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U.S. Geological Survey Cooperative Fish and Wildlife Research Units Program—2016–2017 Research Abstracts

Circular 1427
Version 1.1, May 2017

U.S. Department of the Interior
U.S. Geological Survey

Front cover. U.S. Geological Survey (USGS) researcher downloading location data from a global positioning system (GPS) collar during a 2014 moose capture. Photograph by Mark Gocke, Wyoming Game and Fish Department. Used with permission.

Back cover. USGS researcher drawing blood from a live-captured moose. Photograph by Mark Gocke, Wyoming Game and Fish Department. Used with permission.

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Edited by Donald E. Dennerline and Dawn E. Childs

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Pictured above: Virginia Cooperative Fish and Wildlife Research Unit graduate student removing a northern long-eared bat from a mist net in Rock Creek National Park, District of Columbia.

U.S. Department of the Interior
RYAN K. ZINKE, Secretary

U.S. Geological Survey
William H. Werkheiser, Acting Director

U.S. Geological Survey, Reston, Virginia
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Contents

Pictured above: Yellow tang, a common reef fish in Hawaii.

Abbreviations

2,4-D	2,4-Dichlorophenoxyacetic acid
AFS	American Fisheries Society
AIM	Assessment, Inventory, and Monitoring
AM	adaptive management
BCA	bird conservation areas
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BMP	best management practices
CPE	catch per effort
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CRSA	Colville River Special Area
CVPIA	Central Valley Project Improvement Act
CWD	chronic wasting disease
DDT	dichlorodiphenyltrichloroethane
DEB	dynamic energy budget
DIDSON	dual-frequency identification sonar
DNA	deoxyribonucleic acid
DoD	Department of Defense
DOI	Department of the Interior
EDC	endocrine disrupting chemicals
eDNA	environmental DNA
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
GAP	National Gap Analysis Program
GIS	geographic information system
GNP	Glacier National Park
GPS	Global Positioning System
IEM	Integrated Ecosystem Model
IHNV	infectious hematopoietic necrosis virus
I&M	inventory and monitoring
LCC	Landscape Conservation Cooperative
lidar	light detection and ranging
LTER	Long Term Ecological Research Network
MBTA	Migratory Bird Treaty Act
MEDIFW	Maine Department of Inland Fisheries and Wildlife
MHC	Major Histocompatibility Complex
NASA	National Aeronautics and Space Administration
NAWMP	North American Waterfowl Management Plan
NFHS	National Fish Hatchery System
NGO	nongovernmental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NPWRC	Northern Prairie Wildlife Research Center
NRCS	Natural Resources Conservation Service
NRDAR	Natural Resource Damage Assessment and Restoration
NWR	National Wildlife Refuge
PAH	polycyclic aromatic hydrocarbon
PIT	passive integrated transponder
PWS	Prince William Sound
S3	Stream Salmonid Simulator
SAV	submersed aquatic vegetation
SDM	structured decision making
SEZ	solar energy zone
SGCN	species of greatest conservation need
SGI	Sage-Grouse Initiative
SNAP	Scenarios Network for Alaska and Arctic Planning
SSA	species status assessment
SWAP	State Wildlife Action Plan
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
WBCI	Wisconsin Bird Conservation Initiative
WMA	wildlife management area
WNS	white-nose syndrome

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Introduction

The U.S. Geological Survey (USGS) has several strategic goals that focus its efforts on serving the American people. The USGS Ecosystems Mission Area has responsibility for the following objectives under the strategic goal of "Science to Manage and Sustain Resources for Thriving Economies and Healthy Ecosystems":

- Understand, model, and predict change in natural systems
- Conserve and protect wildlife and fish species and their habitats
- Reduce or eliminate the threat of invasive species and wildlife disease

This report provides abstracts of the majority of ongoing research investigations of the USGS Cooperative Fish and Wildlife Research Units program and is intended to complement the 2016 Cooperative Research Units Program Year in Review Circular 1424 (https://doi.org/10.3133/cir1424). The report is organized by the following major science themes that contribute to the objectives of the USGS:

- Advanced Technologies
- Climate Science
- Decision Science
- Ecological Flows
- Ecosystem Services
- Endangered Species Conservation, Recovery, and Proactive Strategies
- Energy
- Human Dimensions
- Invasive Species
- Landscape Ecology
- Species of Greatest Conservation Need
- Species Population, Habitat, and Harvest Management
- Wildlife Health and Disease

Pictured below: Canada lynx. Photograph courtesy of the Maine Department of Inland Fisheries and Wildlife.

Project Abstracts

Project abstracts are organized alphabetically by Unit within each of the thematic areas. Research conducted as part of the Cooperative Fish and Wildlife Research Units program is determined, approved, and supported by each Unit's coordinating committee composed of representatives from the U.S. Geological Survey, one or more of the respective State fish and wildlife agencies, the host university, the Wildlife Management Institute, and the U.S. Fish and Wildlife Service (USFWS). The stakeholder-driven nature of the Units' research portfolio is designed to assure that the science comports with the Survey's strategic goals and serves the needs of the Department of the Interior (DOI) and the States as well as the needs of their strategic conservation partners.

Scientific names for species referred to by their common names in the abstracts are listed in a table at the back of the book. Contact information for each Cooperative Fish and Wildlife Research Unit and additional contact information are provided at the back of the book.

List of Projects

Pictured below: Alligators are territorial—the movement of individual alligators can be influenced by the presence of other alligators.

Advanced Technologies

Development and Application of an Integrated Ecosystem Model

Alaska Cooperative Fish and Wildlife Research Unit

The Alaska Integrated Ecosystem Modeling Project is a multifaceted institutional and multidisciplinary enterprise designed to meet the needs of Alaska's land managers in understanding the nature and rate of landscape change. Ultimately, this tool can provide an integrated framework for natural resource managers and decision makers and produce specific scenarios of changes in landscape structure and function that could be used to develop resource-specific impact models.

Monitoring the Endangered Tidewater Goby by Using Environmental DNA in Water Samples

California Cooperative Fish and Wildlife Research Unit

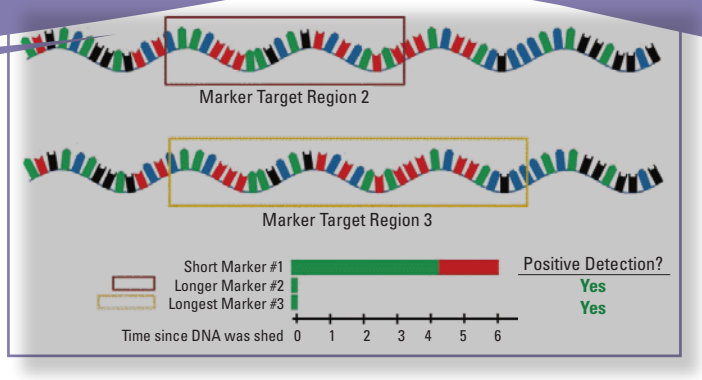
Environmental deoxyribonucleic acid (DNA) or eDNA is a cost-effective and noninvasive technique that has been successfully used to monitor a broad range of taxonomic groups, including fishes. Studies show that eDNA in water samples can be used to track the presence or absence of a species, particularly species that cannot be detected using conventional field approaches. Insufficient testing has been conducted to determine the suitability of eDNA approaches for monitoring tidewater goby. This project proposes to assess the potential of using eDNA in water samples as a tool for monitoring the endangered tidewater goby in lagoon and bay habitats.

Tidewater goby.

Tidewater Goby Survey

California Cooperative Fish and Wildlife Research Unit

Environmental DNA can be used to monitor the presence or absence of endangered species. The goal of this project is to develop eDNA techniques and methods for use in monitoring the endangered tidewater goby in California Department of Transportation project areas and in performing specified surveys. The new eDNA techniques and methods can be used to help develop a survey protocol that can be used to detect tidewater goby with higher confidence. Improved survey techniques can help the California Department of Transportation save money and avoid delays during road and bridge maintenance and construction by means of rapid, cost-effective determination of the presence of tidewater goby.



Integration, Validation, and Fusion of Small Unmanned Aircraft System Multimodal Sensor Data in Support of the U.S. Geological Survey

Florida Cooperative Fish and Wildlife Research Unit

Since 1998, a group of interdisciplinary researchers at the University of Florida have been involved in the development of small, affordable, high-resolution, digital imaging sensor systems designed for use in small unmanned aircraft as potential tools for collecting data to assist in answering natural resource-based questions and ecosystem monitoring efforts. This project continues the development and necessary modifications of such a system. The University of Florida Unmanned Aircraft Systems Research Program has been noted as one of the leaders in developing affordable and scientific-grade technology for natural resource-based applications.

The University of Florida Unmanned Aircraft Systems Research Program has been noted as one of the leaders in developing and fielding affordable and scientific-grade technology for natural resource-based applications.

Evaluating Occupancy Estimation and Abundance Relations as an Alternative Method for Ungulate Abundance Surveys

Montana Cooperative Wildlife Research Unit

Occupancy estimation and abundance relations are being evaluated as an alternative method for ungulate abundance surveys. Researchers plan to test a camera-based occupancy estimation method that exploits the steep side of the occupancy-abundance relation to estimate ungulate abundance. Critical components of grid cell size, habitat relations, and camera distribution are to be examined.

Development and Extension of the R Package for Statistical Modeling and Analysis

New York Cooperative Fish and Wildlife Research Unit

New functions to increase the occupancy modeling capabilities of the R package are being implemented using conventional statistical methods, such as maximum likelihood estimation and basic R functions of optimization. The research team plans to develop case studies using bird monitoring data provided by the National Park Service (NPS) and, as part of the project, build the conceptual and technical foundation of hierarchical modeling methods, after which the team plans to release a new version of the R package.

Using eDNA to Assess the Presence of Cavefish and Crayfish Populations in Caves of the Ozark Highlands

Oklahoma Cooperative Fish and Wildlife Research Unit

Environmental DNA can be used to verify the presence of cavefish and crayfish populations in caves of the Ozark Highlands. The proposed project intends to support the recovery and monitoring efforts of the USFWS and various conservation partners and help inform conservation decisions.

The Ozark Highlands.

Developing Noninvasive Methods to Monitor Burrow-Nesting Seabird Populations

Oregon Cooperative Fish and Wildlife Research Unit

Surface-nesting seabird populations can be monitored using aerial photography and visual counts; however, monitoring of burrow-nesting seabird populations is more challenging, especially on offshore islands that are difficult to access. This study intends to develop, test, and validate new, efficient, and minimally invasive techniques to monitor populations of a burrow-nesting seabird, Leach's storm-petrel. Researchers plan to use remote cameras and acoustic recorders to generate abundance estimates. Through partnerships, these efforts may lead to the design and implementation of a comprehensive inventory and standardized census program for seabirds to obtain a more accurate estimate of populations and establish a long-term research program using seabirds as biological indicators of ocean conditions and the effects of climate change.

