafe cat collar cover. Results can be used to better manage human-wildlife conflict regarding pets and wild birds and will provide excellent outreach opportunities.



Contact: Abby Powell, Florida Cooperative Fish and Wildlife Research Unit, abby_powell@usgs.gov

Partners: Florida Fish and Wildlife Conservation Commission

For more information: <https://www1.usgs.gov/coopunits/project/193778825216/ffanp>

F26. Trophic Consequences of a Recovering Apex Predator

The recovery of piscivorous birds around the world is touted as one of the great conservation successes of the 21st century, but for some species, this success was short-lived. Bald eagles, ospreys, and great blue herons began repatriating Voyageurs National Park, in the mid-20th century. However, after 1990, only eagles continued their recovery, while osprey and heron recovery failed for unknown reasons. Habitat quality and fish resources were evaluated to discern whether top-down effects of bald eagles or bottom-up effects of inclement weather contributed to the failed recovery of ospreys and herons in a protected area. Using 26 years (1986–2012) of spatially explicit monitoring data, effects were quantified for top-down and bottom-up factors on nest colonization, persistence and success for ospreys, and occurrence and size of heronries. Returning top predators, or rewilding, is widely promoted as a conservation strategy for top-down ecosystem recovery but managing top predators in isolation of jointly recovering species may halt or reverse ecosystem recovery. Multispecies management is paramount to realizing ecosystem benefits of top predator recovery.



Contact: Wayne Thogmartin, Upper Midwest Environmental Sciences Center, wthogmartin@usgs.gov

Partners: NPS, University of Wisconsin-Madison, University of Wisconsin-Stevens Point

Recent products:

Top-down effects of repatriating bald eagles hinder jointly recovering competitors, <https://doi.org/10.1111/1365-2656.12990>

F27. Restoration of Wetland Invertebrates to Improve Wildlife Habitat in Minnesota

USGS scientists are investigating limitations to restoring abundant aquatic macroinvertebrate populations to Minnesota wetlands and shallow lakes. Recent research on larger, more permanent wetlands in Minnesota indicates that the quality of wetlands used by ducks has decreased. The research also describes a decline in abundance of amphipods, a shrimp-like crustacean. Amphipods are important forage for ducks during spring migration because amphipods are nutritious and can be present at high densities. The objective of the project is to determine what factors limit super abundance of amphipods in Minnesota wetlands. Scientists will investigate the limitations of amphipod dispersal and factors that reduce wetland quality (for example, invasive species, agricultural effects, pesticides, and water quality). This study combines a large-scale observational study with laboratory toxicology experiments and a field experiment that involves stocking amphipods.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USGS Upper Midwest Environmental Sciences Center, Minnesota Department of Natural Resources (lead agency), Bemidji State University, Environment and Natural Resources Trust Fund, Idaho State University, Legislative-Citizen Commission on Minnesota Resources, Lincoln Bait

For more information: <https://www.usgs.gov/centers/npwrc/science/restoration-wetland-invertebrates-improve-wildlife-habitat-minnesota>



Amphipods collected during spring when pairs cling together for breeding. Photograph by Michael J. Anteau, U.S. Geological Survey.



F28. Using Stakeholder Preferences to Inform Continental-Scale Waterfowl and Wetlands Management for Hunting and Recreation

The success of the North American Waterfowl Management Plan depends on maintaining relevance to stakeholders and society. To be relevant, a first step is to better understand what people value in regard to waterfowl and their habitats. Without this information, population, habitat, and people objectives may not reflect stakeholder and societal values. Also, management and policy decisions may lead to actions that either could be irrelevant or counter to stakeholder and societal expectations. The total research effort includes focus groups in each flyway to identify preferences in recreational experiences, surveys of hunters and other waterfowl conservationists (for example, members of organizations supporting migratory bird conservation including viewers) using discrete choice modeling, a survey of waterfowl management professionals, and a survey of the general public that includes individuals not necessarily vested in waterfowl management issues.

Contact: Rudy Schuster, Fort Collins Science Center, schusterr@usgs.gov

Partners: USGS Minnesota Cooperative Fish and Wildlife Unit

For more information: <https://www.usgs.gov/centers/fort/science/north-american-waterfowl-management-plan>



Restored Ohio wetland. Photograph by Alejandro Morales, U.S. Fish and Wildlife Service.



Conservation Genetics

G01. Genetic Analysis of Nonbreeding Population Structure of Red Knots

Using genetic analysis to better understand the population structure of the red knot is critical to conserving the species. A key question regarding the two subspecies that spend the nonbreeding season in the Americas is if individual populations are segregated enough that each population faces a unique mix of conservation issues and, thus, need different management strategies. The objective of this project is to estimate proportions of each genetically distinguishable unit within red knot subspecies at all major wintering and passage areas in the Americas where the two subspecies may potentially overlap. Elucidating the nonbreeding population structure of red knots in the Americas, between and within recognized subspecies, will allow more precise population estimates, help clarify population trends and threats, and enable appropriate strategies to mitigate declines in this threatened species.



Contact: Terry Chesser, Eastern Ecological Science Center, tchesser@usgs.gov

Partners: USFWS, University of Groningen (Netherlands)

G02. Population Genetic Analysis of Caribbean and Northeastern Roseate Terns

The roseate tern includes a federally endangered northeastern population and a threatened Caribbean population. Research indicates that these two populations do not interbreed and, therefore, are managed accordingly. USGS scientists are leading a comprehensive genetic analysis of relatedness between these two populations. Results will be used to assess connectivity between the two populations. Because the populations may have been connected before mass declines and habitat loss in the early 19th century, a temporal analysis of connectivity using tissue from museum specimens also is being performed. Connectivity may contribute to understanding of long-term population declines, because genetic isolation is known to negatively affect population viability. Results from this research also will be used to make within-population comparisons between historical and contemporary population parameters, including genetic diversity and effective population size, which may further aid in identifying potential inhibitors to population growth and recovery.



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Partners: University of Louisiana at Lafayette, USFWS—Virgin Islands, Smithsonian Institution

Roseate terns on their breeding grounds on Leduck Island, St. John, U.S. Virgin Islands. Genetic studies are being done to determine connectivity between the Caribbean and Northeastern populations of this species. Photograph by Daniel Nellis.



G03. Developing and Applying Molecular Tools to Natural Resource Problems in Alaska

This project is a broad-scale, multidecade, multicomponent research effort that develops and applies genetic/genomic markers and analyses to describe biodiversity in high-latitude migratory and resident avian species, generally within the context of changing climates. Emphasis is placed on species managed by DOI partners. Active projects are diverse but represent the broad-scope research program that encompasses studies of more than 60 species, including Arctic nesting geese, North American sea ducks, shorebirds, gulls, seabirds, passerines, loons, and raptors (falcons, hawks, eagles, and owls). The purpose of this project is to provide information about basic life-history characteristics and strategies not reliably assayable by nongenetic technologies (for example, reproductive strategies, migratory connectivity, population delineation, and phylogenetic status), often including species and locations that are difficult to sample. The project also provides genetic tools to determine species and individual identity in genetic tagging studies and assess kinship relationships within wild avian species.



Contact: Sandra Talbot, Alaska Science Center, stalbot@usgs.gov

Partners: USFWS, NPS, Alaska Department of Fish and Game

Recent products:

Development and characterization of polymorphic microsatellite markers in northern fulmar, *Fulmarus glacialis* (Procellariiformes), and cross-species amplification in eight other seabirds, <https://doi.org/10.1007/s13258-019-00819-5>

Isolation and characterization of microsatellite loci in merlins (*Falco columbarius*) and cross-species amplification in gyrfalcon (*F. rusticolus*) and peregrine falcon (*F. peregrinus*), <https://doi.org/10.1007/s11033-020-05842-4>

Use of genetic mark-recapture to estimate breeding site fidelity and philopatry in a threatened sea duck population, Alaska-breeding Steller's eiders, <https://doi.org/10.3354/esr01026>

Coast to coast—High genomic connectivity in North American scoters, <https://doi.org/10.1002/ece3.5297>

Identification of single nucleotide polymorphisms for use in a genetic stock identification system for greater white-fronted goose (*Anser albifrons*) subspecies wintering in California., <https://doi.org/10.3133/ofr20191040>

For more information: <https://www.usgs.gov/labs/melab>



Samples being loaded onto an electrophoresis gel. Photograph by Yvette Gillies, U.S. Geological Survey.

G04. Landscape Genetic Structure of the Western Continental Golden Eagle Population

Studies of golden eagle mortality linked to wind energy facilities are cause for concern, especially when coupled with the knowledge that golden eagles move great distances between breeding and wintering areas. Thus, mortalities at a particular wind energy facility may not only affect a local breeding population of golden eagles but also could affect breeding populations on a continent-wide scale. Understanding the movement ecology and landscape genetic structure of golden eagles in the western United States would be critically important toward understanding the potential risks wind energy facilities pose to the continental population of golden eagles. The goal of this project is to assess the landscape genetic structure of golden eagles in the United States in efforts to understand the distribution of breeding populations of eagles, the level of connectivity that exists among eagles, and where individuals from these populations migrate to in the winter. Results will provide information for the management of golden eagles on a continent wide scale.



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Partners: USFWS, New Mexico State University

For more information: <https://www1.usgs.gov/coopunits/project/98015033344/jwcain>

G05. An Assessment of the Genetic Structure of an Urban Cooper's Hawk Population



The USFWS has been coordinating a study of the population ecology of an urban population of Cooper's hawks in Albuquerque, New Mexico, since 2011. That study developed a detailed understanding of the demography and population ecology of a model raptor population to obtain insights into the population ecology of harder to study species of management concern, such as golden eagles. The objective of this project is to analyze genetic material and stable isotopes of feathers from the Albuquerque Cooper's hawk study population to gain additional insights into their mating system, behavioral ecology, and population genetic structure. Results of this project present a valuable opportunity to compare and contrast genetic estimates of population attributes (for example, estimates of paternity certainty and of effective population size) with direct measures obtained through banding and radio telemetry.

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Partners: USFWS, New Mexico State University

For more information: <https://www1.usgs.gov/coopunits/project/133833717760/jwcain>



Cooper's hawk. Photograph by Gary Eslinger, U.S. Fish and Wildlife Service.

Lacreek National Wildlife Refuge.
Photograph by Tom Koerner,
U.S. Fish and Wildlife Service.





Bald eagles at Trempealeau National Wildlife Refuge. Photograph by Larry Palmer, U.S. Fish and Wildlife Service.

Response to Habitat Change and Management

H01. A Multiscale Approach to Understanding Migratory Landbird Habitat Use of Functional Stopover Habitat Types and Management Efforts



The purpose of this project is to develop a better understanding of migratory landbird habitat use along the northern Gulf of Mexico coast. Scientists are investigating landbird use of stopover habitats that differ in their function for migrants (for example, resting or feeding), are measuring migrant habitat use in relation to management efforts, and are assessing if weather surveillance radar can serve as an effective conservation tool for migratory birds. Weather surveillance radar, on the ground data, and land cover maps are being used to model migrant bioenergetics for the northern Gulf of Mexico region. Weather radar allows investigators to measure the response of migrants to management efforts, including habitat protection and restoration programs. Results of this project will provide information on how birds use stopover habitat on the northern Gulf of Mexico coast. This information will assist resource managers in addressing declines in migratory bird populations linked to quality and quantity of stopover habitat.

Contact: Theodore Zenzal, Jr., Wetland and Aquatic Research Center, tzenzal@usgs.gov and Wylie Barrow, Jr., Wetland and Aquatic Research Center, barroww@usgs.gov

Partners: USFWS, Gulf of Mexico Avian Monitoring Network, Louisiana Department of Wildlife and Fisheries, Alabama Department of Conservation and Natural Resources, The Nature Conservancy, Alabama Ornithological Society, NOAA, Alabama Audubon, University of Delaware, University of Southern Mississippi, Mississippi Department of Marine Resources, Gulf Coast Bird Observatory, Audubon Coastal Bird Stewardship, Louisiana State University, Louisiana Ornithological Society, Colorado State University, University of Rhode Island, University of Maryland Center for Environmental Science, Mississippi State University

For more information: <https://www.usgs.gov/centers/wetland-and-aquatic-research-center-warc/science/a-multiscale-approach-understanding>

H02. Managing Coastal Wetlands for Wildlife and Sustainability in the Face of Sea Level Rise



Coastal marshes are critical habitat for a variety of wildlife and fish species. Marsh loss, however, is common along the Gulf Coast and may increase with sea level rise. To keep up with sea level rise, marsh accretion rates must exceed decomposition rates. Common marsh management practices, such as fire, flooding, and drawdowns affect decomposition and accretion and have led to elevation declines of several feet in many waterfowl management units. The USGS is working with the Texas Parks and Wildlife Department to determine effects of selected management practices on accretion and decomposition processes in waterfowl management units at J.D. Murphree Wildlife Management Area near Port Arthur, Texas. Results of this research will be used to develop waterfowl management practices that benefit waterfowl and allow marshes to adjust to increasing sea levels.

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Partners: Texas Parks and Wildlife Department

For more information: <https://www1.usgs.gov/coopunits/project/157280317440/sking16>

H03. Avian Response to Estuarine Habitat Management and Restoration



Estuaries and healthy coastal habitats are among the most productive ecosystems on Earth. These ecosystems provide a variety of benefits, including habitat and food for fish and wildlife, flood and erosion protection, improved water quality, increased carbon sequestration, and opportunities for recreation. The San Francisco Bay Estuary is a critical estuarine ecosystem that supports a diverse array of wildlife and is inextricably linked to human health and well-being. USGS scientists are studying estuary enhancements and restorations, developing innovative methods to investigate restoration processes, and assessing restoration benefits for migratory birds and other wildlife species. Project objectives are as follows: (1) modeling waterbird response to management

and tidal restoration of former salt ponds in south and north San Francisco Bay and identifying habitat features critical for maximizing multispecies habitat use, (2) evaluating avian use of “living shoreline” subtidal habitat restorations designed to restore native eelgrass and oysters to create self-sustaining habitat that reduces the effects of sea level rise and storm surges, and (3) assessing the San Francisco Bay aerial midwinter waterfowl surveys and implementing a new design with greater ability to help managers track avian use of changing habitats. The purpose of this project is to provide physical and biological data to the DOI and State resource management agencies. The data will be used in the design and adaptive management of restorations to optimize ecological benefits.