Monitoring Success of Farm Bill Programs in Conserving Avian Wildlife

South Carolina Cooperative Fish and Wildlife Research Unit

A new tool is being evaluated to monitor the effectiveness of Farm Bill incentive programs related to avian species of conservation concern. In this project, the researchers plan to investigate the use of new remote acoustical detecting technology for monitoring avian community responses on private lands in South Carolina. Findings may provide guidance on improving the effectiveness of incentive programs and provide unique insights into how such technology can be used to identify areas of future focus.

Assessing the Feasibility of Using Acoustic Monitoring for Burbot Conservation, Management, and Production

Texas Cooperative Fish and Wildlife Research Unit

A pilot study is being conducted to determine whether the calls reportedly produced by burbot spawning can be used to locate spawning grounds, quantify spawning activity, and enhance production of the species in hatcheries.

Publication

Grabowski, T.B., 2016, Assessing the feasibility of using acoustic monitoring for burbot conservation, management, and production: Lubbock, Texas, Texas Cooperative Fish and Wildlife Research Unit, U.S. Geological Survey, U.S. Fish and Wildlife Service, Cooperator Science Series no. 118–2016, 34 p., http://digitalmedia.fws.gov/cdm/ref/collection/document/id/2126.

Advancing Adaptive Management in the Riverside East Solar Energy Zone (SEZ) in California

Vermont Cooperative Fish and Wildlife Research Unit

A major challenge in monitoring wildlife in the solar energy zone (SEZ) in California is the sheer size of the landscape. The goal of this study is to develop methods to facilitate feasible implementations of wildlife monitoring projects that produce high-quality, high-resolution data for landscape-scale community monitoring. As part of this study, researchers are investigating use of the cellular phone-based Wireless Sensor Network as a major vehicle for remote data collection and distribution at a landscape scale, and developing analytical tools using a web application that facilitates near real-time analysis for use in land-management decisions.

Sally Jewell, 51st U.S. Secretary of the Interior, visits the Vermont Cooperative Fish and Wildlife Research Unit. Pictured left to right: Terri Donovan, Sally Jewell, Donna Parrish.

Assessing Marine Biodiversity in the Elwha River Using eDNA From Nearshore Water Samples

Washington Cooperative Fish and Wildlife Research Unit

The Elwha River dam removal project is a large ecosystem and salmon restoration project involving the removal of two long-standing dams. These dams, in the largest such project ever attempted, were removed over a 3-year period (2011–14), which resulted in a massive release of sediment stored in the reservoirs. The primary objective of the project is to compare the results generated from visual biodiversity surveys of the seafloor with those generated from eDNA extracted from water samples. This information would allow the research team to determine the efficacy of using the emerging tool of eDNA in biodiversity surveys of Puget Sound and elsewhere. The information could also be used to evaluate the effectiveness of eDNA approaches in assessing ecosystem response to large-scale disturbances.

Use of a Portable Ultrasound to Determine Sex and Maturation Status of Lake Sturgeon in the White Rapids Section and Other Portions of the Menominee River

Wisconsin Cooperative Wildlife Research Unit

The Menominee River currently supports some of the largest stocks of lake sturgeon associated with the Great Lakes, including the section of river between White Rapids and Grand Rapids dams. Lake sturgeon management and research activities would be greatly enhanced if sex and maturation status could be more accurately determined. The research team plans to use a portable ultrasound to determine the sex and maturation status of lake sturgeon by combining the use of passive integrated transponder (PIT) technology with the ultrasound, which would allow biologists to better determine population sex ratios and maturation history of individual lake sturgeon.

Monitoring Elk Migrations With Remote Photography

Wyoming Cooperative Fish and Wildlife Research Unit

Most elk population estimates are based largely on data collected from aerial surveys. Although aerial surveys are an excellent source of data, they can be costly and dangerous. Recent wildlife underpass projects and pilot projects to monitor migratory elk populations suggest there may be potential to obtain accurate estimates of annual elk population trends by using digital cameras to photograph animals as they move through migration bottlenecks during their spring and fall migrations. This project intends to evaluate the use of remote cameras to monitor population dynamics and migration patterns of elk in northwest Wyoming.

A large herd of elk pass this camera site on their way to low-elevation winter habitat near Cody, Wyoming.

Climate Science

Application of an Integrated Ecosystem Model: A Multifaceted Institutional and Multidisciplinary Effort to Understand Potential Landscape, Habitat, and Ecosystem Change in Alaska and Northwest Canada

Alaska Cooperative Fish and Wildlife Research Unit

Research is continuing in the development and application of the Integrated Ecosystem Model (IEM), which integrates the driving components for, and the interactions among, disturbance regimes, permafrost dynamics, hydrology, and vegetation in Alaska and northwest Canada. The outputs from the model can provide natural resource managers and decision makers an improved understanding of the potential response of ecosystems to a changing climate. These projections of key ecological variables of interest (for example, wildlife habitat conditions) can facilitate the integration of how landscapes may respond to climate change into resource-management decisions.

Pictured below: Oblique aerial photograph showing changes in the terminus of Bear Glacier, Kenai Mountains, Kenai Fjords National Park, Alaska, over time.

Broad Whitefish Ecology on the Arctic Coastal Plain

Alaska Cooperative Fish and Wildlife Research Unit

Climate change is rapidly changing stream habitat conditions and migratory patterns, spawning habitats, and food web productivity in broad whitefish. This study aims to help understand foraging and migration patterns of broad whitefish on the Arctic Coastal Plain of Alaska. The research can help managers make informed decisions on this important subsistence species.

Climate Change Effects on Kenai River Salmon

Alaska Cooperative Fish and Wildlife Research Unit

Climate change is occurring at unprecedented rates in arctic ecosystems, and the effects on important freshwater species and freshwater systems are not well understood. This study is being conducted to investigate how Chinook and coho salmon habitats are changing in response to landscape and climate change. The research is focused on how landscape change is affecting salmon habitats. Results from this study can inform local, State, and Federal resource managers and Chinook salmon subsistence resource users who would be most vulnerable to the loss and degradation of rearing habitats.

Differential Effects of Climate-Mediated Forest Change on the Habitats of Two Ungulates Important to Subsistence and Sport Hunting Economies

Alaska Cooperative Fish and Wildlife Research Unit

Climate change is a complex process that may affect the food resources of different species of wildlife in contrasting ways. Moose and caribou are important to both subsistence and sport hunting economies throughout Alaska. The winter diets of these species are quite different; caribou focus on snow covered, ground hugging lichens, and moose focus on the twigs of erect deciduous shrubs that protrude above the snow. This project can use output from the IEM to estimate the differential effects of climate change on the quantity of food available to these two species throughout most of Alaska and parts of Canada. The results can be stratified by land ownership and landscape characteristics to provide maps of expected changes in winter food for moose and caribou that are tailored to, and directly usable by, natural resource managers as they devise strategies for adapting to a changing climate.

A mother caribou and her offspring, east of Chicken, Alaska, on the Yukon-Alaska border.

Effects of Large-Scale Climate Patterns on Caribou in the Yukon Territory

Alaska Cooperative Fish and Wildlife Research Unit

The effects of large-scale climate patterns on calving ground location, food availability, and calf survival of the porcupine caribou herd in the Yukon Territory are being studied. The goal of this research is to develop an understanding of why calving areas of the porcupine caribou herd, located predominantly in the Yukon Territory from 2000 to 2013, have seemingly shifted to include the 1002 Area, east of Prudhoe Bay in northern Alaska. The research team plans to assess whether the eastward shift in concentrated calving is "permanent" or a phase of some cyclic phenomenon. Results from this multiagency, collaborative project can help managers understand the factors that determine the location of the calving grounds so future development activities can be located to minimize negative effects during the calving season.

Identifying Mechanisms of State Change and Forecasting Future Vulnerability

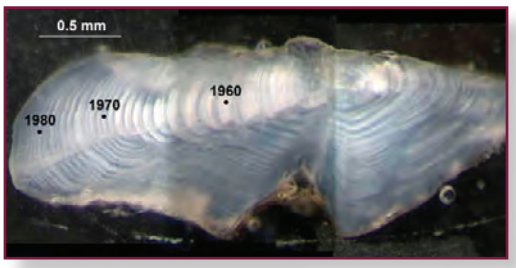
Alaska Cooperative Fish and Wildlife Research Unit

Managers are interested in identifying mechanisms for forecasting future vulnerability in boreal ecosystems in the Alaska Interior. Researchers plan to use field measurements to construct models that detect and predict changes in response to climate and land management. Scientists can then determine links among fire, soils, permafrost, and vegetation succession in order to develop and test field-based ecosystem indicators that can be used to directly predict ecosystem vulnerability to state change. Additionally, the research team plans to forecast landscape change in response to projected changes in climate, fire regime, and fire management.

Lake Trout Otoliths as Biochronological Indicators of Recent Climate Patterns in Arctic Lakes

Alaska Cooperative Fish and Wildlife Research Unit

High latitude ecosystems such as arctic Alaska show increased effects of climate change. Unfortunately, long-term air temperature data only exist for relatively few locations, and lake temperatures have only recently been added to routine monitoring efforts. Lake trout are present across the arctic landscape and are also a long-lived fish, so scientists are evaluating the utility of using lake trout otoliths for discerning recent climate patterns. Researchers plan to use lake trout from the Fish Creek and Ikpikpuk Sand Sea/Teshekpuk Lake watersheds, which are experiencing the impacts of climate change as well as large-scale changes in land use involving oil and gas development. Given the broad distribution of lake trout, this project can provide a valuable tool for inferring climate change where long-term monitoring data are unavailable.



Cross section of a lake trout otolith collected in April 1989 from Chandler Lake, Alaska. Dots indicate decadal growth increments (1980, 1970, and 1960).

Projected Effects of Climate-Induced Vegetation Changes on Caribou Energetics in Northern Alaska

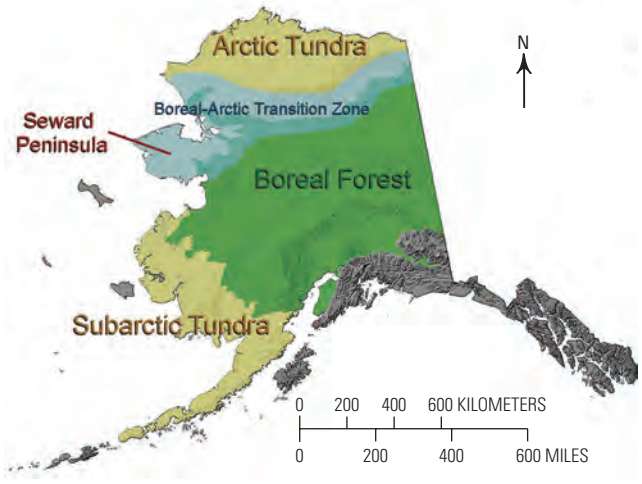
Alaska Cooperative Fish and Wildlife Research Unit

Without quantitative projections of the direction and magnitude of climate-vegetation-wildlife interactions under alternate warming scenarios, it is difficult to clearly detect the effects, or lack of effects, for nonclimate influences such as industrial development on wildlife populations in arctic regions. Researchers plan to focus on caribou because they are important to subsistence economies, their habitat associations are better understood than other wildlife in the Arctic, and a model is available that allows assessment of projected climate-induced changes. Although the focus of this project is caribou, the data are likely to be applicable across a suite of species, including many migratory birds. These data can enable managers to make informed decisions for the future.

Regional Consequences of Changing Climate-Disturbance Interactions for the Resilience of Alaska's Boreal Forest

Alaska Cooperative Fish and Wildlife Research Unit

Climate change is affecting rural Alaskans in multiple ways. Researchers are focusing on social-ecological resilience and response to change by studying how climate variability and change are affecting the social-ecological dynamics of rural Alaskan villages and exploring the effects of climate change on ecosystems and landscape structure. By understanding how changes in ecosystem services are affecting community resilience, this work can help identify opportunities for adaptation and transformation of community practices.



Transition zone between boreal forest and arctic and subarctic tundra in Alaska.

Reproductive Success of Arctic-Breeding Shorebirds in a Changing Climate

Alaska Cooperative Fish and Wildlife Research Unit

Worldwide declines in shorebird populations, including arctic breeding species, have recently become apparent. Climate change is projected to increase air temperatures and alter hydrologic systems in arctic environments. Additionally, little is understood about how such climate-induced changes in habitat and prey may affect the reproductive success of migratory birds during the short arctic breeding season. This study is designed to evaluate the reproductive success of two shorebird species, American and Pacific golden-plovers. This research can help managers protect coastal resources and mitigate climate change and anthropogenic stressors.

Temperature, Phenology, and Embryo Survival in Western Alaska Sockeye Salmon Populations: The Potential for Adaptation to a Warming World

Alaska Cooperative Fish and Wildlife Research Unit

A fundamental ecological challenge is to understand and predict population responses to rapid environmental change. Viable sockeye populations are critical to the economy, culture, and freshwater ecosystems of Bristol Bay in western Alaska. Researchers plan to investigate temperature, phenology, and embryo survival in western Alaska sockeye salmon populations. This work can benefit managers and local communities that depend on sustainable sockeye salmon runs for their livelihoods and subsistence.

The Role of Environmental Processes in Structuring the Distribution of Chinook Salmon Spawning and Rearing Habitats Across a Large Alaska River Basin

Alaska Cooperative Fish and Wildlife Research Unit

Chinook salmon are an important subsistence, sport-fishing, and ecological resource in Alaska. Poor adult returns in recent years have resulted in fishery closures, leading to social and economic hardships for subsistence and sport fishing. The mechanisms driving these declines are poorly understood. This project is designed to provide a better understanding of past and contemporary relations among spawning and rearing habitat quality for Chinook salmon. Study results could greatly improve the ability to prioritize conservation and management action in a changing world.

Arctic Seabird Habitat Selection: Implications for Climate Change

California Cooperative Fish and Wildlife Research Unit

Climate change is projected to have its greatest impact in arctic regions where temperature increases are expected to cause rapid changes to ecosystems, which can affect wildlife. These changes range from phenological mismatches to altered habitats where warmer climates favor changes in plant communities. The semipalmated sandpiper (hereafter "sandpiper") is an abundant, arctic seabird whose breeding range extends across nearly all of the Nearctic. The sandpiper breeds in wet, coastal tundra that is likely to be strongly affected by climate change. The goal of this research is to investigate current aspects of habitat selection by sandpipers to predict how future climate changes may affect their habitats and population.

Semipalmated sandpiper. Photograph by U.S. Fish and Wildlife Service.

Trophic Structure Response of Great Lakes Basin Fish to Climate Change

Georgia Cooperative Fish and Wildlife Research Unit

Predicting population responses to climate change requires an understanding of how population dynamics vary spatially and temporally. Although variability has historically been viewed as an impediment to understanding population responses to ecological changes, it can provide an important signal, rather than just being viewed as noise. This project intends to build upon fish population data collected in the Great Lakes Basin. The research can elucidate the extent to which quantifiable responses in space and time variability occur in different forms of fish population data.

Causes of Elevational Patterns in Avian Species Richness

Idaho Cooperative Fish and Wildlife Research Unit

Many studies predict that the distributions of species might shift upward in elevation in response to climate change, and this movement has already been observed in some species. Birds are expected to, and in some instances already have, exhibit climate-induced elevational shifts in distributions. The research team is using National Gap Analysis Program (GAP) data to explain elevational patterns in bird species richness in the United States. This information can allow managers to prioritize land for conservation on the basis of understanding why different elevations are likely to support differing levels of biodiversity.

Climatic and Anthropogenic Forcing of Wetland Landscape Connectivity in the Great Plains

Kansas Cooperative Fish and Wildlife Research Unit

Prairie wetlands have been identified as highly sensitive and vulnerable systems to climate and landscape change. This project uses new data acquisition, simulation models, and analytical techniques that enable "fourth paradigm" science to examine human-ecological dimensions. By examining interactions between climate projections, land-cover projections, and habitat connectivity in Great Plains wetlands, the models can be used to identify the habitats implicit in climate projections, locate which habitats might be affected by climate and land-cover change, and assess the ability of affected species, specifically waterbirds and amphibians, to move to other locations via habitat connectivity.

Coupled Climate, Cultivation, and Culture in the Great Plains: Understanding Water Supply and Water Quality in a Fragile Landscape

Kansas Cooperative Fish and Wildlife Research Unit

In fragile landscapes, water resource managers face complex decisions. Researchers developed a human-landscape model that incorporates the linkages and feedbacks among atmospheric, terrestrial, aquatic, and social processes to predict the potential effect of climate variability, climate change, land use, and human activity on water resources. The research team plans to develop and model the hydrosystem, the aquatic ecosystem, and the human system.

Historical Trends of the Landscape Structure of Plant Communities of Sand Shinnery Oak Prairie

Kansas Cooperative Fish and Wildlife Research Unit

Lesser prairie-chickens have experienced a decline in population numbers and distribution throughout the Great Plains, which led to their status as a threatened species under the Endangered Species Act (ESA). However, the listing was vacated in September 2015 by a Federal judge in Texas. Regardless, the lesser prairie-chicken remains a species of conservation concern, and ecological data are pertinent to understanding population demography. This demography study in the sand shinnery oak prairie and mixed-grass prairie regions of the southern High Plains ecoregion of the Great Plains can inform management efforts regarding future climate change.

Occurrence and Variation in Submerged Aquatic Vegetation Along the Northern Coast of the Gulf of Mexico

Louisiana Cooperative Fish and Wildlife Research Unit

Submerged aquatic vegetation (SAV) communities are highly productive ecosystems that provide significant ecological benefits within coastal areas, including support for many important species of fish and wildlife. Despite their critical importance, and loss globally, consistent baseline data on SAV resources are lacking. This project intends to provide data on the occurrence and abundance of SAV resources within the northern Gulf of Mexico, quantitatively assess environmental factors affecting its spatial and temporal variation, and develop a conceptual model of factors influencing SAV resources. These data are critical in identifying relations between SAV resources and environmental variables, and can enable predictive modeling of SAV resources under different scenarios of landscape and climate change.

Submersed Aquatic Vegetation Along the Northern Gulf of Mexico (Alabama to Texas): Vulnerability Assessment and Potential Climate Change Impacts

Louisiana Cooperative Fish and Wildlife Research Unit

A primary means to increase waterfowl habitat has involved management of coastal areas for increased SAV abundance. Despite extensive SAV-fishery habitat research in other parts of the country, data documenting the added benefits resulting from increased SAV abundance to fishery resources in Louisiana are limited. This project looks to examine the fishery community use and value of SAV habitats of varying size and location across the landscape. The project could have direct management application by providing data and vulnerability and climate change scenario analyses to enable managers to determine if management actions can achieve desired biological objectives under different scenarios.

Assessing Priority Amphibian and Reptile Conservation Areas and Vulnerability to Climate Change in the North Atlantic Landscape Conservation Cooperative

Maine Cooperative Fish and Wildlife Research Unit

Amphibians and reptiles are experiencing severe habitat loss throughout North America; however, this threat to biodiversity may be mitigated by identifying and managing areas that serve a disproportionate role in sustaining herpetofauna. As climate rapidly changes, it is possible that areas currently deemed suitable may no longer be suitable in the future. The identification of such areas should take into consideration the dynamic nature of habitat suitability. To address these needs, researchers plan to generate spatially explicit data that can (1) identify priority amphibian and reptile conservation areas—those discrete areas most vital to maintaining reptile and amphibian diversity, (2) project regions of current and future climatic suitability for a number of priority reptiles and amphibians in the North Atlantic Region, and (3) identify gaps in distributional data for these species that may prevent or inhibit the identification of species-level climatic suitability. The data from this project can help managers prioritize long-term conservation goals.

A Global Review of Freshwater Crayfish Thermal Ecology

Missouri Cooperative Fish and Wildlife Research Unit

Fisheries managers are becoming increasingly interested in climate data. The research team is investigating the life history (for example, timing of reproduction) and thermal ecology of freshwater crayfish to inform future climate models, describe their habitat requirements, and elucidate the role of crayfish in ecosystem function, particularly their role as prey items in stream ecosystems. The results can be used to determine temperature tolerance, temperature preference, or optimal growth.

Assessing the Impact of Climate Change on Global Inland Fisheries

Missouri Cooperative Fish and Wildlife Research Unit

To effectively manage streams from current impacts and future threats, managers require regionwide information to aid in decision making. This project intends to determine the data gaps on what we know about how climate change might affect inland fish globally. Accounting for stream change is essential for managing and conserving fishes and their habitats. With such information presented in an integrated, spatially continuous, and scalable format, managers can more effectively conserve, protect, and restore stream fish and their habitats.