Contact: Susan De La Cruz, Western Ecological Research Center, sdelacruz@usgs.gov and Josh Ackerman, Western Ecological Research Center, jackerman@usgs.gov

Partners: USFWS, California Department of Water Resources, California Department of Fish and Wildlife, California State Coastal Conservancy, South Bay Salt Ponds Restoration Project

Recent products:

Establishing Forster’s tern (*Sterna forsteri*) nesting sites at pond A16 using social attraction for the South Bay Salt Pond restoration project, <https://doi.org/10.3133/ofr20201081>

Transmitter effects on growth and survival of Forster's tern chicks, <https://doi.org/10.1002/jwmg.21864>

Social attraction used to establish Caspian tern nesting colonies in San Francisco Bay, <https://doi.org/10.1016/j.gecco.2019.e00757>

For more information: <https://www.usgs.gov/centers/werc/science/wetland-restoration-san-francisco-bay-delta-and-pacific-northwest>



U.S. Geological Survey scientist measuring wetland elevation at a tidal marsh, Pacific coast. Photograph by David Nelson, U.S. Geological Survey.

H04. Effects of Conifer Range Expansion and Removal on Songbird Abundances and Reproductive Success in High-Elevation Sagebrush of Southwestern Montana

Conifer removal is a core practice in sage-steppe restoration to benefit elk and greater sage-grouse as well as other sagebrush species of management concern. However, research of the demographic effects on sagebrush-obligate songbirds and conifer-dependent songbird species, is lacking. The objective of this project is to evaluate consequences of conifer removal on the abundance and reproductive output of songbirds using conifer and sagebrush habitats in high-elevation Montana. Results will be used to develop best practices for the removal of conifer trees in stands of mountain big sagebrush habitats and to provide specific recommendations on landscape contexts and distances from woody cover that will collectively benefit songbirds most.

Contact: Thomas Martin, Montana Cooperative Wildlife Research Unit, tmartin@usgs.gov

Partners: BLM, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/202938918912/Tom.Martin>



H05. Prairie Pothole Wetland Condition Assessment

The Prairie Pothole Region supports some of the most productive wetlands in the world for waterfowl. As much as 90 percent of seasonal and temporary wetlands have been lost in areas of the region because of conversion of grasslands to croplands and the drainage of wetlands. Waterfowl Production Areas and NWRs managed by the USFWS in North Dakota, South Dakota, and eastern Montana provide critical grassland and wetland habitat for migrating and nesting waterfowl. However, neighboring agricultural activities combined with invasion of nonnative plants (for example, cattail and reed canary grass) makes temporary and seasonal wetlands less attractive to breeding waterfowl. Researchers are developing a multiphase plan to assess the state of temporary and



seasonal wetlands on USFWS-managed lands. The first phase involves development of a spatially balanced, wetland sampling design across the region, followed by vegetation surveys during the second phase. A third phase will use data from the first two phases to develop predictive models of wetland vegetation condition on the landscape. The results will provide information to help managers make effective and efficient decisions to protect wetland habitat.

Contact: Sheel Bansal, Northern Prairie Wildlife Research Center, sbansal@usgs.gov

Partners: USFWS, North Dakota State University

Recent products:

Study design and methods for a wetland condition assessment on U.S. Fish and Wildlife Service fee-title lands in the Prairie Pothole Region of North Dakota, South Dakota, and Montana, USA, <https://doi.org/10.3133/ofr20191118>



Wetlands of the Prairie Pothole Region are nested within a matrix of grassland and agriculture. Photograph by Laura Hubers, U.S. Fish and Wildlife Service.

H06. Cerulean Warbler and Associated Species Response to Silvicultural Operations in the Central Appalachian Region

Cerulean warblers benefit from forest management practices that promote a heterogeneous canopy structure based on an experimental study that resulted in guidelines for enhancing breeding habitat for these species in Appalachian hardwood forests. The purpose of this project is to investigate application of the guidelines through operational silviculture based on a broad set of conditions and harvest types. Four States in the central Appalachians completed timber harvests that incorporated recommendations of the guidelines, and USGS scientists quantified the response of cerulean warbler and associated avian species. Results will determine if guidelines were effective based on broader topographic conditions and will identify specific management targets for preferred tree species basal area to better guide management practices.



Contact: Petra Wood, West Virginia Cooperative Fish and Wildlife Research Unit, pbwood@usgs.gov

Partners: Pennsylvania Game Commission, West Virginia Department of Natural Resources

Recent products:

Cerulean warbler (*Setophaga cerulea*) response to operational silviculture in the central Appalachian region, <https://doi.org/10.1016/j.foreco.2019.05.062>

For more information: <https://www1.usgs.gov/coopunits/project/115062120448/pbwood>

H07. Effects of Management on Grassland Birds—Literature Reviews

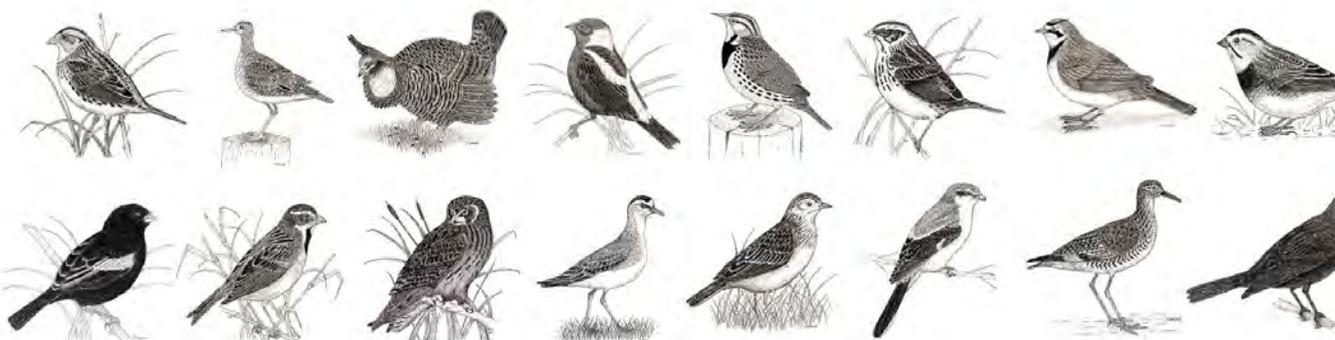
The decline of North American grassland birds has highlighted the need to better understand habitat requirements of grassland birds and how management practices affect grassland birds. The need for this information led to the writing of a compendium on the effects of management practices on grassland birds. The compendium will include an introductory chapter, 40 accounts describing individual species responses to management, a chapter summarizing rates of cowbird parasitism for each species, and a concluding chapter. The species represent a taxonomically diverse group that includes grouse, shorebirds, owls, diurnal raptors, and songbirds. The species accounts include information on distribution, breeding habitat, area requirements, landscape associations, breeding-season phenology, brood parasitism, responses to habitat management, and management recommendations from the literature. The final product will provide land managers with a summary of information on the effects of specific management practices on grassland birds and identify for researchers the most critical research gaps in understanding of grassland bird ecology, habitat needs, and responses to management practices.



Contact: Lawrence Igl, Northern Prairie Wildlife Research Center, ligl@usgs.gov and Jill Shaffer, Northern Prairie Wildlife Research Center, jshaffer@usgs.gov

Partners: USFWS, USFS, The Nature Conservancy

For more information and list of recent products: <https://www.usgs.gov/centers/npwrc/science/effects-management-practices-grassland-birds>



Composite image of grassland bird illustrations. Photograph by Christopher Goldade, U.S. Geological Survey.

H08. Pretreatment and Posttreatment Monitoring on Working Lands for Wildlife and Regional Conservation Partnership Program Sites in West Virginia

Cerulean warbler and golden-winged warbler are two high-priority species for conservation on private lands in West Virginia through NRCS conservation practices. The effectiveness of these conservation practices for increasing cerulean warbler and golden-winged warbler populations on private lands has not been investigated. The objective of this project is to quantify avian populations preimplementation and postimplementation of NRCS conservation practices. Focal species for the research also include blue-winged warblers and other species in need of conservation in the region. Results will help to improve future habitat management actions for these species.



Contact: Petra Wood, West Virginia Cooperative Fish and Wildlife Research Unit, pbwood@usgs.gov

Partners: West Virginia Division of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/192888610816/pbwood>

H09. Evaluation of Cover Crops for Grassland Nesting Waterfowl in Eastern South Dakota

Because of continuing grassland losses throughout the Prairie Pothole Region, alternative methods of providing nesting cover for avifauna are warranted. Fall-seeded cover crops may provide such an alternate habitat type; however, because a cash crop is generally planted and harvested during the waterfowl nesting season, the effect on wildlife, and nesting waterfowl in particular, is unknown. The objective of this project is to evaluate the efficacy of fall-seeded cover crops as a means to benefit nesting waterfowl in eastern South Dakota. Results will help managers understand if this cover crop program is beneficial to nesting waterfowl. If not beneficial, managers can target their efforts at compensatory habitats or perhaps can alter the timing of agricultural practices to maximize benefits to breeding waterfowl.

Contact: Joshua Stafford, South Dakota Cooperative Fish and Wildlife Research Unit, jstafford@usgs.gov

Partners: Ducks Unlimited, Inc., South Dakota Game, Fish and Parks

For more information: <https://www1.usgs.gov/coopunits/project/150650136576/joshua.stafford>



H10. Breeding Bird Use of Grasslands Enrolled in the Conservation Reserve Program in the Northern Great Plains

Agriculture is the dominant land use on privately owned lands in the northern Great Plains. Management decisions on agricultural lands are affected by a variety of policies and programs established by the Federal Government in periodic Farm Bills. In 1985, Congress passed the Food Security Act. Title XII of the Act established the Conservation Reserve Program; a voluntary, long-term, cropland retirement program that is available to agricultural producers to help safeguard environmentally sensitive land. Since 1990, USGS scientists have evaluated breeding-bird use of grasslands and associated wetlands enrolled in the program in four States in the northern Great Plains. Results from this and allied studies have been used to generate support for renewal of the Conservation Reserve Program in subsequent Farm Bills and to make the Prairie Pothole Region a high-priority area for the program in the United States. Results from this study also will provide information to private landowners, managers, and policy makers on program improvements for grassland birds related to management (for example, haying, grazing), grassland patch size, and seeding mixtures (native versus exotic).

Contact: Lawrence Igl, Northern Prairie Wildlife Research Center, ligl@usgs.gov

Partners: USDA

Recent products:

The relative importance of wetland area versus habitat heterogeneity for promoting species richness and abundance of wetland birds in the Prairie Pothole Region, USA, <https://doi.org/10.1093/condor/duz060>

For more information: <https://www.usgs.gov/centers/npwrc/science/breeding-bird-use-grasslands-enrolled-conservation-reserve-program-northern>



Clay-colored sparrow in grassland. Photograph by Ryan Moehring, U.S. Fish and Wildlife Service.

H11. Red-Headed Woodpecker—Indicators of Oak Savanna Health

The red-headed woodpecker is the flagship species of the oak savanna ecosystem. Red-headed woodpeckers are ecosystem engineers and a keystone species, and their presence may have far-reaching effects on species richness and ecosystem health. Historically, red-headed woodpeckers were common across the Midwest; however, regional populations have declined dramatically since 1970. The objectives of this project are to identify oak savanna habitat characteristics and adult condition and behaviors associated with successful production of young, to determine factors related to if and where individuals migrate, and to understand consequences of migratory status on productivity and survival. Results will provide insight into factors that affect population ecology of red-headed woodpeckers. Results also will be used to develop a long-term management plan for restoring oak savanna ecosystems to support red-headed woodpeckers and other oak-savanna habitat specialists in Minnesota and the Midwest.

Contact: David Andersen, Minnesota Cooperative Fish and Wildlife Research Unit, dea@usgs.gov

Partners: State of Minnesota, University of Minnesota Cedar Creek Ecosystem Science Reserve, University of Toledo, Minneapolis Chapter of the Audubon Society

For more information: <https://www1.usgs.gov/coopunits/project/189724944384/dea>

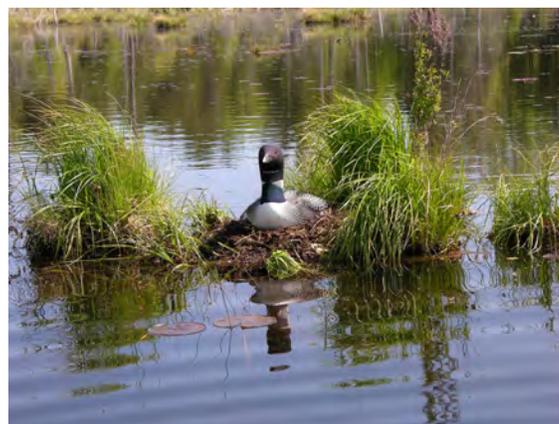


H12. Common Loon Habitat Model

Changes to breeding lake water quality, reductions in suitable nesting substrate stemming from shoreline development, and altered water levels threaten habitat quality within the breeding range of common loons in Wisconsin. Shoreland habitat loss and declining lake levels are likely to remain a threat to breeding common loons in the Upper Midwest. Conservation projects have been initiated to restore common loons to their historical breeding range. The goals of this project are to identify characteristics of lakes associated with territorial common loon occupancy within their breeding distribution throughout Wisconsin and to produce a regional loon habitat suitability model to characterize lakes suitable for loon occupancy, or potentially suitable if appropriate management actions can be applied. Results can be used to determine where and how restoration efforts are targeted, as well as to define achievable conservation goals.