Smallmouth bass in Sparking Lake, Wisconsin. Photograph by Gretchen Hansen, Minnesota Department of Natural Resources.

Publications

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Changes in Fish Communities in Arid Rivers Under Climate Change

Missouri Cooperative Fish and Wildlife Research Unit

Inland fisheries are especially vulnerable to climate change because they have limited habitat availability and have a direct link to terrestrial systems, land-use patterns, and water use. Climate change impacts on inland systems may be magnified as a result of climate impacts on terrestrial systems. The research team plans to coordinate a workshop composed of inland fisheries experts from around the world to provide input on how climate change can affect inland fisheries. The outcomes of this project can help guide future conservation efforts.

Developing Measures of Vulnerability to Climate Change and Disturbance of Aquatic Communities in Heartland Network National Parks

Missouri Cooperative Fish and Wildlife Research Unit

The NPS Inventory and Monitoring Program is designed, in part, to elucidate the current variability in biotic metrics typically encountered within parks. Using several metrics (for example, Index of Biotic Integrity, Ephemeroptera, Plecoptera, and Trichoptera species diversity), variability can be determined using the coefficient of variation of these metrics and nonmetric, multidimensional scaling among sites and years. Ultimately, this project can help the NPS identify stable and unstable aquatic communities in Midwestern national parks and whether vulnerability to climate and land-use change differs by stream size or geographic region. These results can be used with climate and land-use scenarios to determine the vulnerability of aquatic biota to changes.

Playa Wetlands: Ecosystem Function and Potential Risk in a Changing Climate

Missouri Cooperative Fish and Wildlife Research Unit

The playa wetlands in Missouri represents a unique habitat that supports flora and fauna which could be at risk under changing climate scenarios. This project is designed to (1) quantify the effects of changing climatic conditions on wetland plant production, soil chemistry greenhouse gas emissions, and overall ecological tipping points within these wetlands; (2) compare ecosystem response to changing climatic conditions between northern and southern playa soils; and (3) assess impacts of increased agricultural nutrients from runoff on the playa soil properties.

Stakeholder-Led Science: Engaging Resource Managers to Identify Science Needs for Long-Term Management of Floodplain Conservation Lands

Missouri Cooperative Fish and Wildlife Research Unit

Large tracts of Mississippi and Missouri River floodplains have been converted to conservation status through the purchase of easements, and managers face uncertainties ranging from site-specific designs for water infrastructure to long-term land-acquisition strategies. Additionally, stakeholders are asking questions about how the lands can best be managed under land-use change and climate change. Researchers have developed models relating external drivers and have made climate change projections. This study demonstrates state-of-the-art modeling to inform decisions.

Statistical Analyses to Direct Conservation and Restoration Priorities for the Yellowstone Cutthroat Trout in the Context of Climate Change

Montana Cooperative Fishery Research Unit

Population densities of Yellowstone cutthroat trout have been reduced because of a variety of factors, including interbreeding with introduced rainbow trout, competition with nonnative trout species, loss of habitat, disease, and occasional drought. The project team plans to assemble and analyze empirical, georeferenced data to assess how changes in climate and other factors have influenced the distributions of native and nonnative fishes through time. This information is needed to help guide future restoration and management efforts in Yellowstone National Park.

Effects of Climate and Habitat Change on Structure and Function of a High-Priority Montane Ecosystem

Montana Cooperative Wildlife Research Unit

Understanding climate change is a high priority for decision makers who manage elk in montane ecosystems. Research continues and extends a long-term study of climate effects on a human-natural ecosystem classified by the Intergovernmental Panel on Climate Change as a high-priority and vulnerable ecosystem: a montane riparian system in the arid Southwest. The research team plans to examine the mechanisms underlying changes in ecosystem species composition and function in response to climate variation and elk.

Pictured at left: A U.S. Geological Survey researcher collecting elk telemetry data.

Pictured below: Desert bighorn sheep. Photograph by U.S. Fish and Wildlife Service.

Assessment of Drought Impacts on Selected Fish and Wildlife Species in the Southwestern United States

New Mexico Cooperative Fish and Wildlife Research Unit

The responses of individual species to environmental changes can be manifested at multiple levels—from individuals to entire populations. The research team plans to investigate the impacts of drought on desert bighorn sheep, American pronghorn, Rio Grande cutthroat trout, and scaled quail. The data should inform the understanding of drought impacts on selected fish and wildlife species in the Southwestern United States.

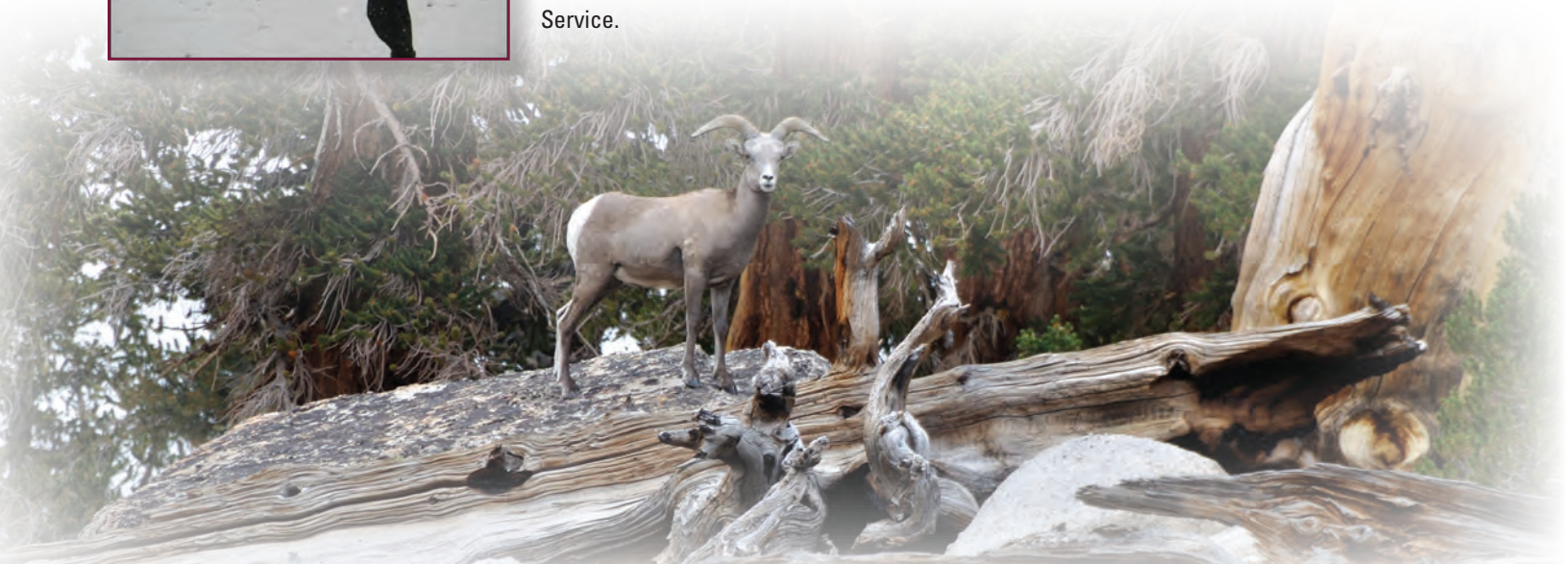
Publication

Gedir, J.V., Cain, J.W., III, Harris, Grant, and Turnbull, T.T., 2015, Effects of climate change on long-term population growth of pronghorn in an arid environment: Ecosphere, v. 6, no. 10, p. 1–20, https://doi.org/10.1890/ES15-00266.1.

Evaluating Adaptive Capacity of Desert Bighorn Sheep to Climate Change: Identifying Genetic Links to Climate Adaptations in Native and Reintroduced Populations

New Mexico Cooperative Fish and Wildlife Research Unit

The predicted increased occurrence of extreme droughts, overall decline in precipitation, and increase in temperature have the potential to affect a large number of species in the Southwestern United States. In spite of their adaptations, both domestic and wild ungulates are not always able to cope with the effects of high temperatures and limited water availability by using behavioral and physiological mechanisms. Understanding potential adaptations of desert bighorn sheep has the potential to illustrate the vulnerability of populations to potential future changes in climate change and other stressors. The results can help wildlife managers determine which actions may allow for desert bighorn sheep to persist as climate continues to change.



Measuring Scaled Quail Demography and Seasonal Habitat Use in Response to a Shrub Reduction Treatment in Southwestern New Mexico and Effect of Climate on Nest and Brood Success

New Mexico Cooperative Fish and Wildlife Research Unit

In 2008, the Bureau of Land Management (BLM) began a shrub reduction program focused on reclaiming historic grasslands from woody plant encroachment caused by over grazing and climate change. A recent study on areas treated to reduce creosote dominance indicated treatment areas had higher scaled quail densities. What that study did not reveal is when and for what purpose these areas are being utilized and whether treated areas provide increased survival and reproductive rates relative to untreated areas. This study is designed to measure scaled quail demography and seasonal habitat use in response to a shrub reduction treatment in southwestern New Mexico and the effect of climate on nest and brood success. Results from this study can inform grassland restoration and quail management programs.

Adélie Penguin Response to Climate Change at the Individual, Colony, and Metapopulation Levels

Oregon Cooperative Fish and Wildlife Research Unit

A long-term study is being conducted to investigate the population dynamics of the Adélie penguin on Ross Island, Antarctica. Researchers have collected an extensive amount of foraging, breeding, and survival information on marked, known-age individuals for this coastal, polar, colony-nesting, top-trophic species at three study colonies. The data from this project should help researchers predict potential changes in population size and overall metapopulation dynamics in relation to habitat change and environmental variation.

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Climate Change Effects Along a Latitudinal Gradient in the Pacific Northwest

Oregon Cooperative Fish and Wildlife Research Unit

Coastal areas have been identified as high-risk zones from the impact of global climate change. Significant increases in sea level have been forecasted by 2100, resulting in the loss of salt marshes and their component species. This project can characterize nearshore habitats across a coastal

continuum in Oregon and Washington, determine the vulnerability of nearshore habitats and their associated avian guilds from climate change, and determine whether projected site vulnerability varies with latitudinal gradient. This study seeks to address the significance and priority goals established in "Rising to the Urgent Challenge" developed by the USFWS to establish their strategic climate change plan to assist managers with the development of adaptation and planning strategies.

Long-Term Changes in Marine Bird Populations of Prince William Sound, Alaska

Oregon Cooperative Fish and Wildlife Research Unit

In the aftermath of the *Exxon Valdez* oil spill, the USFWS initiated a long-term monitoring program for marine birds in Prince William Sound (PWS), Alaska. Using these monitoring data, researchers are investigating the population trends and changes in seabird community structure that have occurred in PWS over the last 40 years, including since the oil spill. The study has demonstrated that long-term changes in the marine bird community are more closely linked with decadal shifts in climate and ocean conditions than to lingering effects of the oil spill. This research has demonstrated the importance of changes in climate and ocean conditions in structuring a marine ecosystem in the aftermath of major anthropogenic perturbation.

Can Plasticity Protect Populations from Rapid Environmental Fluctuation?

Pennsylvania Cooperative Fish and Wildlife Research Unit

Rates of population extirpation caused by habitat loss have reached unprecedented levels, and climate change is predicted to be a leading cause of future species extinctions.

The Pennsylvania Cooperative Fish and Wildlife Research Unit is leading research on how the interactive effects of genetics and behavior influence differential survival of fish populations in a changing climate.

Though it has been demonstrated that phenotypic plasticity increases resilience to habitat loss, the ability for plasticity to promote population persistence under climate change and habitat degradation has not been explored. This research focuses on an economically and socially important species—brook trout—to determine how the interactive effects of genetics and behavior influence differential survival of fish populations under a changing climate.

Connecticut River Migratory Fish

Vermont Cooperative Fish and Wildlife Research Unit

The concept of climate change has been the recent focus of much of the popular science literature, including some very simple predictions on how climate change is expected to affect temperature, especially in northern latitudes. Fish are affected directly by changes in temperature, including altering foraging, reproduction, metabolism, or migration. In the Connecticut River, anadromous fish are predicted to change migration patterns in relation to climate change. The research team plans to investigate how temperature, discharge, and the indirect effects of dams relate to the survival of Atlantic salmon smolts. This research should contribute to efforts to increase and improve the knowledge of Atlantic fisheries.

Integrated Forest Ecosystem Assessment to Support Sustainable Management Decisions in a Changing Climate

Vermont Cooperative Fish and Wildlife Research Unit

Since the 1970s, temperatures across the Northeastern United States have warmed, accompanied by a wide range of biological changes. It is predicted that climate change should continue to restructure forests over the coming century, although the details of potential changes remain uncertain. To refine the understanding of how climate may impact forested ecosystems, this study can develop an integrated assessment of the role of climate in forest ecosystem health and function through a combination of monitoring, experimental, and modeling activities. This framework can allow land managers to compare the probability of management activity success on a case-by-case basis.

Water Temperature Regimes in the Togiak National Wildlife Refuge and Wood-Tikchik State Park, Alaska

Washington Cooperative Fish and Wildlife Research Unit

Southwest Alaska is one of the fastest warming regions on Earth, and its aquatic resources are at distinct risk from changing climate. The research team plans to use existing water temperature data on streams, rivers, and lakes

to refine a monitoring plan developed to characterize thermal response to ongoing climate change in the Togiak National Wildlife Refuge (NWR) and the Wood-Tikchik State Park. Models constructed from the data would provide tangible examples of the extent of ongoing ecosystem responses to climate change and the possible magnitude and character of future climate impacts on aquatic ecosystems. The results can be informative to resource managers working in this region.

Safe Operating Space for Walleye: Adapting Inland Recreational Fisheries for Climate Change

Wisconsin Cooperative Fishery Research Unit

Climate change affects inland recreational fisheries by influencing lake thermal structure, water clarity, habitat, and other factors that influence economically valuable sport fishes. The safe operating space for a given fishery is the range of biophysical and social conditions that allows for self-sustaining populations of target species. Walleye, a socially and economically important sportfish across much of North America, is undergoing declines due to recruitment failures in many lakes throughout their range. Researchers can identify mechanisms behind recruitment failures to help inform the rehabilitation of walleye recruitment and populations. Results can be communicated to managers through regular management workshops as well as technical papers in scientific literature.

Walleye populations have declined in many northern Wisconsin lakes, and the reasons for these declines are not known.

Wisconsin's Wildlife and Climate Change

Wisconsin Cooperative Wildlife Research Unit

Natural resource managers monitor climate change in order to develop strategies to meet species conservation goals. The research team is investigating climate change impacts on Wisconsin's wildlife, with a focus on species that are likely to become federally threatened or endangered in the next 30–50 years. This research can aid in the development of powerful tools that allow managers and scientists to develop a common vision of the potential impacts of climate change on conservation targets.

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Influence of Climate Change on American Pika

Wyoming Cooperative Fish and Wildlife Research Unit

Alpine and northern latitude environments are expected to be particularly affected by ongoing climate change. The American pika is vulnerable to climate change. The factors limiting pika distribution and abundance in the Central Rocky Mountains, or what may drive declines in the future, are unclear. Moreover, the January 2010 decision not to list the pika under the ESA due to lack of sufficient data has elucidated the critical need for further study of the status and potential threats to pika populations throughout its range. Data from this project can play a key role in assisting decision makers in managing American pika in alpine ecosystems.

Phenology Tracking in Migratory Mule Deer

Wyoming Cooperative Fish and Wildlife Research Unit

In terrestrial ecosystems, there is a critical need to understand the influence of climate change on the spatial and temporal heterogeneity in the condition of forage (that is, quantity and quality) and the wildlife species that depend on it. Nevertheless, observing and quantifying how climate change affects behavior, distribution, and abundance of wildlife is difficult. In response to seasonal changes in plant growth and phenology and local climatic conditions, ungulates migrate between high-elevation summer ranges and low-elevation winter ranges. Various stakeholders, including the public, depend on this important research.

A researcher with the Wyoming Cooperative Fish and Wildlife Research Unit releases a collared mule deer.

Pictured below: Wyoming Cooperative Fish and Wildlife Research Unit graduate student recording vegetation data as part of her Ph.D. research.

Decision Science

Decision science is a much needed approach for enabling transparent, quantifiable decisions in the face of uncertainty and contention, and allowing managers and scientists to learn through management actions.

Pictured left to right: Mike Runge, Tara Gancos Crawford, Lynn Maguire, Abby Lawson, Julien Martin, Duane Diefenbach, Sarah Converse, Clint Moore, Barry Grand, Conor McGowan, and Jim Nichols.

Adaptive Management for Turkey Harvest in Alabama

Alabama Cooperative Fish and Wildlife Research Unit

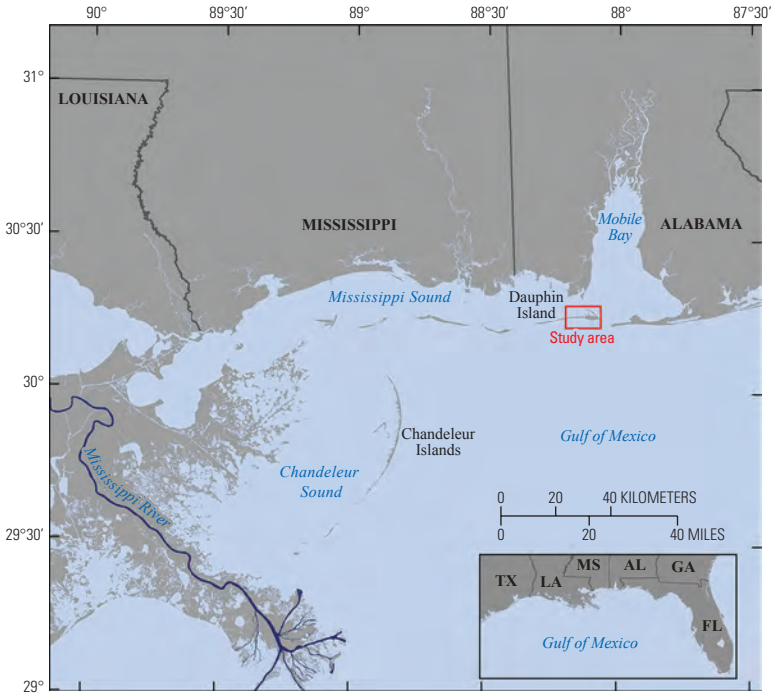
The Alabama Department of Conservation and Natural Resources is conducting a long-term study to inform science-based adaptive management (AM) of eastern wild turkey populations. A decision tool based on region-specific vital rates for turkey populations is a requirement of AM. The tool can employ a population model that predicts the dynamics of turkey populations on the basis of vital rates and a management model that predicts the effects of harvest regulations on vital rates. This research can allow scientists to estimate the temporal and spatial variation in vital rates, update the recently developed expert-driven model, test methods for monitoring decision criteria, and provide the State agency with a method for incorporating the best available information for decisions regarding turkey harvest.

Wild turkeys. Photograph by Randolph Femmer, U.S. Geological Survey.

Analysis of Alternatives for Sustainable Restoration of Dauphin Island, Alabama

Alabama Cooperative Fish and Wildlife Research Unit

Dauphin Island is a significant barrier island along the northern Gulf of Mexico and, more specifically, serves as the only barrier island providing protection to much of the State of Alabama's coastal natural resources. The goal of this work is to investigate viable options for the restoration of Dauphin Island as a sustainable barrier island to protect and restore island resources, including habitat and living coastal and marine resources, as well as protect the coastal resources of the Mississippi Sound/Mobile Bay and the southern part of Mobile County, including the Heron Bay wetlands. The research team plans to apply a structured decision making (SDM) framework to predict the consequences of various alternatives for restoration of Dauphin Island to ensure island sustainability and protection of natural resources and ecosystem integrity.



Dauphin Island is a significant barrier island along the northern Gulf of Mexico and, more specifically, serves as the only barrier island providing protection to much of the State of Alabama's coastal natural resources.

Grassland Habitat Management for Birds and Other Wildlife Species

Alabama Cooperative Fish and Wildlife Research Unit

Populations of many game and nongame bird species in the Eastern United States are declining rapidly, which has led to efforts to conserve grasslands and other habitats. With limited funding for conservation, there is an urgent need to make informed conservation decisions that affect birds and other wildlife species. The research should contribute to the development of decision models for grassland birds and non-avian taxa that rely on the same habitat and are of high conservation concern. Results from this study can influence how State and Federal agencies manage habitat to benefit wildlife populations.

Klamath Basin Stream Salmonid Simulator Model

California Cooperative Fish and Wildlife Research Unit

The USFWS is working with the USGS Columbia River Research Laboratory and Texas State University to develop decision-support systems such as the Stream Salmonid Simulator (S3) model. The S3 model for the Klamath River represents an integrated set of submodels that can be used to predict the effects of water-management alternatives on the production of juvenile Chinook salmon. The model is also being extended to include the Trinity Basin. These improvements can transform the S3 model into a basinwide, full life cycle model; future development of the S3 model is anticipated to include its expansion to incorporate coho salmon as requested by National Oceanic and Atmospheric Administration (NOAA) Fisheries and the Bureau of Reclamation.