Contact: Kevin Kenow, Upper Midwest Environmental Sciences Center, kkenow@usgs.gov

Partners: Wisconsin Department of Natural Resources, Wisconsin Focus on Energy, Environmental and Economic Research and Development Program Grant Program



Nesting common loon on a reservoir in Jackson County, Wisconsin. Photograph by Kevin Kenow, U.S. Geological Survey.



H13. Effects of Forest Management Practices in the Acadian Northern Hardwood/Conifer Forests of Maine on Forest Bird Communities, with Emphasis on Species of Regional Conservation Priority and Concern

Effects of Maine's forest harvest practices in the northern deciduous/coniferous forest on the diversity and abundance of the forest bird community of selected species of conservation interest (for example, bay-breasted warbler, blackburnian warbler, and Cape May warbler) are unknown. The objective of this project is to document bird communities in manipulated stands compared to reference stands and within the larger landscape context. Results will provide information to help understand avian responses to stand age, stand structure, relations to habitat quality, and in the context of changing land-use practices in the northern forest landscape.

Contact: Cynthia Loftin, Maine Cooperative Fish and Wildlife Research Unit, cindy_loftin@usgs.gov

Partners: University of Maine, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/59016908800/cynthia.loftin>



H14. Oregon Songbird Response to Forest Thinning and Riparian Restoration

Land managers in Pacific Northwest forests require more information regarding federally listed and candidate species and rare and declining communities in the region. Information needs include testing and adaptation of new technologies to investigate habitat and species status to help managers establish, develop, and assess management priorities and actions. The USGS is leading efforts to understand how bird populations respond to forest harvest and riparian restoration. This information is critical for land managers who must balance multiple uses of forest land and waterways. Results and tools will provide an improved understanding of the structure and setting of trees used by forest birds and will help guide resource managers in the development of species conservation plans or adaptively manage projects that will minimize effects on these species and manage these habitats.

Contact: Joan Hagar, Forest and Rangeland Ecosystem Science Center, joan_hagar@usgs.gov

Partners: Willamette Focused Investment Partnership, Willamette Mainstem Anchor Habitat Working Group, Oregon Watershed Enhancement Board, BLM, USFWS, Oregon State University

Recent products:

Removal of cattle grazing correlates with increases in vegetation productivity and in abundance of imperiled breeding birds, <https://doi.org/10.1016/j.biocon.2019.108378>



U.S. Geological Survey biologists assess the long-term ecological value and characteristics of snags created for wildlife. Photograph by Sarah Beldin, U.S. Geological Survey.



H15. Avian Community Response to Brush Control on the Welder Wildlife Refuge—Phase II

Grassland-obligate birds are experiencing widespread population declines across North America. Despite widespread prairie restoration efforts, evaluations of the success of coastal prairie restoration for avian community structure are limited. The Texas coastal prairie has had extensive brushland encroachment and prairie loss. Efforts to restore coastal prairie grasslands and the natural avian communities have been overlooked. Data will provide insights as to the success of different brush control methods to restore prairie, whether or not natural avian communities can be restored and, if so, potential lag periods for avian community restoration.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: Welder Wildlife Foundation

For more information: <https://www1.usgs.gov/coopunits/project/170226554880/clint.boal>



H16. Fire Effects in Gulf of Mexico Marshes—Historical Perspectives, Management, and Monitoring of Mottled Ducks and Black and Yellow Rails

Black rails were recently listed as a threatened species, and yellow rails are identified as a species of conservation concern. Mottled ducks are of high conservation concern as the only species of duck that spends its entire year along the Gulf Coast. Natural resource managers are tasked with conserving all three bird species; however, little information is available about how these species respond to fire in high marsh wetlands. The purpose of this project is to address specific information needs of resource managers and conservation organizations. Specific objectives include determining distribution and habitat use of yellow rails, black rails, and mottled ducks during breeding and nonbreeding seasons and understanding how prescribed fire practices affect that distribution and abundance in high marsh habitats.



Contact: Jim Lyons, Eastern Ecological Science Center, jelyons@usgs.gov and Nicholas Enwright, Wetland and Aquatic Research Center, enwrightn@usgs.gov

Partners: Mississippi State University, University of Illinois Urbana-Champaign, Louisiana State University, Louisiana State University Agricultural Center, USFWS, Gulf Coast Joint Venture, Florida Fish and Wildlife Conservation Commission

For more information: <https://noaafirebird.home.blog/>



High marsh in Grand Chenier, Louisiana. Photograph by Rachel Villiani, U.S. Geological Survey.

H17. Landscape-Scale Management of Grassland Birds in Wisconsin

Obligate grassland birds are declining faster than any other bird community in the Upper Midwest. Conservation delivery has changed from focusing on individual sites at the local scale to focusing on landscape-scale conservation areas. The objective of this project is to estimate State-level densities for a suite of grassland birds in the Midwest. This information will be used to evaluate the importance of landscape-scale conservation areas in Wisconsin for grassland bird populations.

Contact: Christine Ribic, Wisconsin Cooperative Wildlife Research Unit, caribic@usgs.gov

Partners: USFWS, Wisconsin Department of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/59628312576/caribic>



H18. Assessing the Importance of Wetlands on Department of Defense Installations for the Persistence of Wetland-Dependent Birds

DoD lands offer many opportunities for conservation and management of wildlife species throughout the Nation. The objectives of this project are to develop detailed habitat models for rare and endangered wetland birds and subsequently use models to rank importance of more than 600 DoD installations to wetland birds. Models will be validated by performing surveys for wetland birds on a random subset of DoD installations, and surveys also will provide estimates of abundance for these rare species. Results will provide information to a large partnership of agencies and organizations in North America that are surveying marsh birds using a standardized protocol. A substantial product will be a first of its kind inventory of the biological value of wetlands on DoD lands, detailed habitat models for each species, and baseline survey data of secretive marsh birds at a large subset of DoD installations.

Contact: Courtney Conway, Idaho Cooperative Fish and Wildlife Research Unit, cconway@usgs.gov

Partners: USACE, Nebraska Game and Parks Commission, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/60127143936/cconway>



Sora rail in a Wyoming wetland. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

H19. Response of Bachman's Sparrow to Habitat Management

Bachman's sparrow is a species of conservation concern that typically inhabits open forest systems with wiregrass; however, little information is available about how the species responds to wiregrass-free ecosystems similar to those in South Carolina. The objective of this project is to quantify abundance, nest success, and survival of Bachman's sparrows in these special ecosystems. The results will help managers understand optimal burn frequencies and vegetation needs for Bachman's sparrows and provide additional information about the ecology of the species.

Contact: Beth Ross, South Carolina Cooperative Fish and Wildlife Research Unit, bross@usgs.gov

Partners: South Carolina Department of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/194333229056/beross>



H20. Do Grassland Birds and Beekeepers Select the Same Habitat Patches in the Prairie Pothole Region?

Conservation biologists have understood the importance of natural and seminatural lands in supporting biodiversity. Biodiversity and dependent habitats have intrinsic value; however, this intrinsic value is often underrecognized by policy makers. Linking the intrinsic value of natural lands with economic or direct use values is needed so that policy makers can recognize the full costs of natural land conversion. USGS scientists are developing spatial models of grassland bird abundance and commercial honey bee colony distributions in the Prairie Pothole Region to determine if migratory grassland birds and commercial beekeepers select similar land cover features. USGS scientists will then develop an economic model of honeybee colony honey production and pollination services that estimates revenue generated by commercial beekeepers by placing honeybee colonies on grasslands. This research will likely demonstrate the intrinsic value of grasslands in supporting migratory grassland birds and the economic value of grasslands to the commercial beekeeping industry.

Contact: Clint Otto, Northern Prairie Wildlife Research Center, cotto@usgs.gov



A beekeeper inspects the health of their honeybee colony on a North Dakota grassland. Photograph by U.S. Geological Survey.

H21. Identification of Hydrologic Controls on Coastal Marshes and Optimal Hydrologic Conditions for Sustainable Mottled Duck Habitat



Mottled ducks, which are considered among the most critically endangered habitats in the United States, rely on the coastal marshes of the Texas Chenier Plain. Mottled duck habitat is threatened by high rates of sea level rise, extreme flood events, and extreme droughts. USGS scientists are identifying causes of mottled duck habitat degradation to better understand how to mitigate those losses and decrease threats to mottled ducks.

Contact: Camille Stagg, Wetland and Aquatic Research Center, staggc@usgs.gov

Partners: McFaddin NWR, San Bernard NWR, Ducks Unlimited, Inc.

Recent products:

Quantifying hydrologic controls on local- and landscape-scale indicators of coastal wetland loss, <https://doi.org/10.1093/aob/mcz144>

Using UAS capabilities to help identify hummock-hollow formation and fragmentation in critical marsh habitat (*Spartina patens*) for mottled ducks in southeast Texas, <https://doi.org/10.3133/ofr20191045>

For more information: <https://www.usgs.gov/centers/wetland-and-aquatic-research-center-warc/science/identification-hydrologic-controls-coastal>

H22. Developing Tools to Assist Natural Resource Managers in Planning for Future Climate Effects on Migratory Waterfowl Habitat



The Prairie Pothole Region is recognized as one of the most productive areas for waterfowl in North America and supports an estimated 50–80 percent of the continent’s duck population. The southeastern Prairie Pothole Region in Minnesota and Iowa has faced some of the greatest challenges in wetland conservation. Although advances have been made to restore these habitats, land managers now face new challenges in the form of climate change and continued land-use change pressures. The purpose of this project is to provide wetland managers with an assessment of wetland trends and forecasts to better plan and target conservation actions. By combining long-term monitoring and mechanistic modeling with the most up to date climate and land-use change projections, scientists aim to produce a reproducible workflow for assessing site-specific and regional changes in the hydrological functioning of critical waterfowl habitat. To ensure the most effective application of these results, scientists will bring together a diverse set of wetland managers and solicit feedback throughout the research process.

Contact: Owen McKenna, Northern Prairie Wildlife Research Center, omckenna@usgs.gov

Partners: USFWS, Morris Wetland Management District

For more information: <https://caseprojects.org/#/project/5050cb0ee4b0be20bb30eac0/5f29c43982cef313ed9edb1d>

H23. Supporting the U.S. Fish and Wildlife Service and Prairie Pothole Joint Venture in Monitoring and Management of Migratory Bird Populations

Sound management of migratory bird breeding populations in the Prairie Pothole Region hinges on effective monitoring programs and comprehensive analyses of long-term survey data. Therefore, USGS scientists provide support to the USFWS in several important areas. The Four-Square-Mile Breeding Duck and Habitat Survey was developed in the mid-1980s and, since the late 1980s, USFWS refuge personnel led by their Habitat and Population Evaluation Team have completed the survey annually. A concurrent effort to assemble and archive information on duck nest survival from studies completed by several partners has resulted in a database of nest records spanning 66 years, 11 States, and 3 Provinces. The USGS and partners periodically analyze these two long-term datasets to improve understanding of duck settling ecology and to update estimates of duck nest survival. These results and other analyses will provide information to help Prairie Pothole Joint Venture partners make decisions regarding prioritizing and targeting conservation efforts.

Contact: Terry Shaffer, Northern Prairie Wildlife Research Center, tshaffer@usgs.gov and Thomas Buhl, Northern Prairie Wildlife Research Center, tbuhl@usgs.gov

Partners: USFWS-Habitat and Population Evaluation Team, Prairie Pothole Joint Venture

For more information: <https://www.usgs.gov/centers/npwrc/science/support-fish-and-wildlife-service-and-prairie-pothole-joint-venture-monitoring>



Mallard hen flushing from nest. Photograph by Ryan Moehring, U.S. Fish and Wildlife Service.

H24. Effects of Forest Management on Early Successional Avian Species in South Carolina

Although South Carolina has the southernmost extent for several early successional avian species in the Appalachian Region, the State is often not included when monitoring or surveying for these species. As several of these species are in decline, more information is needed to determine how these species use habitats in the southern part of their range as well as more information on the occupancy rates of these species across suitable habitats. The objective of this project is to assess the response of ruffed grouse, golden-winged warblers, and other early successional forest species to habitat management in the upstate of South Carolina. Results will provide managers with information regarding management practices and conservation needs of species in the State as well as provide general ecological information about habitat use of these avian species at the edge of their range.

Contact: Beth Ross, South Carolina Cooperative Fish and Wildlife Research Unit, bross@usgs.gov

Partners: South Carolina Department of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/201279932416/beross>



H25. Interactions of Consolidation Drainage and Climate on Water-Level Dynamics, Wetland Productivity, and Waterbirds

USGS scientists recently completed a project aimed at understanding the effects of wetland drainage on wetlands that receive drainage water. The biological communities of prairie-pothole wetlands evolved in a hydrologically dynamic system because of periodic wet and dry conditions. This research indicates that relative to wetlands in undrained landscapes, wetlands that receive consolidation drainage water drawdown less during dry conditions and progressively get larger and stabilize at their spill point during wet conditions. The implications of this water-level increase and eventual stabilization include reduced biological productivity and favorable conditions for invasive species. These results have informed conservation efforts toward watershed-oriented restoration and protection of wetlands in the Prairie Pothole Region.



Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USFWS, South Dakota State University

Recent products:

Synergistic interaction of climate and land-use drivers alter the function of North American, prairie-pothole wetlands, <https://doi.org/10.3390/su11236581>

For more information: <https://www.usgs.gov/centers/npwrc/science/interactions-consolidation-drainage-and-climate-water-level-dynamics-wetland>

H26. Understanding Consequences of Management Strategies for Farmed Wetlands to Ecosystem Services in the Prairie Pothole Region



USGS scientists are leading a partnership to investigate ecological, social, and financial considerations of farming practices within temporarily ponded wetlands. Farmers strive to maximize crop production and, therefore, may be more successful with additional information on costs and benefits of certain management practices. During many years, crops have been planted in prairie-pothole wetlands that are embedded within farm fields. For example, during dry falls, farmers often disturb or remove cattail within seasonal wetlands with hopes of planting crops in the wetlands during the subsequent spring. Wet conditions during spring or summer often prevent a harvestable yield from these areas; however, disturbance of these wetlands may be beneficial because wetlands choked with cattail provide little benefit for wildlife. The purpose of this project is to incorporate precision agriculture data provided by cooperating farmers, field surveys of bird use and wetland characteristics, and opinion surveys of farmers. The information will provide insights about ecological implications of wetland disturbance to migrating birds, profitability of farming wetlands, and farmer motivations in making land-use decisions about wetlands. Results of this project will provide information for future experimental conservation practices whereby farmers may become more profitable and provide management actions to wetlands that benefit wildlife, particularly migratory waterbirds.



Waterfowl using a partially cultivated wetland in an agricultural field. Photograph by Dustin Toy, U.S. Geological Survey.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: North Dakota State University

For more information: <https://www.usgs.gov/centers/npwrc/science/understanding-consequences-management-strategies-farmed-wetlands-ecosystem>

H27. Demographic Response of Least Terns and Piping Plovers to the 2011 Missouri River Flood



The largest recorded flood event on the Missouri River occurred during 2011. In 2014, the USGS led a study that evaluated effects of the 2011 flood on least tern and piping plover breeding populations. These federally listed species nest on riverine sandbars and reservoir shorelines. Since construction of the dams on the Missouri River, there have been few floods of a magnitude great enough to create sandbar habitat for these species. Scientists collected breeding productivity data of least terns and piping plovers during 2012–14. Scientists compared estimates of breeding population, nest success, and chick survival at the Garrison River segment and Lake Sakakawea to estimates from data collected in the same area during 2006–08. These comparisons provided the USACE with information about how quickly newly created habitat is used and about how long quality habitat persists.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USACE, USFWS, North Dakota Ecological Services Field Office

Recent products:

Demographic responses of least terns and piping plovers to the 2011 Missouri River flood—A large-scale case study, <https://doi.org/10.3133/ofr20181176>

Asymmetric benefits of a heterospecific breeding association vary with habitat, conspecific abundance and breeding stage, <https://doi.org/10.1111/oik.07256>

For more information: <https://www.usgs.gov/centers/npwrc/science/demographic-response-least-terns-and-piping-plovers-2011-missouri-river-flood>

Common merganser at Seedskaadee National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.





Red-headed woodpecker. Photograph by Jim Hudgins, U.S. Fish and Wildlife Service.

Monitoring and Population Estimation Techniques

101. Partnering with National Aeronautics and Space Administration to Advance Transmitter Technology for Wildlife Tracking



The USGS is leading a collaborative effort among multiple scientists and engineers at the National Aeronautics and Space Administration (NASA) Ames Research Center to produce advanced GPS prototype tags. This partnership pairs USGS research and tagging expertise on diverse wildlife species with NASA cutting-edge engineering and nanotechnology expertise. Together, the USGS and NASA hope to help researchers maximize the type and accuracy of data gained from the widest array of species and greatest number of individuals by reducing battery size, improving battery performance, integrating light-weight environmental sensors, and developing peer-to-peer network capability that will enable two-way data exchange between tagged animals. The USGS and NASA are taking an open-hardware, open-software approach that aims to produce a low-cost design that can be adopted, modified, and improved by commercial providers, universities, and other government labs.



Contact: Susan De La Cruz,
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Partners: NASA

For more information::

<https://www.usgs.gov/centers/werc/science/avian-ecology-and-multi-species-habitat-use-pacific-coast-estuaries>

The U.S. Geological Survey and National Aeronautics and Space Administration collaborated to develop a prototype, miniaturized tag to support research of wildlife biologists. The new tag weighs about one-third of a house key. Photograph by National Aeronautics and Space Administration.

102. Evaluating Sea Duck Detectability in the Puget Sound Winter Ambient Monitoring Program



The Washington Department of Fish and Wildlife leads an annual survey to monitor sea ducks in Puget Sound. This survey, the Puget Sound Ambient Monitoring Program, is critical to understanding status and trends of sea ducks on this continentally important wintering area and to providing managers with information regarding the Washington sea duck hunting season. Whereas abundance indices have been available from the survey, a lack of information on detection rates has made estimation of absolute abundance untenable. However, a 2012 effort led to collection of digital imagery to assist in the estimation of detection rates. The purpose of this project is to complete the analysis of these data to produce a correction factor for sea duck detection. Results will provide information for the design and analysis of the Puget Sound Ambient Monitoring Program and, therefore, provide better information on the status of sea ducks in Puget Sound.

Contact: Sarah Converse, Washington Cooperative Fish and Wildlife Research Unit, sconverse@usgs.gov

Partners: Washington Department of Fish and Wildlife, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/197306202112/sconverse>

103. Estimating the Population Size of North American Landbirds



An important metric for many aspects of species conservation planning and risk assessment is an estimate of population size. For landbirds breeding in North America, Partners in Flight generates global, continental, and regional population size estimates. These estimates are an important component of the Partners in Flight species assessment process but also have been used by others for a range of applications. Partners in Flight population size estimates are primarily calculated using a formula designed to extrapolate bird counts recorded by the North American Breeding Bird Survey to regional population estimates. The extrapolation formula includes multiple assumptions and sources of uncertainty. The purpose of this project is to address these assumptions and sources of uncertainty by propagating the main sources of uncertainty arising from individual components of the Partners in Flight model through to the final estimation of landbird population sizes. A spatially explicit formulation that accommodates both Breeding Bird Survey-like roadside surveys along with off-road counts will be evaluated. The effort to propagate uncertainty resulted in distributions of population size estimates rather than point estimates, with the width of uncertainty in those estimates generally narrower than the order of magnitude distances between the population size score categories Partners in Flight previously used in the species assessment process. The spatially explicit approach to population estimation has been adopted for use in modeling count data and population size for landbirds throughout North America.

Contact: Wayne Thogmartin, Upper Midwest Environmental Sciences Center, wthogmartin@usgs.gov

Partners: Partners in Flight, Cornell University, University of Alberta, Bird Conservancy of the Rockies

Recent products:

Lessons learned from comparing spatially explicit models and the Partners in Flight approach to estimate population sizes of boreal birds in Alberta, Canada, <https://doi.org/10.1093/condor/duaa007>

104. Long-Term Seabird Monitoring Data Analysis to Update Channel Islands National Park Seabird Inventory and Monitoring Program and Inform Management and Conservation

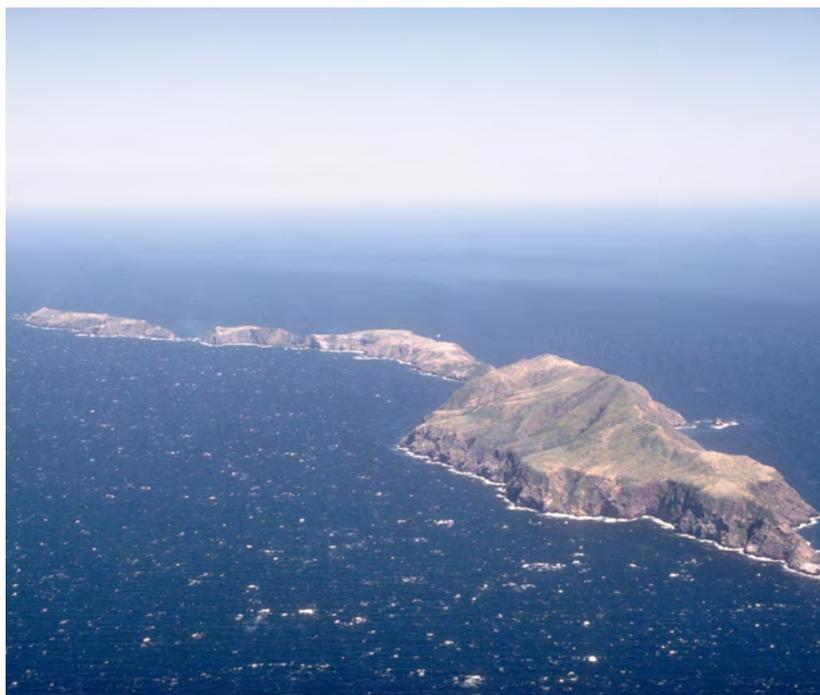


Established in 1980, Channel Islands National Park in California has essential breeding grounds for at least 14 seabirds and shorebirds. These species were collectively identified as one of the Park's monitoring vital signs, but staff turnover and funding gaps have led to inconsistent efforts in monitoring. The purpose of this project is to advance Channel Islands National Park's Seabird Monitoring Program by compiling all known datasets for eight prioritized species and by completing species-specific in-depth program and status reviews. The results of the research will support status reviews, identify threats, and assist updates to monitoring plans for seabirds at Channel Islands National Park.

Contact: Sarah Converse, Washington Cooperative Fish and Wildlife Research Unit, sconverse@usgs.gov

Partners: NPS—Channel Islands Seabird Inventory and Monitoring Program

For more information: <https://www1.usgs.gov/coopunits/project/202454452224/sconverse>



Anacapa Island at Channel Island National Park, California. Photograph by National Park Service.

105. Ecosystems Analytics

As analytical techniques have become more complex, content experts are challenged with the need to be fluent in emerging statistical methods, geographic information system (GIS) software, and data visualization. This challenge has created a need to solicit help from analysts to complete parts of projects or better design a novel study that can incorporate recently developed methods. The Ecosystems Analytics group at the Alaska Science Center provides analytical support ranging from specific coding questions to general analysis assistance from staff and DOI partners. Migratory bird projects include evaluating habitat associations of boreal-breeding birds, developing a photographic aerial survey design for fall staging brant, characterizing environmental drivers of growth of young birds, and evaluating effects of capture or marking on bird survival and data acquisition.



Contact: Vijay Patil, Alaska Science Center, vpatil@usgs.gov and Emily Weiser, Alaska Science Center, eweiser@usgs.gov

Partners: USFWS, BLM

Recent products:

Spatio-temporal population change of Arctic-breeding waterbirds on the Arctic Coastal Plain of Alaska, <https://doi.org/10.5751/ACE-01383-140118>

Prioritizing habitats based on abundance and distribution of molting waterfowl in the Teshekpuk Lake Special Area of the National Petroleum Reserve, Alaska, <https://doi.org/10.3133/ofr20201034>

Sample-size considerations for a study of shorebird nest survival in the 1002 Area, Arctic National Wildlife Refuge, Alaska, <https://doi.org/10.3133/ofr20201066>

Visualizing populations of North American sea ducks—Maps to guide research and management planning, <https://doi.org/10.3133/ofr20191142>

Annual adult survival drives trends in Arctic-breeding shorebirds but knowledge gaps in other vital rates remain, <https://doi.org/10.1093/condor/duaa026>

Monitoring annual trends in abundance of eelgrass (*Zostera marina*) at Izembek National Wildlife Refuge, Alaska, 2018, <https://doi.org/10.3133/ofr20191042>

For more information: <https://www.usgs.gov/centers/asc/science/ecosystems-analytics>

106. A Meta-Analysis of Secretive Marshbird Habitat Use Across the Full Annual Cycle

The group of birds known collectively as secretive marshbirds includes some hunted species, as well as species of greatest conservation need, within the Midwest and the Mississippi Flyway. Unfortunately, little basic ecological information is available to evaluate if wetland habitats available on public lands and if management actions directed toward other wetland-dependent taxa within the Mississippi Flyway are meeting annual life cycle needs for this diverse suite of birds. Consequently, the goals of this project are to better understand habitat requirements of secretive marshbirds across their full annual cycle (for example, migration, breeding, and wintering periods) throughout the Midwest and the Mississippi Flyway and to evaluate how wetland management practices on public lands affect secretive marshbirds species distribution and habitat use. Results will further the understanding of seasonal interactions for secretive marshbirds species throughout the Midwest, identify critical information gaps in knowledge of full annual cycle secretive marshbirds habitat needs, and meet technical information needs identified by the Midwest Marshbird Working Group and the Mississippi Flyway Nongame Technical Section.



Contact: Lisa Webb, Missouri Cooperative Fish and Wildlife Research Unit, ewebb@usgs.gov

Partners: USFWS

For more information: <https://www1.usgs.gov/coopunits/project/203292981248/webbli>

107. Using Global Positioning System/Global System for Mobile Communications Telemetry to Study Condor Flight

In California, condor populations are recovering but face many threats, and one of these threats is the development of wind energy facilities within the condor range. To understand how condor flight behavior may expose birds to risk from wind energy, researchers are tracking condor flight using high-frequency GPS/GSM telemetry systems. Researchers are recording movements of California condors to understand how flight behavior, especially altitude, responds to variation in topography and weather. This information can be used to identify wind and topographic variables that may be preferentially used by condors and to predict risk to birds from existing and proposed turbines.

Contact: Todd Katzner, Forest and Rangeland Ecosystem Science Center, tkatzner@usgs.gov

Partners: BLM, West Virginia University, USFWS, California Department of Fish and Wildlife

Recent products:

Characteristics of feeding sites of California condors (*Gymnogyps californianus*) in the human-dominated landscape of Southern California, <https://doi.org/10.1676/17-23>



California condor soars above Los Padres National Forest. Photograph by U.S. Fish and Wildlife Service.