Adjusting Adaptive Harvest Management Decision Frameworks in Response to Climate Change

Colorado Cooperative Fish and Wildlife Research Unit

The habitats required by waterfowl are undergoing large-scale system shifts associated with climate change. Changes in climate, waterfowl habitat, and migration behavior represent an additional form of uncertainty that current decision-making frameworks must address through the principles of AM. Although AM offers an approach to inform decisions, climate change may result in nonstationary shifts in system dynamics that complicate current AM protocols. Specifically, the project is set to involve performance of biological assessments, statistical analyses, and development of adjustments to waterfowl population models used in the USFWS Adaptive Harvest Management Program. The results can allow USFWS to explore the implications of climate change on adaptive harvest management protocols while also providing a framework for evaluating potential adjustments to AM approaches in the face of large-scale system change.

Adaptive Management of Federal Investments to Great Lakes Restoration Activities

Georgia Cooperative Fish and Wildlife Research Unit

The development of a planning approach to prioritize projects under the Great Lakes Restoration Initiative is part of a pilot project in the western basin of Lake Erie. The approach should support the selection of annual project portfolios that (1) address critical ecosystem problems with the best available methods, (2) identify key uncertainties and address these issues through AM or other applications of science, (3) capacitate monitoring of ecosystem status at appropriate scales and time intervals, and (4) incorporate learning feedbacks into the annual planning process. The data from this project can help decision makers achieve Great Lakes management goals.

An Adaptive Landscape Planning and Decision Framework for Gopher Tortoise Conservation

Georgia Cooperative Fish and Wildlife Research Unit

The rangewide decline of gopher tortoise has led to its designation by the USFWS as "warranted but precluded" for listing. The research team plans to develop a decision tool for gopher tortoise conservation strategies in Georgia. Researchers can use SDM to articulate objectives, define alternative management actions, and develop predictive models. This work should result in an integrated system of databases, computer algorithms, and monitoring designs.

Publication

Jafari, Nahid, Nuse, B.L., Moore, C.T., Dilkina, Bistra, and Hepinstall-Cymerman, Jeffrey, 2017, Achieving full connectivity of sites in the multiperiod reserve network design problem: Computers & Operations Research, v. 81, p. 119–127, https://doi.org/10.1016/j.cor.2016.12.017.

Decision Support for Public Alligator Harvesting in Georgia, Florida, and South Carolina

Georgia Cooperative Fish and Wildlife Research Unit

Predictive modeling tools are needed for managing alligator populations in the Southeastern United States and for establishing public harvest regulations. This research seeks to develop a dynamic AM framework for the public harvest of alligator in Georgia, Florida, and South Carolina. The approach takes advantage of regional commonalities in population biology, habitat relations, and sampling characteristics. Wildlife managers can use the data to guide conservation plans.

Developing an Adaptive Management Framework for Robust Redhorse

Georgia Cooperative Fish and Wildlife Research Unit

Robust redhorse is an imperiled species that was thought to be extinct but was rediscovered in the Oconee River, Georgia, in 1991. Researchers are using SDM to evaluate alternative conservation strategies for robust redhorse. Research results serve, in part, as the basis for a broad-based conservation strategy and everexpanding, increasingly successful recovery effort.

Robust redhorse. Photograph by U.S. Fish and Wildlife Service.

Developing an Adaptive Management Framework to Reduce the Impact of Invasive *Phragmites* in the Great Lakes Basin

Georgia Cooperative Fish and Wildlife Research Unit

Wetland invasion by the common reed is a significant threat recognized by the public, nongovernmental organizations (NGOs), and governmental agencies at all levels. The goal of this project is to develop a decision-support tool for the management of *Phragmites* in the Great Lakes Basin. The research team plans to develop dynamic system models and decision-support tools that are informed by on-the-ground data and build on existing successful programs and resources (for example, the Great Lakes *Phragmites* Collaborative), SDM, and best management practices (BMP) guidelines. This project should lead to a framework for managing *Phragmites* on the habitat patch and landscape scale.

A new type of *Phragmites*, a wetlands grass from Europe, has rapidly spread across North America, altering soil, producing copious seeds, and resulting in dense, mostly monotypic stands.

Using Qualitative Knowledge of Life History Traits to Predict Taxon Group Response to Levels of Coarse Woody Debris

Georgia Cooperative Fish and Wildlife Research Unit

The Georgia Cooperative Fish and Wildlife Research Unit is conducting a study to address how to use various qualitative and disparate sources of information to develop a reliable predictive framework for specific management actions or practices in Georgia forests. The research incorporates the best available data and should allow forest managers to develop robust forest conservation strategies.

Developing and Testing a Spatially Explicit, Science-Based, Decision-Support Tool for Making Riverscape-Scale Management Decisions: Dams and Culverts Affect a Threatened Native Stream Fish—the Neosho Madtom—and Select Tributary Fish Species

Kansas Cooperative Fish and Wildlife Research Unit

Decision makers need science-based tools to assess how human activities affect resources. Useful tools based on rigorous, current science are needed to address specific problems. A broad range of ecological conditions, such as habitat, temperature, discharge, and the biotic community, must be considered in the development of such a tool to manage fish species affected by dams. A decision-support tool can enable fisheries managers to place their management actions in a synthetic, landscape-scale, multiple-stressor context.

Making Decisions in Complex Landscapes: Headwater Stream Management Across Multiple Agencies

Massachusetts Cooperative Fish and Wildlife Research Unit

Headwater stream ecosystems are especially vulnerable to changing climate and land use, but conservation efforts are challenged by the need to address these threats at a landscape scale. This project intends to use an SDM process to address the conservation of headwater stream ecosystems in the face of climate change. Scientists can facilitate an SDM process with agencies that have joint management authority to frame the decision. The decision-framing process itself and the decision-support tools (like predictive models) are important products that can be directly relevant and usable by management agencies.

Publication

Katz, Rachel, Grant, Evan, Runge, M.C., Connery, Bruce, Crockett, Marquette, Herland, Libby, Johnson, Sheila, Kirk, Dawn, Wofford, Jeb, Bennett, Rick, Nislow, K.H., Norris, Marian, Hocking, D.J., Letcher, B.H., and Roy, Allison, 2014, Making decisions in complex landscapes—Headwater stream management across multiple federal agencies: Shepherdstown, W. Va., U.S. Fish and Wildlife Service, National Conservation Training Center, Structured Decision Making Workshops Report, https://training.fws.gov/courses/ALC/ALC3159/reports/final-reports/2014FR/Katz-et-al-2014_Headwater-Streams.pdf.

A Decision-Support Mapper for Conserving Stream Fish Habitats in the Northeastern United States

Missouri Cooperative Fish and Wildlife Research Unit

The Northeastern United States includes some of the most densely populated areas of the country. Human activities in the region, including urbanization, agriculture, and the construction of dams, have multiple effects on the region's streams, which support economically valuable stream fishes in a range of unique fluvial habitats. Changes in climate are anticipated to lead to additional changes in stream habitats and the fish assemblages they support. To effectively manage streams of the Northeast from current effects and future threats, managers require regionwide information to aid in decision making and implementation of proactive management strategies. This project intends to develop a mapper for stream reaches in the Northeast to aid in climate change adaptation plans.

Determination of Geomorphological and Landscape Factors Contributing to Diverse Unionoid Mussel Communities in Missouri River Systems, With Particular Emphasis on the Meramec River Drainage Basin

Missouri Cooperative Fish and Wildlife Research Unit

The Missouri Department of Conservation is often queried regarding the general status of endangered and threatened mussels in Missouri, a question that should remain incompletely answered until a sufficiently rigorous and comprehensive assessment and monitoring framework is implemented in the State. The long-term goal of this project is to develop a decision-support monitoring framework specifically designed to maximize the probability of detecting species or assemblage expansions or declines in key areas of Missouri that are the strongholds of mussel diversity, followed by a comprehensive conservation assessment of mussels in the State.

Mussels in the Meramec River drainage basin.

Linking Wetland Management Decisions to Distribution, Habitat Use, and Nesting Efforts of Secretive Marsh Birds in Missouri

Missouri Cooperative Fish and Wildlife Research Unit

Secretive marsh birds encompass a group of wetland-dependent birds including rails, bitterns, and moorhens. Extensive wetland habitat loss throughout the United States is believed to have contributed to the decrease in the geographic range of many secretive marsh bird species. Wetland managers make spatial and temporal decisions to ensure their management actions meet the needs, including a diversity of habitat types and water depths, of wetland-dependent wildlife. This research is investigating the relation between secretive marsh bird occupancy during spring migration and wetland habitat characteristics and management practices.

Enhancing Native Fisheries Through the U.S. Fish and Wildlife Service Fisheries Program in Region 6

Montana Cooperative Fishery Research Unit

The USFWS Fisheries Program and the National Fish Hatchery System (NFHS) were established 130 years ago to address a growing concern over the observed decline in the Nation's fishery resources and a lack of information concerning the status of the Nation's fisheries. Currently, the NFHS plays a vital role in meeting Federal mitigation obligations, restoring and maintaining native fisheries, and participating in the recovery of threatened and endangered aquatic species. Researchers plan to develop a decision-support tool to identify and prioritize conservation propagation for threatened, endangered, imperiled, and declining species and work in conjunction with State partners to coordinate and balance recovery and restoration efforts related to recreational fishing opportunities. Development of similar technologies could benefit recovery of other imperiled native species.

Integrating Adaptive Management, Resilience Thinking, and Optimization

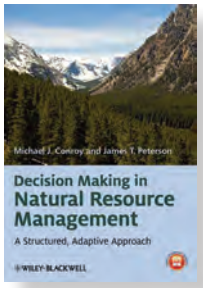
Nebraska Cooperative Fish and Wildlife Research Unit

The natural resources management paradigm has shifted from traditional command-and-control systems to a focus on complex, social-ecological systems and explicit recognition of

uncertainty. Adaptive management is an approach combining management actions and scientific investigation to increase the understanding of environmental systems. Adaptive management is a structured "learning by doing" approach to management that embraces uncertainty and change. Adaptive management, resilience thinking, and optimization have all been suggested as appropriate ways to implement the emerging social-ecological management paradigm, but translation into practice remains a challenge. This research project seeks to explore how SDM can link resilience, AM, and optimization in order to generate a cohesive method of implementing the emerging social-ecological paradigm.