108. An Interdisciplinary Approach to Building Data Literacy in Wildlife Survey Technologies

Many of Maine's nesting seabird species are difficult to survey and, therefore, often prohibit accurate population assessments in coastal habitats critical to their persistence. Consequently, this research uses Gulf of Maine colonial nesting birds as focal species to develop survey, image collection and processing, and data analysis methods and technologies that are transferable to other taxa and survey goals. The objective of this project is to compare nesting seabird data collected during plane surveys, Unmanned Aerial Systems surveys, and ground-based surveys. The results will be used to investigate effects of platform, sensors, timing, and deployment approaches on species' detectability, counts, and behaviors. These surveys traditionally require substantial time for interpretation by observers, so automating the interpretation and counting process is expected to increase precision, accuracy, and affordability of these surveys. Specific objectives include (1) artificial intelligence and machine learning detection algorithms to process the imagery; (2) toolkits that include instructions for best practices of combining Unmanned Aerial Systems, traditional survey methods, and automated analysis for implementing population assessments; and (3) a user interface that can be accessed by professionals and citizen scientists in applications requiring coastal wildlife monitoring.

Contact: Cynthia Loftin, Maine Cooperative Fish and Wildlife Research Unit, cyndy_loftin@usgs.gov

Partners: University of Maine, Maine Department of Inland Fisheries, USFWS

For more information: <https://www1.usgs.gov/coopunits/project/192685871104/cynthia.loftin>



109. Improving Monitoring Techniques for Nests of Interior Least Terns and Piping Plovers

Federally listed least terns and piping plovers are the subject of many large-scale population monitoring efforts that are used to assess needs and outcomes of management actions. Population monitoring requires researchers to visit nesting areas periodically to count and assess the breeding status of the birds. At higher visit frequencies, detection of nests and chicks improves as does ability to determine outcomes of nesting attempts, resulting in more complete and accurate information about productivity. However, frequent visits may affect productivity of the birds by altering nest attendance or behavioral patterns. Scientists used concealed miniature video cameras to (1) observe responses of nesting Missouri River least terns and piping plovers to human activities typically associated with population monitoring, (2) evaluate accuracy of nest fate determined by field observations obtained at visitation frequencies, and (3) describe composition of the nest predator community on the Missouri River. Results of this project will provide management agencies with information to help in designing accurate population monitoring programs that minimize effects on the birds, thereby improving quality of monitoring datasets and contributing to species recovery.

Contact: Mark Sherfy, Northern Prairie Wildlife Research Center, msherfy@usgs.gov

Partners: USFWS, USACE, University of North Dakota

Recent products:

Plasticity of least tern and piping plover nesting behaviors in response to sand temperature, <https://doi.org/10.1016/j.jtherbio.2020.102579>



Nocturnal image of a great-horned owl depredating a least tern nest on the Missouri River. Photograph by Alicia Andes, University of North Dakota.

110. Black Rail Ecology to Inform Effective Survey Design and Support Population Modeling

Black rails have experienced population declines, breeding range retractions, and reductions in number of breeding locations. The species status is being reviewed by the USFWS for protection under the Endangered Species Act. This project includes multiple research and technical assistance components to address research priorities identified by conservation partners. The objectives of this project are to produce estimates of vital rate parameters usable in predictive population models supporting decision making, provide modifications of existing marsh bird protocols to better monitor this secretive species, and provide status assessment information for the black rail's candidacy for protection under the Endangered Species Act.

Contact: Clinton Moore, Georgia Cooperative Fish and Wildlife Research Unit, cmoore@usgs.gov

Partners: USFWS, University of Georgia

For more information: <https://www1.usgs.gov/coopunits/project/136760322048/cmoore>



111. Developing Techniques to Census and Monitor American White Pelicans and Other Colonial Waterbirds at Chase Lake National Wildlife Refuge in North Dakota

Monitoring is essential to provide insights about changes in waterbird distribution and abundance. For colonial waterbirds, major population fluctuations often go undetected because surveys are not completed regularly, inventory methods are inconsistent, or estimates have unknown reliability. Chase Lake NWR in North Dakota supports one of the largest waterbird nesting colonies in the region. Abundance and species diversity of waterbirds nesting at this refuge have generally increased but annually fluctuate. USGS scientists are assessing methods to estimate breeding populations of ground- and shrub-nesting waterbirds at Chase Lake. The goal of this project is to identify reliable methods for estimating abundance of different waterbird species and to provide protocols for monitoring colonial species at Chase Lake NWR. Results will increase knowledge of waterbird abundance at this refuge and provide techniques for long-term monitoring of colonial waterbirds. The methods also will be applicable to other island-nesting waterbird colonies with similar attributes in the region.

Contact: Lawrence Igl, Northern Prairie Wildlife Research Center, ligl@usgs.gov

Partners: USFWS

Recent products:

Evaluation of survey methods for colonial waterbirds at Chase Lake National Wildlife Refuge, North Dakota, <https://doi.org/10.3133/ofr20201008>

For more information: <https://www.usgs.gov/centers/npwrc/science/developing-techniques-census-and-monitor-american-white-pelicans-and-other>



Nesting American white pelicans at Chase Lake National Wildlife Refuge, North Dakota. Photograph by U.S. Fish and Wildlife Service.

112. An Investigation of Transmitter Effects on Avian Flight

Radio and GPS transmitters are a common tool in wildlife research. However, potential effects of transmitters have received little critical evaluation regarding the effects on predatory bird hunting effort and capture success or the effects transmitters may pose in terms of handicapping prey. Transmitters are often used for assessments of survival and causes of mortality. However, if the transmitters are presenting unknown negative effects, knowledge of survival rates and causes of mortality may be biased and inaccurate. The purpose of this project is to complete field trials to better understand the effects of transmitters of different weights and attachment methods. Data will provide a clearer understanding of the effect of different transmitters sizes and weight loading on flight effort of raptors. Data also will determine whether prey birds are randomly or nonrandomly selected by raptors.

Contact: Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, cboal@usgs.gov

Partners: Texas Tech University, Rolling Plains Quail Research Ranch, Nightwings Wildlife Rehabilitation

For more information: <https://www1.usgs.gov/coopunits/project/170226452480/clint.boal>



113. Design and Analysis of Surveys for Estimating Temporal and Spatial Change in Animal Populations

The purpose of this project is to investigate implementation of analysis methods for North American Breeding Bird survey data, along with development of web applications for summary and display. Analyses of Breeding Bird Survey data are completed annually incorporating recent advances in survey analyses. Other specific analyses also are completed for customers in Federal agencies and the scientific community.

Contact: John Sauer, Eastern Ecological Science Center, jrsauer@usgs.gov

Partners: USFWS, USFS, EPA

Recent products:

Assessing the efficacy of protected and multiple-use lands for bird conservation in the U.S., <https://doi.org/10.1371/journal.pone.0239184>

Consistency counts—Modeling the effects of a change in protocol on Breeding Bird Survey counts, <https://doi.org/10.1093/condor/duz009>

Decline of the North American avifauna, <https://doi.org/10.1126/science.aaw1313>

Allowable take of black vultures in the eastern United States, <https://doi.org/10.1002/jwmg.21608>



114. Developing Capture Techniques and Monitoring the Movement of Sandhill Cranes Breeding in Iowa

Sandhill cranes were extirpated from Iowa in the late 19th century as a result of habitat loss and over-harvest. Nearly 100 years passed before sandhill cranes began recolonizing Iowa, the first breeding effort since 1894 was documented in 1992. Information regarding the population such as trends, dynamics, and affiliations consist of anecdotal reports or are entirely unknown. Scientists are gathering data that will improve understanding of how sandhill cranes use the modern day Iowa landscape, define suitable habitat for cranes, and provide documentation on the migration routes and wintering grounds of Iowa's breeding cranes.

Contact: Bob Klaver, Iowa Cooperative Fish and Wildlife Research Unit, bklaver@usgs.gov

Partners: Iowa Department of Natural Resources

For more information: <https://www1.usgs.gov/coopunits/project/201300318208/bklaver>

Sandhill crane in flight. Photograph by Neil Mishler, U.S. Fish and Wildlife Service.



115. Advanced Technologies for Waterbird Research

Threats such as habitat loss, increased severity of storm events, and emerging diseases are affecting wildlife populations; particular concern is for threatened and migratory species. Unfortunately, much of the data required to understand how to best manage these affected species requires heavy disturbance to obtain or is not able to be gathered from available methods. Thus, USGS scientists aim to develop and test a variety of technologies to address these issues and inform the management of waterbird species. For instance, surveying colonies with remote sensing technologies could increase efficiency and decrease disturbance in surveying breeding waterbird populations. Eventually, additional equipment could be added to unmanned aerial vehicles to allow for thermal imaging or other approaches. Similarly, deploying remote camera systems at nests could allow researchers to gather a constant data stream that would allow the examination of fine scale behaviors that may be influencing nest success.

Contact: Diann Prosser, Eastern Ecological Science Center, dprosser@usgs.gov

Partners: USFWS, USACE, Maryland Environmental Service, Unmanned Aerial Systems, BioSpace, LLC



Recent products:

Assessing nest attentiveness of common terns via video cameras and temperature loggers, <https://doi.org/10.1186/s40657-020-00208-7>

Using thermal infrared cameras to detect avian chicks at various distances and vegetative coverages, <https://doi.org/10.3996/072019-JFWM-062>

For more information: <https://www.usgs.gov/centers/pwrc/science/using-advanced-technology-enhance-research-patuxent-wildlife-research-center>

I16. Analysis of Bird Population Count Data

Sea ducks are understudied relative to other species of waterfowl, especially in the southern U.S. Atlantic Coast. Climate change and human activity could affect sea duck wintering sites and, therefore, cause negative carry-over effects through the rest of their lifecycle. This project was designed to better describe wintering sites, movement, and habitat use of black scoters along the southern U.S. Atlantic Coast using satellite telemetry and aerial survey data. Results could be used to better inform survey methods for black scoters or to decrease conflict with wind energy development in the area.



Contact: Beth Ross, South Carolina Cooperative Fish and Wildlife Research Unit, bross@usgs.gov

Partners: USFWS, Environment and Climate Change Canada

For more information: <https://www1.usgs.gov/coopunits/project/135018399744/beross>

I17. North American Breeding Bird Survey

The North American Breeding Bird Survey is a roadside avian point count program that provides the foundation for conservation planning and management of hundreds of North American bird species. Breeding Bird Survey information contributes to all stages of the conservation planning and management process, from identifying regional and national needs to evaluating the outcomes of actions. The survey started in 1966 and annually engages thousands of skilled volunteer birders and professional biologists to measure the status of bird populations across the continent. The dataset is unparalleled in its temporal and geographic scope and its breadth of species covered and, because of its scientifically rigorous and standardized protocol, the dataset is considered a reliable and trusted data source. By 2020, more than 800 published scientific articles had used Breeding Bird Survey data. Researchers continue to develop new applications for the dataset, going beyond its original purpose of tracking population trends to informing myriad emerging wildlife-related issues.



Contact: David Ziolkowski, Jr., Eastern Ecological Science Center, dziolkowski@usgs.gov

Partners: Environment and Climate Change Canada, Mexican National Commission for the Knowledge and Use of Biodiversity, Cornell Lab of Ornithology, Georgetown University-Environment Initiative, USFWS–Division of Migratory Bird Management, USFWS–Habitat and Population Evaluation Team, USFWS–NWR System, Partners in Flight, BLM, NPS, State game and fish departments

Recent products:

Strategic plan for the North American Breeding Bird Survey, 2020–30, <https://doi.org/10.3133/cir1466>

Migratory behavior and winter geography drive differential range shifts of eastern birds in response to recent climate change, <https://doi.org/10.1073/pnas.2000299117>

For more information: <https://www.usgs.gov/centers/pwrc/science/north-american-breeding-bird-survey>

118. Integration of Breeding Bird Survey and eBird Data to Improve Estimates of Bird Distribution and Growth Trends at Multiple Spatial Scales



The conservation and management of migratory birds requires accurate information on the distribution and population trends of populations. The North American Breeding Bird Survey is a continental-scale, citizen science monitoring program that is the primary source of quantitative data on the distribution and status of North American bird species. The Breeding Bird Survey provides annual estimates of abundance indices and population change and trends at multiple spatial and temporal scales. Despite its application and contributions to bird conservation, the Breeding Bird Survey has several limitations that limit its application including (1) road-side sampling frame, (2) variation in detectability with time and across observers, (3) incomplete geographical cover of species ranges, and (4) coarse spatial resolution of the data. A second source of information regarding the distribution and presence of North American birds is the eBird program operated by the Cornell Lab of Ornithology. The eBird program allows recreational and professional birders to report and share information about bird observations. The vast amount of data collected by the Breeding Bird Survey and eBird and the low-cost nature of citizen science makes these programs critical to bird conservation. Moreover, advances in hierarchical modeling techniques provide novel opportunities to integrate the two data sources to maximize their application to scientific research and conservation. The purpose of this project is to develop analytical methods and code for integrating Breeding Bird Survey and eBird data to provide improved estimate of bird distribution and trends at multiple spatial scales.

Contact: Andy Royle, Eastern Ecological Science Center, aroyle@usgs.gov

Partners: USFWS

119. Remote Sensing in Support of the U.S. Fish and Wildlife Service Migratory Bird Surveys Branch



USGS scientists are partnering on the use of a high-resolution, seven-sensor aerial camera to detect and classify pelagic and lacustrine waterfowl and wildlife. This camera, named Safe, Efficient Aerial Bird Detection 1, can acquire imagery with a resolution of 1 centimeter per pixel at 300 meters above ground. Collection parameters (such as focus, gain, aperture, and environmental conditions) are being tested on waterfowl concentrations in upper Lake Michigan. After suitable exposure options are established, the imagery will be used to test automated detection and classification algorithms using machine learning and artificial intelligence. Once a successful workflow is developed, second generation cameras will begin systematic waterfowl and wildlife surveys along the Eastern Seaboard and within the Great Lakes.

Contact: Benjamin Finley, Upper Midwest Environmental Sciences Center, bfmley@usgs.gov and Larry Robinson, Upper Midwest Environmental Sciences Center, lrobinson@usgs.gov

Partners: USFWS, BOEM

120. Developing Survey Methods for Spring-Migrating Waterfowl in the Rainwater Basin, Nebraska



The Rainwater Basin Wetland Complex in Nebraska is a midlatitude focal point of spring migration for many species of birds in the Great Plains. The Rainwater Basin Joint Venture and partners desire geospatial models to identify characteristics of wetland complexes and understand local and landscape level factors that affect habitat selection of migrating waterfowl. To support this effort, USGS scientists developed a monitoring strategy that incorporates the complexities large spatial and temporal variation in ponded water during spring survey periods. This strategy relies on the more than 10 years of surface-water data that the Rainwater Basin Joint Venture has collected during spring. Development of these types of models and conservation planning tools requires long-term study; thus, the sampling strategy, which was initiated in 2017, will be completed annually for the next 10 years to collect data needed to develop models and describe habitat relationships.

Contact: Aaron Pearse, Northern Prairie Wildlife Research Center, apearse@usgs.gov

Partners: Rainwater Basin Joint Venture, Nebraska Game and Parks Commission, Ducks Unlimited, Inc.

For more information: <https://www.usgs.gov/centers/npwrc/science/development-survey-methods-spring-migrating-waterfowl-rainwater-basin>



Millions of waterfowl migrate through the Rainwater Basin Area in southcentral Nebraska during spring, using wetlands as foraging and resting sites. Photograph by U.S. Fish and Wildlife Service.

121. A Novel Wildlife Tag Enabling Weather Radar-Based Animal Tracking

Biologists are continuously challenged to study the long-distance movements of flying animals that provide critical ecosystem services or affect human health. Likewise, the Federal Aviation Administration faces the daunting, yet still unmet flight safety goal of integrating Unmanned Aircraft Vehicles into managed airspace. USGS scientists are designing and testing a small, lightweight, inexpensive hybrid radio-frequency identification tag that would treat the existing Next-Generation Radar weather network as an embedded tracking system. The tag will harvest and return radar pulses to advantage of its hybrid radio-frequency identification capability. The tag will leave a uniquely identifiable footprint in the Next-Generation Radar data stream that is subtle enough not to interfere with its core meteorological mission. A bench prototype indicates that the device should be detectable at considerable distance from individual radars, and a deployable prototype is being developed.

Contact: Robb Diehl, Northern Rocky Mountain Science Center, rhdiehl@usgs.gov

Partners: University of Oklahoma



122. International Piping Plover Census

The piping plover international census is completed every 5 years to assess abundance, distribution, and progress towards population recovery for the federally listed piping plover. Population numbers of the small, migratory shorebird have declined primarily because of habitat change and increasing human use of critical areas. The census provides a snapshot every 5 years of piping plover numbers across their winter and breeding grounds. The USGS is the lead coordinator of the census, which is locally coordinated and implemented by many State and Federal biologists across North America. The census also includes repeated surveys at a sampling of breeding sites to assess detectability. USGS employees compile the data into a formal report that provides information to the USFWS and many others agencies.

Contact: Elise Elliott-Smith, Forest and Rangeland Ecosystem Science Center, eelliott-smith@usgs.gov

Partners: USFWS, DoD, Environment and Climate Change Canada, State wildlife and other management agencies



Piping plover. Photograph by Amanda Anderson, U.S. Geological Survey.

123. Investigating Roadside Bias in Point-Count Surveys of Grassland Passerines

The North American Breeding Bird Survey provides essential information for assessing bird populations, but how inherent assumptions of the Breeding Bird Survey apply to grassland birds in the Northern Great Plains is unknown. Understanding the effects of these assumptions on understanding of grassland bird populations is essential because of widespread declines of grassland birds as well as recent and impending petitions to list some species under the Endangered Species Act. USGS scientists are assessing how occurrence and detection of grassland birds are affected by roadside sampling, seasonal timing of surveys, and fine-grained habitat features such as fences and utility lines that are often associated with roads. The purpose of this project is to provide better interpretation of Breeding Bird Survey results, improve understanding of population trends, and provide information for future population monitoring in the Northern Great Plains. Ultimately, this information will improve inferences made from spatial models used to guide grassland bird conservation and increase confidence in population data used for listing decisions.

Contact: Terry Shaffer, Northern Prairie Wildlife Research Center, tshaffer@usgs.gov and Thomas Buhl, Northern Prairie Wildlife Research Center, tbuhl@usgs.gov

Partners: USFWS–Habitat and Population Evaluation Team, USFWS–NWR System

For more information: <https://www.usgs.gov/centers/npwrc/science/investigating-roadside-bias-point-count-surveys-grassland-passerines>



A field technician completing a bird survey at a road site using Breeding Bird Survey procedures. Photograph by U.S. Geological Survey.

I24. Automated Telemetry to Understand Habitat Use, Movement Ecology, and Migratory Departures



USGS research in wildlife ecology leverages advancing automated radio-telemetry technology to understand the behavior and ecology of animals at multiple spatial scales. USGS scientists are gathering data on the movement ecology of wildlife to understand habitat use, response to environmental factors, and other aspects of wildlife behavioral ecology. In August 2020, the USGS established an array of automated radio-telemetry towers from eastern Louisiana to western Florida (about 500 kilometers) to track movements by migratory birds. The purpose of this project is to investigate habitat use, departure decisions, and circum-Gulf migration of American redstarts and magnolia warblers that stopover at the Bon Secour NWR in coastal Alabama. Results of this project will provide information on the decisions these migratory warblers make when they must negotiate crossing the 1,000 kilometers Gulf of Mexico as well as provide information on habitat use within the Gulf region.

Contact: Theodore Zenzal, Jr., Wetland and Aquatic Research Center, tzenzal@usgs.gov and Wylie Barrow, Jr., Wetland and Aquatic Research Center, barroww@usgs.gov

Partners: USFWS, University of Southern Mississippi, University of Illinois at Urbana-Champaign, Florida Department of Environmental Protection's St. Joseph Bay State Buffer Preserve, Alabama Department of Conservation and Natural Resources, Navarre Beach Sea Turtle Conservation Center, NOAA



An American redstart equipped with a radio transmitter during autumn migration at the Bon Secour National Wildlife Refuge. Photograph by Ivy Ciaburri.

I25. Identifying Important Habitat, Developing Inexpensive Habitat Monitoring, and Developing Habitat-Based Abundance Estimates for Piping Plovers at Wetland Habitats in the Prairie Pothole Region



USGS scientists are leading a multiagency regional study to understand habitat features used by piping plovers at wetlands across the U.S. Prairie Pothole Region. Piping plovers are a federally listed species that nest throughout the region on shorelines of wetlands. Recent research indicates that climate and land changes are decreasing the amount of available habitat for piping plovers at wetlands. A complete inventory of plover habitat for the wetlands of the Prairie Pothole Region is a component of the species recovery plan; however, the inventory has not been completed. The objectives of this project are to (1) define nesting habitat for piping plovers at prairie wetlands considering fine- and broad-spatial scale habitat features, (2) develop procedures for monitoring of piping plover nesting habitat using remote sensing, (3) apply those procedures on existing datasets to produce regional habitat maps for 2006–21, (4) evaluate habitat features that affect nesting density and evaluate if nesting density varies annually, and (5) assess estimates of habitat abundance during 2006–21 to determine temporal trends. Ultimately, having a model that can annually predict the abundance and location of plover habitat and the distribution of breeding piping plovers during early summer would constitute many improvements to management of this endangered species.

Contact: Michael Anteau, Northern Prairie Wildlife Research Center, manteau@usgs.gov

Partners: USFWS, North Dakota Ecological Services Field Office and Region 6 Refuge System; The Nature Conservancy

126. Waterfowl Breeding Population Survey Analytical Support

The Waterfowl Breeding Population and Habitat Survey is the primary data source for waterfowl management in North America. This project is a collaboration with the USFWS to review the geographic extent, design, and analysis procedures of the survey to ensure that the survey covers the important stocks of North American waterfowl species, is efficiently designed, and produces appropriate metrics of population status and trend.



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Partners: USFWS

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Piping plover. Photograph by Mike Morel, U.S. Fish and Wildlife Service.

Western meadowlark at Seedskadee National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.



Tickseed sunflowers at Port Louisa National Wildlife Refuge. Photograph by Jessica Bolser U.S. Fish and Wildlife Service.



Appendix 1 List of Species

Table 1.1. List of species with common name and scientific name.

Common name	Scientific name
American black duck	<i>Anas rubripes</i>
American oystercatcher	<i>Haematopus palliatus</i>
American redstart	<i>Setophaga ruticilla</i>
American white pelican	<i>Pelecanus erythrorhynchos</i>
American woodcock	<i>Scolopax minor</i>
ashy storm-petrel	<i>Hydrobates homochroa</i>
Bachman's sparrow	<i>Peucaea aestivalis</i>
Baird's sparrow	<i>Centronyx bairdii</i>
bald eagle	<i>Haliaeetus leucocephalus</i>
barred owl	<i>Strix varia</i>
Barrow's goldeneye	<i>Bucephala islandica</i>
bay-breasted warbler	<i>Setophaga castanea</i>
big sagebrush	<i>Artemisia tridentata</i>
black oystercatcher	<i>Haematopus bachmani</i>
black rail	<i>Laterallus jamaicensis</i>
black rosy-finch	<i>Leucosticte atrata</i>
black scoter	<i>Melanitta americana</i>
black skimmer	<i>Rynchops niger</i>
black vulture	<i>Coragyps atratus</i>
blackburnian warbler	<i>Setophaga fusca</i>
black-capped petrel	<i>Pterodroma hasitata</i>
black-footed albatross	<i>Phoebastria nigripes</i>
black-legged kittiwake	<i>Rissa tridactyla</i>
black-tailed prairie dog	<i>Cynomys ludovicianus</i>
bluethroat	<i>Cyanecula svecica</i>
blue-winged teal	<i>Spatula discors</i>
blue-winged warbler	<i>Vermivora cyanoptera</i>
bobolink	<i>Dolichonyx oryzivorus</i>
boreal chickadee	<i>Poecile hudsonicus</i>
brant	<i>Branta bernicla</i>
Brewer's sparrow	<i>Spizella breweri</i>
bristle-thighed curlew	<i>Numenius tahitiensis</i>
brown pelican	<i>Pelecanus occidentalis</i>
burrowing owl	<i>Athene cunicularia</i>
California condor	<i>Gymnogyps californianus</i>
Canada goose	<i>Branta canadensis</i>
canvasback	<i>Aythya valisineria</i>
Cape May warbler	<i>Setophaga tigrina</i>
Caspian tern	<i>Hydroprogne caspia</i>
cattail	<i>Typha</i> spp.
cerulean warbler	<i>Setophaga cerulea</i>
cinnamon teal	<i>Spatula cyanoptera</i>

Table 1.1. List of species with common name and scientific name.—Continued

Common name	Scientific name
cisco	<i>Coregonus artedi</i>
Clark's grebe	<i>Aechmophorus clarkii</i>
clay-colored sparrow	<i>Spizella pallida</i>
common eider	<i>Somateria mollissima</i>
common loon	<i>Gavia immer</i>
common murre	<i>Uria aalge</i>
common raven	<i>Corvus corax</i>
common tern	<i>Sterna hirundo</i>
common yellowthroat	<i>Geothlypis trichas</i>
Cooper's hawk	<i>Accipiter cooperii</i>
coyote	<i>Canis latrans</i>
eastern bluebird	<i>Sialia sialis</i>
eelgrass	<i>Zostera marina</i>
elk	<i>Cervus canadensis</i>
emperor goose	<i>Anser canagicus</i>
ferruginous hawk	<i>Buteo regalis</i>
Florida scrub-jay	<i>Aphelocoma coerulescens</i>
Forster's tern	<i>Sterna forsteri</i>
gadwall	<i>Mareca strepera</i>
golden eagle	<i>Aquila chrysaetos</i>
golden-winged warbler	<i>Vermivora chrysoptera</i>
grasshopper sparrow	<i>Ammodramus savannarum</i>
gray-headed chickadee	<i>Poecile cinctus</i>
great blue heron	<i>Ardea herodias</i>
greater sage-grouse	<i>Centrocercus urophasianus</i>
greater white-fronted goose	<i>Anser albifrons</i>
great horned owl	<i>Bubo virginianus</i>
gyrfalcon	<i>Falco rusticolus</i>
Hawaiian petrel	<i>Pterodroma sandwichensis</i>
honey bee	<i>Apis</i> spp.
Hudsonian godwit	<i>Limosa haemastica</i>
juniper titmouse	<i>Baeolophus ridgwayi</i>
king eider	<i>Somateria spectabilis</i>
Kirtland's warbler	<i>Setophaga kirtlandii</i>
Kittlitz's murrelet	<i>Brachyramphus brevirostris</i>
Laysan albatross	<i>Phoebastria immutabilis</i>
Laysan duck	<i>Anas laysanensis</i>
least Bell's vireo	<i>Vireo bellii pusillus</i>
least tern	<i>Sternula antillarum</i>
lesser scaup	<i>Aythya affinis</i>
loggerhead shrike	<i>Lanius ludovicianus</i>
long-tailed duck	<i>Clangula hyemalis</i>
Louisiana waterthrush	<i>Parkesia motacilla</i>
magnolia warbler	<i>Setophaga magnolia</i>