Adaptive Management of Central Valley Project Fisheries

Oregon Cooperative Fish and Wildlife Research Unit



A review of the Central Valley Project Improvement Act (CVPIA) Fish Resource Area activities identified the need to develop a new comprehensive, science-based approach that explicitly links activities with program objectives. In response, the program initiated an SDM approach that resulted in the development of prototype models for prioritizing activities. The models were built using a combination of expert judgment and empirical data and were intended to be used to prioritize CVPIA fisheries activities and watersheds where management actions have the greatest likelihood of achieving CVPIA fisheries objectives. The purpose of this research is to refine models for Chinook salmon and green sturgeon.

Developing a Structured, Adaptive Approach for Cruise Ship Management in Glacier Bay National Park

Oregon Cooperative Fish and Wildlife Research Unit

Managers of Glacier Bay National Park in Alaska face difficult decisions in establishing a balance between the conflicting needs of visitors with diverse backgrounds and interests, native residents, and the pristine terrestrial and marine resources. Although visitors access the park via a diversity of marine vessels, large cruise ships account for more than 95 percent of visitors annually. Cruise ships may contribute to reduced air quality from emissions, affect visitor experience, and disturb important marine wildlife. The park is one of the largest marine protected areas in the world that includes both terrestrial and marine resources and is home to a diverse assemblage of wildlife including federally endangered humpback whales and threatened Steller sea lions. This project plans to employ an SDM process to help managers develop appropriate cruise ship management priorities in Glacier Bay National Park.

Glacier Bay National Park. Photograph by National Park Service.

Development of an Adaptive Decision-Support System for Management of the Trinity River

Oregon Cooperative Fish and Wildlife Research Unit

The Trinity River in California once supported abundant populations of anadromous salmonids that were ecologically, economically, and culturally important resources. Previous investigations of the Trinity River suggested that in-channel spawning and rearing habitats for salmonids were degraded, in part, due to changes in the thermal, hydrologic, and sediment regimes resulting from the installation of Lewiston Dam. The project team intends to work with researchers and managers to develop a decision-support model that integrates the various program disciplines in a framework that uses monitoring data to test hypotheses about system response to management actions.

Incorporating Amphibians in Decision-Support Systems

Oregon Cooperative Fish and Wildlife Research Unit

Amphibians are the most threatened class of vertebrates. Global declines in amphibians are related to a variety of factors including habitat, climate change, disease, contaminants, and invasive species. Because amphibians are nongame vertebrates and only over the last few decades have declines been recognized, amphibians as a group have received little direct management attention. Thus, there remains a need to develop an integrated, adaptive framework for managing amphibians and their habitats in the Pacific Northwest. This project anticipates working collaboratively with researchers from the USGS Forest and Rangeland Ecosystem Science Center and State and Federal natural resource managers in the Pacific Northwest to develop a decision-support system. A useful decision-making model should be a reasonable approximation of the complex life cycle of amphibians that balances complexity

with available information. The model also should allow for the integration of amphibian monitoring data so that reliable information about the factors affecting amphibians and their habitats is updated as data are collected.

Mountain yellow-legged frog.

Modeling Winter Habitat Use of Whooping Cranes in the Eastern Migratory Population

South Carolina Cooperative Fish and Wildlife Research Unit

Researchers have identified a need to assess the wintering ecology of whooping cranes to better predict the types, quantity, and quality of habitats they may use. This information is pertinent not only to understanding winter ecology but also to elucidate the links that exist between winter habitat quality and subsequent reproductive success. The goal of the research is to enhance the understanding of wintering habitat use of whooping cranes to better inform decision making related to wintering habitat assessment as well as the development and protection of current or alternative wintering sites. Researchers can use an SDM framework to evaluate possible wintering habitat locations.

A pair of whooping cranes and chicks.

Structured Decision Support for Bald Eagle Monitoring in Alaska

South Dakota Cooperative Fish and Wildlife Research Unit

Bald eagle populations are susceptible to environmental contaminants contained in their food sources. During the 1940s, bald eagle populations declined precipitously in the lower 48 States as a result of exposure to compounds found in the pesticide dichlorodiphenyltrichloroethane (DDT). Consequently, bald eagles are a “vital sign” monitored by the Southwest Inventory and Monitoring Network in cooperation with Lake Clark National Park and Preserve, Katmai National Park and Preserve, and Kenai Fjords National Park in Alaska. The goal of this project is to a develop a structured decision process that uses surveys to identify core values, sets objectives, identifies reasonable sampling scenarios, and chooses an appropriate sampling regime that optimizes objectives and minimizes cost. The project can be implemented by using the Delphi method—a series of surveys designed to facilitate consensus among disparate groups.

Bald eagle populations are susceptible to environmental contaminants obtained from their food sources. Photograph by Vernon Byrd, U.S. Fish and Wildlife Service.

Advancing Adaptive Management for Healthy Landscape Initiatives

Vermont Cooperative Fish and Wildlife Research Unit

Although much has been written about the process of AM, in practice it can be difficult to implement an AM program that seamlessly integrates data collection, models, decision making, analysis, and outputs. This study proposes to advance AM practices for the BLM's Healthy Landscapes Initiative. The goal of the Assessment, Inventory, and Monitoring (AIM) Strategy is to provide the BLM and its partners with the information needed to understand terrestrial resource location and abundance, condition, and trend, and to provide a basis for effective AM. The strategy supports an integrated approach. This study plans to develop a rapid prototype framework for linking AIM data with a data analysis and decision-making framework; the framework is expected to be informed by a case study in the BLM-administered Riverside East SEZ in Riverside County, California. The open source software program, R, is to be used primarily to develop tools that enable rapid analysis and reporting of data.

Advancing Adaptive Management of Harvested Animals by Using R Statistical Software

Vermont Cooperative Fish and Wildlife Research Unit

Management of game species typically includes a regulated harvest season, when hunters are permitted to harvest animals according to a set of regulations. A critical challenge is predicting how populations respond to both the harvest and to other environmental factors. Adaptive management is a process that attempts to seamlessly integrate data collection, models, decision making, analysis, and outputs. To aid in this process, the research team plans to develop a suite of packages to be used with R statistical software called AMHarvest, AMPop, and AMModels. These packages can include a variety of functions for implementing an AM program for harvested species.

Black bear.

Evaluating the Influence of Harvest Regulations

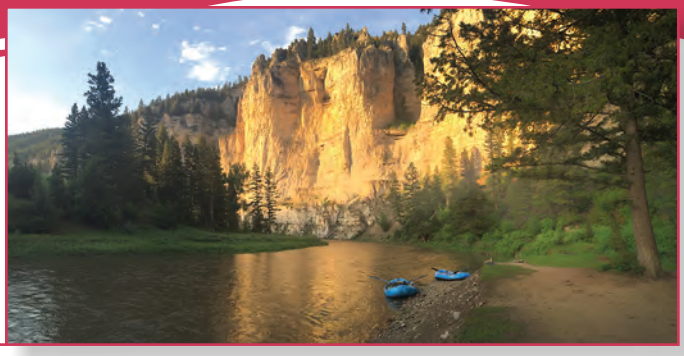
Wisconsin Cooperative Fishery Research Unit

The Wisconsin Department of Natural Resources plans to implement an AM study to identify effective regulations aimed at improving the mean length of bluegill where size of the fish is considered to be poor. The proposed approach would employ three different regulations for bluegill populations for which the growth of individuals is considered to be moderate to fast but with mean lengths less than the American Fisheries Society standard for quality size. Within this study, the research team plans to collaborate with the Fisheries Analysis Center and the Wisconsin Department of Natural Resources to explore angler effort response to suggested harvest regulations changes.

Pictured below: Bluegill.

Ecological Flows

The assessment and prescription of ecological flows require water resource managers and researchers to access and analyze several different types of data and select appropriate tools and approaches from a wide variety of established methodologies.



Establishing Long-Term, Continuous Monitoring of Flow, Temperature, and Macroinvertebrates at Reference Streams to Quantify Potential Effects of Climate Change on Stream Ecosystems

Massachusetts Cooperative Fish and Wildlife Research Unit

Climate change is altering temperatures and flows in stream ecosystems, which can affect the distribution, diversity, and abundance of biotic communities that are used as a basis for resource management. Recently, the U.S. Environmental Protection Agency (EPA) has been collaborating with east coast States to develop regional reference/climate change monitoring networks that can detect small, progressive changes in stream communities. States in the Northeast (Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont) have begun monitoring macroinvertebrates; however, continuous monitoring of temperature (air and water) and streamflow have been limited thus far. To help facilitate more uniform and effective collection of continuous temperature and stream data, researchers and collaborators have developed a guidance document for sampling stream sites. This document addresses equipment needs, installation, maintenance, stream discharge measurements, data retrieval, and data processing.

Publication

Stamp, Jen, Hamilton, Anna, Craddock, Michelle, Parker, Laila, Roy, A.H., Isaak, D.J., Holden, Zachary, Passmore, Margaret, and Bierwagen, B.G., 2014, Best practices for continuous monitoring of temperature and flow in wadeable streams: Office of Research and Development, National Center for Environmental Assessment, U.S. Environmental Protection Agency, EPA/600/R–13/170F, 129 p., http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=520122.

Assessment of Available Missouri Ecological Flow Data

Missouri Cooperative Fish and Wildlife Research Unit

Ensuring adequate water quantity and quality in stream, riparian, and wetland systems is an important issue worldwide. The information needed to address the variety of ecological flow issues that continue to arise due to climate change, increasing human population, and the associated increased demand for water makes this a complex and long-term issue. This project can link data in Missouri associated with flows and disturbance and develop approaches that allow decision makers to make flow recommendations at a regional level in advance of increasing water demands associated with water supply and energy development projects.

Fish Community Response to Streamflow Alterations in Wadeable Mississippi Streams

Missouri Cooperative Fish and Wildlife Research Unit

The Missouri Department of Conservation has made it a priority to be at the forefront of ecological flow science and to understand how flow alterations affect riverine systems and their biota. The information needed to address the diversity of ecological flow issues that continue to arise due to climate change, increasing human population, and the associated increased demand for water makes streamflow management a complex and long-term issue. A literature review was conducted as part of this project to identify fish species responses

Pictured below: A tranquil section of the Mississippi River just upstream from Cairo, Illinois. Photograph by Kevin Oberg, U.S. Geological Survey.

linked to streamflow alteration metrics. The review identified 76 studies that evaluated fish responses to flow with more than 400 occurrences for both hydrologic and biologic metrics and more than 200 significant biologic responses to varying flow components. This information was incorporated into a framework that can be used by researchers, managers, and policymakers to inform ecological flow decisions.