Table 1.1. List of species with common name and scientific name.—Continued

Common name	Scientific name
mallard	<i>Anas platyrhynchos</i>
marbled godwit	<i>Limosa fedoa</i>
marbled murrelet	<i>Brachyramphus marmoratus</i>
Mariana crow	<i>Corvus kubaryi</i>
masked booby	<i>Sula dactylatra</i>
McKay's bunting	<i>Plectrophenax hyperboreus</i>
merlin	<i>Falco columbarius</i>
mottled duck	<i>Anas fulvigula</i>
mourning dove	<i>Zenaida macroura</i>
Newell's shearwater	<i>Puffinus newelli</i>
Nihoa millerbird	<i>Acrocephalus familiaris</i>
Nordmann's greenshank	<i>Tringa guttifer</i>
northern fulmar	<i>Fulmarus glacialis</i>
northern harrier	<i>Circus hudsonius</i>
northern pintail	<i>Anas acuta</i>
osprey	<i>Pandion haliaetus</i>
Pacific loon	<i>Gavia pacifica</i>
palila	<i>Loxioides bailleui</i>
peregrine falcon	<i>Falco peregrinus</i>
pine grosbeak	<i>Pinicola enucleator</i>
pink-footed shearwater	<i>Ardenna creatopus</i>
pinyon jay	<i>Gymnorhinus cyanocephalus</i>
piping plovers	<i>Charadrius melodus</i>
Pribilof rock sandpiper	<i>Calidris ptilocnemis</i>
Puerto Rican plain pigeon	<i>Patagioenas inornata wetmorei</i>
Puerto Rican sharp-shinned hawk	<i>Accipiter striatus venator</i>
purple martin	<i>Progne subis</i>
red fox	<i>Vulpes</i>
red knot	<i>Calidris canutus</i>
red-footed booby	<i>Sula</i>
redhead	<i>Aythya americana</i>
red-headed woodpecker	<i>Melanerpes erythrocephalus</i>
red-shouldered hawk	<i>Buteo lineatus</i>
red-tailed hawk	<i>Buteo jamaicensis</i>
red-tailed tropicbird	<i>Phaethon rubricauda</i>
red-throated loon	<i>Gavia stellata</i>
red-winged blackbird	<i>Agelaius phoeniceus</i>
reed canary grass	<i>Phalaris arundinacea</i>
rhinoceros auklet	<i>Cerorhinca monocerata</i>
ring-necked duck	<i>Aythya collaris</i>
roseate tern	<i>Sterna dougallii</i>
Ross's goose	<i>Anser rossii</i>
royal tern	<i>Thalasseus maximus</i>
ruddy duck	<i>Oxyura jamaicensis</i>

Table 1.1. List of species with common name and scientific name.—Continued

Common name	Scientific name
ruffed grouse	<i>Bonasa umbellus</i>
sage thrasher	<i>Oreoscoptes montanus</i>
sagebrush sparrow	<i>Artemisiospiza nevadensis</i>
sandhill crane	<i>Antigone canadensis</i>
sandwich tern	<i>Thalasseus sandvicensis</i>
semipalmated sandpiper	<i>Calidris pusilla</i>
shothole borer	<i>Scolytus rugulosus</i>
snow goose	<i>Anser caerulescens</i>
snowy plover	<i>Charadrius nivosus</i>
sora	<i>Porzana carolina</i>
spectacled eider	<i>Somateria fischeri</i>
spotted owl	<i>Strix occidentalis</i>
Sprague's pipit	<i>Anthus spragueii</i>
Steller's eider	<i>Polysticta stelleri</i>
surf scoter	<i>Melanitta perspicillata</i>
Swainson's hawk	<i>Buteo swainsoni</i>
Tasmanian wedge-tailed eagle	<i>Aquila audax fleayi</i>
tree swallow	<i>Tachycineta bicolor</i>
trumpeter swan	<i>Cygnus buccinator</i>
tufted puffin	<i>Fratercula cirrhata</i>
turkey vulture	<i>Cathartes aura</i>
wedge-tailed shearwater	<i>Ardenna pacifica</i>
western grebe	<i>Aechmophorus occidentalis</i>
western meadowlark	<i>Sturnella neglecta</i>
whooping crane	<i>Grus americana</i>
wild rice	<i>Zizania</i> spp.
willow flycatcher	<i>Empidonax traillii</i>
wiregrass	<i>Juncus tenuis</i>
yellow rail	<i>Coturnicops noveboracensis</i>
yellow-billed cuckoo	<i>Coccyzus americanus</i>
yellow-billed loon	<i>Gavia adamsii</i>
Yuma Ridgway's rail	<i>Rallus obsoletus yumanensis</i>

Appendix 2 Geographic Index

Table 2.1. List of geographic narrative sections for specific locations.

Location	Section
Alabama	A04, A25, A28, A30, C01, C19, D06, D18, D34, E02, E16, E18, F04, F10, F11, F19, F21, G04, H01, H16, H18, I03, I13, I17, I21, I22, I24
Alaska	A04, A05, A22, A25, A30, B05, B10, B11, B19, B22, C01, C03, C06, C18, C19, C23, D03, D05, D06, D14, D18, D21, D28, D31, D34, E02, E07, E16, F09, F12, F13, G03, G04, H18, I03, I05, I13, I17, I21, I26
American Samoa	C02
Arizona	A04, A05, A21, A25, A30, A31, C01, C19, D06, D18, D20, D34, E02, E16, F03, G04, H07, H18, I03, I13, I17, I21
Arkansas	A03, A04, A10, A12, A25, A30, B14, B16, C01, C19, C22, D06, D18, D34, E02, E16, G04, H18, I03, I06, I13, I17, I21
California	A01, A04, A05, A07, A09, A21, A25, A30, A33, B01, B05, C01, C05, C10, C11, C13, C14, C18, C19, C20, C21, C23, C24, D03, D05, D06, D07, D09, D18, D20, D27, D29, D34, E02, E05, E09, E16, E17, E19, F05, F23, G04, H03, H07, H18, I01, I03, I04, I07, I13, I17, I21
Colorado	A02, A04, A21, A25, A30, A32, B02, C01, C04, C19, D06, D07, D08, D09, D18, D32, D34, E02, E03, E11, E16, F20, G04, H07, H18, I03, I13, I17, I21, I22
Connecticut	A04, A25, A30, C01, C19, D06, D11, D16, D18, D34, E02, E16, H18, I03, I13, I17, I21
Delaware	A04, A25, A30, C01, C19, C24, D06, D11, D16, D18, D34, E02, E16, G01, H18, I03, I13, I17, I21
Florida	A04, A08, A24, A25, A26, A28, A29, A30, C01, C19, D06, D16, D18, D30, D34, E02, E16, E18, F04, F10, F22, F25, G01, G02, H01, H16, H18, I03, I10, I13, I16, I17, I21, I22, I24
Georgia	A04, A08, A25, A26, A28, A29, A30, C01, C12, C19, D06, D16, D18, D34, E02, E16, G01, H18, I03, I13, I16, I17, I21, I22
Guam	C02
Hawaii	A25, C01, C02, C20, D02, D14, D18, D21, E19, F02, H18
Idaho	A04, A05, A21, A25, A30, B05, B13, C01, C19, C21, D06, D07, D09, D18, D34, E02, E16, G04, H07, H18, H23, I03, I13, I17, I21
Illinois	A04, A06, A13, A17, A25, A27, A30, C01, C17, C19, D06, D18, D34, E02, E16, F19, F21, H07, H17, H18, I03, I13, I17, I21, I22
Indiana	A04, A13, A17, A30, C01, C17, C19, D06, D18, D34, E02, E16, F19, F21, H07, H17, H18, I03, I13, I17, I21, I22
Iowa	A04, A06, A20, A27, A30, B03, B06, B21, C01, C19, D06, D18, D24, D34, E02, E16, G04, H07, H18, H22, H23, I03, I13, I14, I17, I21, I22
Kansas	A04, A21, A30, A31, B17, C01, C19, D06, D18, D34, E02, E16, F01, F20, F21, G04, H07, H18, I03, I13, I17, I21, I22
Kentucky	A04, A30, C01, C19, C24, D06, D11, D18, D34, E02, E16, F19, F21, H06, H18, I03, I13, I17, I21
Louisiana	A04, A12, A28, A30, C01, C09, C16, C18, C19, D04, D06, D18, D34, E02, E16, E18, F04, F06, F07, F10, F11, G01, G04, H01, H02, H16, H18, I03, I13, I17, I21, I24
Maine	A04, A30, C01, C14, C19, D06, D11, D16, D18, D34, E02, E16, H13, H18, I03, I08, I13, I17, I21, I26
Maryland	A04, A30, B09, C01, C12, C14, C17, C19, C24, D06, D11, D16, D18, D19, D34, E02, E16, H18, I03, I13, I15, I17, I21
Massachusetts	A04, A30, C01, C19, D06, D11, D16, D18, D34, E02, E16, G02, H18, I03, I13, I17, I21

Table 2.1. List of geographic narrative sections for specific locations.—Continued

Location	Section
Michigan	A04, A13, A17, A20, A28, A30, C01, C17, C19, D06, D18, D34, E02, E16, F18, H07, H17, H18, I03, I13, I17, I19, I21, I22, I26
Minnesota	A04, A11, A19, A20, A23, A27, A30, B03, B21, C01, C17, C18, C19, D06, D18, D34, E02, E16, F15, F17, F26, F27, H07, H10, H11, H18, H22, H23, I03, I13, I17, I21, I22, I26
Mississippi	A04, A12, A18, A28, A30, C01, C19, D06, D18, D34, E02, E16, F04, F10, F11, H01, H16, H18, I03, I13, I17, I21, I22, I24
Missouri	A04, A10, A12, A30, C01, C19, D06, D18, D34, E02, E16, G04, H07, H18, I03, I06, I13, I17, I21
Montana	A04, A21, A25, A28, A30, A32, B03, C01, C19, D06, D08, D18, D33, D34, E02, E16, F01, F15, F20, G04, H04, H05, H07, H10, H18, H23, I03, I13, I17, I21, I22, I23, I25, I26
Nebraska	A04, A10, A21, A25, A28, A30, A31, A32, B20, C01, C19, D06, D08, D18, D31, D34, E02, E16, F01, F20, F21, G04, H07, H18, H23, I03, I13, I17, I20, I21, I22
Nevada	A04, A05, A21, A25, A30, C01, C19, D05, D06, D07, D09, D18, D20, D34, E02, E16, G04, H07, H18, I03, I13, I17, I21
New Hampshire	A04, A25, A30, C01, C19, D06, D11, D16, D18, D34, E02, E16, H13, H18, I03, I13, I17, I21
New Jersey	A04, A25, A30, C01, C19, D06, D11, D16, D18, D34, E02, E16, G01, H18, I03, I13, I17, I21
New Mexico	A04, A21, A25, A30, A31, A32, C01, C09, C19, D06, D08, D18, D23, D34, E02, E16, F14, F20, G04, G05, H07, H18, I03, I13, I17, I21
New York	A04, A25, A30, C01, C17, C19, D06, D11, D11, D16, D18, D34, E02, E04, E16, H07, H18, I03, I13, I17, I21, I22
North Carolina	A04, A25, A26, A28, A30, C01, C19, C24, D06, D16, D18, D34, E02, E16, H18, I03, I13, I16, I17, I21, I22
North Dakota	A04, A14, A21, A25, A27, A28, A30, A31, A32, B03, B07, B15, B21, C01, C07, C19, C25, D06, D08, D18, D31, D33, D34, E02, E06, E08, E16, F01, F15, F20, F21, G04, H05, H07, H10, H18, H20, H23, H25, H26, H27, I03, I09, I11, I13, I17, I21, I22, I23, I25, I26
Northern Mariana Islands	C02
Ohio	A04, A20, A25, A30, C01, C17, C19, D06, D18, D34, E02, E04, E16, H07, H11, H17, H18, I03, I06, I13, I17, I21, I22
Oklahoma	A04, A21, A25, A30, A31, A32, C01, C09, C19, D06, D08, D18, D34, E01, E02, E16, F01, F20, F21, G04, H07, H18, I03, I13, I17, I21
Oregon	A04, A05, A09, A21, A25, A30, B05, C01, C05, C19, C21, C23, D03, D05, D06, D07, D09, D13, D18, D34, E02, E16, F05, F23, G04, H07, H14, H18, I03, I13, I17, I21
Pennsylvania	A04, A30, C01, C17, C19, C24, D06, D11, D18, D34, E02, E04, E16, H06, H07, H18, I03, I13, I17, I21, I22
Puerto Rico	C07, D15, D17, I22
Rhode Island	A04, A30, C01, C19, D06, D11, D16, D18, D34, E02, E16, H18, I03, I13, I17, I21
South Carolina	A04, A08, A26, A28, A29, A30, C01, C19, D06, D16, D18, D34, E02, E16, G01, H18, H19, H24, I03, I13, I16, I17, I21, I22
South Dakota	A04, A10, A14, A21, A27, A28, A30, A31, A32, B03, B04, B15, B21, C01, C07, C19, D06, D08, D18, D31, D33, D34, E02, E08, E16, F01, F15, F20, F21, G04, H05, H07, H09, H10, H18, H20, H23, H26, H27, I03, I13, I17, I21, I22, I25, I26

Table 2.1. List of geographic narrative sections for specific locations.—Continued

Location	Section
Tennessee	A04, A30, C01, C19, C24, D06, D11, D18, D34, E02, E16, F19, F21, H18, I03, I13, I17, I21
Texas	A04, A21, A28, A30, A31, A32, B12, C01, C09, C16, C18, C19, D01, D04, D06, D08, D18, D22, D34, E02, E10, E12, E13, E16, E18, F01, F07, F10, F11, F20, F21, G01, G04, H01, H02, H07, H15, H16, H18, H21, I03, I12, I13, I17, I21, I22
U.S. Virgin Islands	G02
Utah	A04, A05, A21, A30, C01, C19, D06, D07, D09, D18, D34, E02, E16, G04, H18, H23, I03, I13, I17, I21
Vermont	A04, A30, C01, C19, D06, D11, D18, D34, E02, E16, H13, H18, I03, I13, I17, I21
Virginia	A04, A29, A30, C01, C14, C19, C24, D06, D11, D16, D18, D19, D34, E02, E16, H06, H18, I03, I13, I16, I17, I21, I22
Washington	A01, A04, A05, A07, A21, A30, B05, C01, C05, C19, C23, D03, D05, D06, D07, D09, D10, D18, D34, E02, E16, F05, F23, G01, G04, H07, H18, H23, I02, I03, I13, I17, I21
West Virginia	A04, A30, C01, C19, C24, D06, D11, D18, D34, E02, E04, E16, F08, H06, H08, H18, I03, I13, I17, I21
Wisconsin	A04, A11, A13, A15, A17, A20, A23, A28, A30, C01, C03, C08, C17, C19, D06, D11, D18, D34, E02, E16, F16, F18, F19, F21, H07, H12, H17, H18, H23, I03, I06, I13, I17, I19, I21, I22, I26
Wyoming	A04, A21, A30, A32, B18, C01, C19, D06, D08, D18, D26, D34, E01, E02, E14, E15, E16, F20, G04, H07, H18, H23, I03, I13, I17, I21

Appendix 3 Subject Index

Table 3.1. List of geographic narrative sections for specific subjects.

Subject	Section
Ecosystems and habitats	
Alpine	A25, D18, D26
Barrier islands	A08, D12, E18, F07, I24
Beaches	A08, A24, D02, D16, D28, D30, E18, F02, G01, G02
Desert	D20, D23, E09, E17, H07, I17
Forest	D01, D13, E04, F07, F08, F14, F18, F22, F23, F24, H01, H06, H08, H13, H14, H17, H19, H24, I17, I24
Grassland	A21, B03, B05, B07, B12, B15, C04, C07, D23, E08, E10, E11, E12, E13, F07, F11, F15, F16, F20, H07, H07, H09, H10, H15, H17, H22, H23, I17, I23
Lake	A13, A17, A19, A23, B13, C08, C17, D10, F17, H12
Marine/offshore	A08, A15, A23, C20, D02, D12, D16, D28, D30, E18, E19, F02, F10, I04, I08, I16
Rangeland	A21, B07, D23, F11, I17, I23
Riparian/floodplain	A02, C17, D11, D20, D22, D27, D29, E03, F07, I17, I26
Riverine	B20, D20, D27, D29, D33, E03, F07, H27, I09
Sagebrush Steppe	A21, B18, D23, E14, E15, H04, I17
Urban	F07, F25, I17
Wetland	A01, A02, A07, A20, A29, B01, B02, B03, B05, B13, B19, C03, C07, C10, C11, C13, D04, D05, D16, D20, E03, F01, F06, F11, F19, F21, F24, H02, H03, H05, H07, H10, H16, H21, H22, H23, I06, I08, I10, I11, I17, I23
Landscapes and places	
Alaska	A05, A22, A25, B10, B11, B19, B22, C06, C18, C23, D03, D05, D14, D21, D25, D28, D31, E07, F09, F13, I05, I13, I17, I26
Appalachian Mountains	D18, E04, F08, H06, H08, H24, I17
Arctic/Sub-Arctic	A22, A25, B10, B19, D05, D18, D28, E07, F09, F24
Atlantic Coast	A08, A23, A26, B09, D11, D16, D19, G01, G02, H19, I08, I10, I15, I16, I17
Canada	A21, A25, A29, A31, D05, D11, E08, F01, I13, I17, I26
Caribbean	A26, C07, D12, G02
Chesapeake Bay	B09, C12, C14, D19, I15, I17
Everglades	I17
Great Lakes	A13, A15, A17, A20, A23, C08, C17, H11, I17, I19
Gulf Coast	A23, A24, A26, A31, C09, D01, D04, D30, E18, F04, F06, F07, F10, F11, G01, H01, H02, H15, H16, H21, I17, I24
Hawaiian/Pacific Islands	C02, C20, D02, E19, F02
Klamath Basin	A09, D05, I17
Mexico/Central America	A21, D20, D23, G01
Mississippi River	A06, A11, A20, F07, I17
Pacific Coast	A01, A07, C06, C11, C20, D05, D10, E19, G01, H03, I01, I04, I17
Playa Lakes	A31
Prairie Pothole Region	A27, B03, B04, B15, B21, C07, C25, D05, D31, E08, F15, F20, F27, H05, H07, H09, H10, H20, H22, H23, H25, H26, I11, I17, I23, I25
Puget Sound	A07, D10, I02
Rocky Mountains	A02, B02, D26, F14, H04, I17
San Francisco Bay	A01, A07, B01, C11, H03, I01, I17

Table 3.1. List of geographic narrative sections for specific subjects.—Continued

Subject	Section
Management focus	
Adaptive Management	A04, A30, B01, B09, C20, D04, D06, D11, E04, E19, F07, F08, F15, F17, F26, H01, H03, H06, H08, H15, H16, H21, I12, I13, I20, I26
Agriculture	A02, A29, C04, C15, C19, D05, F11, H07, H10
Climate Change	A08, A22, A25, B03, B11, B18, B22, C09, C18, D06, D14, D18, D19, D21, D25, D26, E14, F07, F09, F13, F16, F20, H03, H07, H17, H21, H22, I04, I16, I17
Conservation Programs	A12, A19, A26, B12, C10, C20, D02, D10, D11, D12, D20, D23, D27, D29, F02, F04, F07, F10, F11, F16, F18, F20, F22, F23, F24, H01, H03, H07, H10, H11, H17, H19, I04, I10, I12, I13, I17, I26
Contaminants	A01, A08, B13, C02, C04, C08, C10, C11, C13, C17, C21, C22, C24, C25, E03, E18, F17, H07
Disease	A17, C01, C02, C03, C05, C07, C12, C13, C14, C15, C16, C18, C19, C23, D25
ESA Listing/Pre-Listing	B13, B20, C10, C20, D14, D20, D25, D27, D29, D32, D33, F03, F19, F21, G01, G02, H18, H24, H27, I17, I23, I25
Grazing	A07, B07, F15, H07
Habitat Loss/Degradation	A01, A02, A04, A24, A26, A30, B13, C10, C20, D05, D06, D10, D22, D27, D29, D30, E08, E14, E15, F04, F07, F11, F18, F20, F22, F24, H01, H02, H03, H07, H12, H18, H19, H20, H21, H24, I02, I04
Habitat Restoration	A06, A07, A27, B01, B09, B21, C10, C25, D13, D22, D27, D29, E08, E18, F06, F07, F14, F15, F17, F22, F27, H01, H02, H03, H04, H07, H10, H11, H12, H14, H15, H19, H21, H25, H26
Human Disturbance	A11, A24, D02, D10, D18, D20, D23, D27, D29, D30, E07, E08, F02, F07, F17, H16, H18, I15
Hunting/Harvest	A02, A04, A10, A13, A15, A29, A30, A31, B01, B02, D04, D05, D05, D06, D11, D21, D34, I02, I13, I26
Hydropower	I09
Oil and gas	B07, B10, B11, B22, D03, D12, E03, E07, E08, E14, E15, E18, F10, F13, H07, I05
Solar energy	D20, E01, E08, E09
Wind energy	A08, A13, A17, C21, D12, E01, E02, E05, E08, E10, E11, E12, E13, E19, F01, H07, I16
Migratory bird guilds	
Eagles and Raptors	A05, A21, A25, A32, A33, B05, B10, C04, C24, C24, D18, D22, D23, E01, E01, E02, E03, E05, E10, E12, E13, E16, E17, F23, F26, G03, G04, G05, H07, I12, I17, I21
Grassland Birds	A21, B07, C04, C25, D18, D23, E03, E06, E08, E10, F07, F15, F16, F20, H07, H10, H15, H17, H20, H23, I03, I13, I17, I23
Neotropical Migrants	D01, D18, D22, D23, D25, E03, E04, E09, E10, F03, F07, F08, F09, F14, F18, F25, H01, H06, H08, H13, H15, H17, I03, I13, I17, I24
Passerines	B07, B18, C02, C04, C07, C11, C17, D14, D18, D22, D25, D26, D27, D29, E03, E04, E08, E10, E11, E14, E15, F07, F08, F09, F14, F16, F18, F20, F22, F25, G03, H01, H04, H06, H07, H08, H13, H15, H17, H19, H24, I03, I13, I17, I21, I24
Seabirds	A08, B22, C02, C06, C18, C20, D02, D10, D12, D16, D18, E18, E19, F02, F10, F13, I02, I04, I08

Table 3.1. List of geographic narrative sections for specific subjects.—Continued

Subject	Section
Shorebirds	A01, A07, A24, A26, A28, B07, B11, B12, B19, B20, C09, C11, D14, D16, D18, D21, D28, D30, D31, D32, D33, E03, F09, F11, F24, G01, G03, H03, H07, H16, H25, H26, H27, I05, I09, I10, I17, I22, I25
Waterbirds	A01, A02, A07, A17, A19, A23, A31, B09, B13, B19, B20, C02, C03, C08, C09, C10, C11, C15, C18, D16, D18, D20, D32, E03, E08, E09, F01, F04, F06, F09, F17, G02, G03, H02, H03, H12, H18, H21, H27, I01, I06, I08, I11, I14, I15, I17, I19, I21
Waterfowl	A01, A04, A06, A09, A10, A11, A12, A13, A14, A15, A20, A22, A27, A29, A30, B01, B02, B03, B04, B05, B11, B15, B17, B19, B21, C02, C05, C09, C11, C12, C13, C14, C15, C16, C18, C19, C25, D03, D04, D05, D06, D07, D09, D11, D14, D16, D18, D19, D24, D34, E03, E07, E08, E10, F09, F11, F20, F26, F27, H02, H03, H09, H16, H22, H23, H25, H26, I01, I02, I05, I13, I16, I17, I19, I20, I21, I26
Research focus and tools	
Banding	A08, A24, B11, B22, D02, D04, D05, D14, D21, D25, D27, D29, D30, D31, E07, E12, E18, F02, F04, F13, H01, H11, H15, I10, I24
Breeding ecology	A08, A19, A29, B01, B02, B04, B05, B07, B10, B11, B12, B13, B14, B15, B18, B20, B21, B22, C07, C08, C10, C11, C25, D02, D05, D12, D14, D21, D22, D23, D25, D30, D31, D32, D33, E08, E14, E15, E18, F02, F03, F09, F13, F15, F16, F18, F19, F20, F22, F24, H07, H09, H10, H11, H12, H13, H16, H19, H23, H24, H27, I04, I08, I09, I11, I17, I23, I25
Brood-rearing	B01, D30, F17, F19, F22, F24
Cross-seasonal Effects	A24, D31, E10, E15, F04
Foraging	A01, A02, A07, A08, A13, A19, A23, B11, B22, C04, C06, C10, D12, D21, D25, E18, F09, F13, F21, H01
Genetics	A19, C17, C18, C20, D14, D21, D25, D27, D29, F09, G01, G02, G03
Habitat Use	A02, A03, A07, A08, A13, A14, A17, A20, A26, A29, B01, B03, B04, B05, B07, B10, B11, B13, B16, B19, B22, C05, C10, C15, C18, D05, D07, D10, D12, D14, D18, D20, D21, D22, D26, D27, D28, D29, D30, D31, E03, E04, E08, E12, E13, E18, E19, F03, F07, F08, F10, F13, F14, F15, F17, F24, H01, H03, H04, H06, H07, H08, H10, H11, H12, H13, H15, H16, H18, H19, H23, H24, I01, I05, I10, I19, I23, I23, I24, I25
Migration	A04, A05, A06, A08, A11, A13, A17, A19, A20, A21, A22, A23, A25, A27, A28, A29, A30, A31, A32, A33, B05, C09, C12, C13, C14, C15, C16, C19, C23, D01, D03, D04, D05, D06, D09, D20, D21, D31, E12, E13, E15, E18, E19, F01, F04, F07, F11, F19, F21, G01, H01, H11, H26, I01, I16, I20, I24
Nesting	B01, B02, B05, B09, B10, B13, B14, B16, B18, B19, C10, C22, D05, D23, D25, D28, D30, D31, E08, E14, E15, E18, F03, F06, F17, F19, F21, F22, H11, H12, H16, H19, I08, I09, I10, I11, I15
Nutritional Ecology	A01, A02, A03, A07, A08, A27, C10, E18, F21, H01
Population Ecology	A02, A04, A20, A30, B10, B12, C20, D02, D04, D05, D06, D16, D21, D25, D27, D29, D31, D34, E02, E10, F02, F03, F07, F18, F20, F24, F26, H01, H04, H11, H15, H16, H17, H19, H23, H24, I02, I03, I04, I08, I10, I16, I17, I23, I25
Predation	A01, A07, B01, B05, B14, B16, C20, C22, D30, D31, E14, E15, F25, I12

Table 3.1. List of geographic narrative sections for specific subjects.—Continued

Subject	Section
Recovery/Restoration Planning	A07, A24, A26, C10, C20, D20, D27, D29, D30, F04, F07, F11, F17, F19, F21, F22, F24, F28, H01, H03, H18, I06, I25
Remote Sensing	B03, D05, E09, E11, F07, F11, H01, H16, H22, I08, I19, I21, I25
Telemetry	A05, A08, A09, A13, A14, A20, A21, A23, A25, A26, A29, A31, A32, A33, B04, B05, B05, B11, B22, C05, C10, C20, C23, D03, D05, D05, D07, D09, D12, D20, E07, E17, E18, E19, F01, F04, F09, F13, F19, H11, I01, I05, I10, I1, I24
Unmanned Aircraft Vehicles	I08
Wintering Grounds	A07, A12, A13, A17, A21, A23, A24, A25, A26, A28, A29, B05, B11, C04, D05, D20, D31, E18, F01, F04, F18, G01, H03, H16, I16



Wood duck at Seedskadee
National Wildlife Refuge.
Photograph by Tom Koerner,
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White fronted geese and
wigeon. Photograph by
Clayton Ferrell, U.S. Fish
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Facing page. Wood duck at Seedskafee National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

Inside back cover. White fronted geese and wigeon. Photograph by Clayton Ferrell, U.S. Fish and Wildlife Service.

Back cover. Mallards at Seedskafee National Wildlife Refuge. Photograph by Tom Koerner, U.S. Fish and Wildlife Service.