Linking Habitat Features to Dissolved Oxygen and Streamflow in the Lower Osage River, Missouri

Missouri Cooperative Fish and Wildlife Research Unit

Flow-management decisions concerning rivers throughout the world are increasingly incorporating the physical habitat and water-quality needs of fish and other aquatic life. Streamflow regimes that meet the ecological needs of an entire aquatic community are vital in supporting healthy, sustainable sport fisheries in flow regulated systems. This project intends to link Missouri Department of Conservation fish collections with temperature and dissolved oxygen to determine the tolerances of fishes to these parameters. Ultimately, this work may improve management decisions regarding streamflows in Missouri.

Movement and Habitat Selection of Fishes Under Different Flow Regimes

Missouri Cooperative Fish and Wildlife Research Unit

Flow regime plays a fundamental role in the biology of aquatic species for which life events are often affected by changes in streamflow. This study used radio telemetry to track the daily movement and habitat selection of spotted bass and shorthead redhorse during variable streamflows to provide a better understanding of how streamflow alteration in regulated rivers affects these fish. The results should identify the effects of regulated flows on fish movement and habitat use in regulated rivers so information on flow modifications that benefit native fish can be provided to decision makers.

A researcher exchanges a datasonde at a dissolved-oxygen monitoring site on the Lower Osage River.

Assessing Flow Ecology Hypotheses With an Emphasis on the Arbuckle Mountains

Oklahoma Cooperative Fish and Wildlife Research Unit

Most developed hypotheses relating streamflow to the well-being of fishes have focused simply on changes in the number of species or other count metrics rather than the fitness consequences related to fishes. In particular, we have a limited understanding of the temperature tolerances of stream fishes and how groundwater-surface water interactions via hyporheic flow mediate stream temperatures at multiple spatial scales. The goal of this study is to develop and test flow-ecology hypotheses that include alterations to the fitness of stream fish populations. Results from this project are to be integrated into the Oklahoma water-management plan to support environmental flow decisions. In addition, results can contribute to a small body of literature on temperature effects on the fitness of nongame fish.

Researchers conducting electrofishing in the Elk River.

Evaluating Changes in Fish Assemblages of the Red River Via Flow Alteration

Oklahoma Cooperative Fish and Wildlife Research Unit

The seemingly simple question of how much water should be left in an altered aquatic system is often difficult to address because of a lack of spatial and temporal coverage of flow data and an understanding of how altered flow actually affects the ecological integrity of river systems. Environmental flows represent a mechanism that is used to balance honoring existing water uses, meeting the needs of future uses, and maintaining aquatic ecosystems and other nonuse values. Conceptual advancements are essential to promoting trait-based research in stream ecology; however, the successful application of species traits is also expected to require the use of nontraditional statistical methods that can identify trends in large, complex datasets.

Predicting the Effects of Incremental Decreases in Minimum Flows on Endangered Mussels

Tennessee Cooperative Fishery Research Unit

Despite improved habitat conditions, increased abundance and distribution, and ongoing reintroduction efforts, the mussel fauna of the Duck River in Tennessee is faced with an impending threat: a conflict over water. Urban and industrial growth in the watershed is placing ever greater demands for offstream use of water. Currently, there is no protocol for determining instream flow requirements of freshwater mussels. This research plans to incorporate both laboratory and field measurements and experimental manipulation of mussel distributions and hydraulic modeling. The data can allow resource agencies to predict possible effects of any proposed flow reduction and prescribe water allocations for endangered mussels on the basis of scientifically defensible data.

Endangered freshwater mussels. Photograph by U.S. Fish and Wildlife Service.

Pictured below: Duck River, Tennessee. Photograph by Michael Woodside, U.S. Geological Survey.

Guadalupe Bass Flow-Ecology Relations and the Impact of Flow on Recruitment

Texas Cooperative Fish and Wildlife Research Unit

The Guadalupe bass is considered to be vulnerable because of its dependence on intact stream habitats, yet the flow requirements for the species, or even how flow influences its growth, recruitment, or mortality, are not well understood. Flow regime is among the most important environmental factors influencing population dynamics for stream fishes; however, without a thorough understanding of these relations, it is difficult to develop recommendations for instream flows to benefit species of conservation concern, such as Guadalupe bass. The research team plans to evaluate the influence of flow regime and monitor the impact of changing flow regime on the growth and mortality of young-of-year through the first summer. These data can be used to reconstruct the year classes and to estimate recruitment and mean growth rates related to flow conditions.

The Guadalupe bass is considered to be vulnerable because of its dependence on intact stream habitats.

Burbot Migration and Movement: The Impact of a Managed Flow Regime

Wyoming Cooperative Fish and Wildlife Research Unit

The effects of flow-management practices on burbot populations are unknown. The research team plans to examine the relation between seasonal out-migration patterns of burbot and the associated flow and temperature regimes. In addition, researchers intend to determine the age and size structure of burbot migrants. This information can be used to develop flow regime scenarios that can be used to balance water needs with flows that are favorable to the burbot population.

Ecosystem Services

Ecosystem services are attributes and outputs of ecosystems that create value for humans. An ecosystem service is any positive benefit provided to society by fish, wildlife, or components of ecosystems through their functions.

Assessment of Pollinator Diversity and Abundance on National Wildlife Refuges and Other Private and Public Lands in the Lower Mississippi Alluvial Valley of Arkansas

Arkansas Cooperative Fish and Wildlife Research Unit

Despite the effectiveness of the honey bee as a pollinator for many crops, the risks associated with reliance on a single managed pollinator species have become evident over the past 24 years as North American honey bee populations have declined. In 2014, the President established a Pollinator Health Task Force to create an action plan that would focus Federal efforts on understanding, preventing, and recovering losses from pollinator species. This project supports the Pollinator Health Task Force initiatives of monitoring and documenting pollinator diversity and abundance at local and regional scales. The findings can also help public/private landowners make better decisions about pollinator habitat management. The Natural Resources Conservation Service (NRCS) has recently added a new program to incentivize landowners to plant a mix of pollinator friendly plants to create a suitable habitat for pollinators.

Honey bees play a major role in pollinating the world's plants.

Pollinator Communities on Native and Managed Emergent Wetlands in the Lower Mississippi Alluvial Valley of Arkansas

Arkansas Cooperative Fish and Wildlife Research Unit

Recent declines in insect pollinators in the United States have caused land managers to consider altering land management to bolster pollinator community diversity and abundance. One community of insect pollinators that remains virtually unstudied is those in wetlands. Researchers plan to survey wetland pollinator communities to document species richness and diversity in native and managed emergent wetlands in eastern Arkansas and assess whether those pollinators travel to adjacent croplands to pollinate. The goal of this research is to inform decisions regarding the Farm Bill.

Engaging Maine Blueberry Growers to Develop Tools for Native Bee Use and Conservation

Maine Cooperative Fish and Wildlife Research Unit

Pollinator loss is a significant, global problem for crop and wild plants that rely on animal pollination. Although many growers continue to rely heavily on honey bee pollination, there is growing interest in reliance on pollination by native bees; however, there is uncertainty about how this change in pollinator reliance may affect crop yield. This research addresses the need of Maine lowbush blueberry growers for tools that may help them use and conserve native bees. The project is developing a spatial "pollination toolkit" for growers to use to assess the quality of bee habitat in their crop landscape and identify optimum locations for planting bee pastures.

Pollination Security for Fruit and Vegetable Crops in the Northeast

Maine Cooperative Fish and Wildlife Research Unit

Pollinator-dependent crops require a readily available source of pollinators to ensure sustainability. Native bee pollinators potentially contribute to this sustainability; however, knowledge about factors that affect their abundance and distribution is lacking. A team of scientists is examining a variety of factors that potentially affect native bee pollinators of blueberries with a focus on understanding relations between native pollinators of wild blueberries and the landscape composition and arrangement around wild blueberry fields. Study results can provide Maine blueberry growers the tools necessary for native bee conservation.

Graduate student setting bowl traps. Fieldwork to collect information about the bees found in powerline rights-of-way and the various land-cover classes involves conducting surveys of bees along transects.

Publication

Groff, S.C., Loftin, C.S., Drummond, Frank, Bushmann, Sara, and McGill, Brian, 2016, Parameterization of the InVEST Crop Pollination Model to spatially predict abundance of wild blueberry (*Vaccinium angustifolium* Aiton) native bee pollinators in Maine, U.S.A.: Environmental Modeling & Software, v. 79, p. 1–9, https://doi.org/10.1016/j.envsoft.2016.01.003.

Mapping Biodiversity Metrics

New Mexico Cooperative Fish and Wildlife Research Unit

Ecosystem services, that is, "services provided to humans from natural systems," have become key issues in resource management, conservation, human well-being, and environmental decision analysis. Mapping and quantifying ecosystem services have become strategic national interests for integrating ecology with economics to help explain the effects of human policies and the subsequent impacts on both ecosystem function and human welfare. This project is using USGS National GAP data including land cover, land stewardship, and habitat models for terrestrial species to map metrics reflecting ecosystem services or biodiversity aspects valued by humans over large areas. The project is being conducted at multiple scales in a phased approach—place-based watersheds (San Pedro, Tampa Bay, Albemarle-Pamlico estuary) to multistate regional areas (Southwest and Southeast)—that should eventually culminate in a national-level sustainable atlas of ecosystem services developed by the EPA for the conterminous United States.

The National Gap Analysis Program (GAP) land-cover viewer allows online inspection of detailed data and access to downloads.

Publications

Boykin, K.G., Kepner, W.G., Bradford, D.F., Guy, R.K., Kopp, D.A., Leimer, A.K., Samson, E.A., East, N.F., Neale, A.C., and Gergely, K.J., 2013, A national approach for mapping and quantifying habitat-based biodiversity metrics across multiple spatial scales: Ecological Indicators, v. 33, p. 139–147, https://doi.org/10.1016/j.ecolind.2012.11.005.

Samson, E.A., Kepner, W.G., Boykin, K.G., Bradford, D.F., Bierwagen, B.G., Leimer, A.K., and Guy, R.K., 2011, Evaluating biodiversity response to forecasted land-use change—A case study in the South Platte River, Colorado, *in* Medley, C.N., Patterson, Glen, and Parker, M.J., eds., Proceedings of the Fourth Interagency Conference on research in the watersheds—Observing, studying, and managing for change: U.S. Geological Survey Scientific Investigations Report 2011–5169, p. 56–62, https://pubs.usgs.gov/sir/2011/5169/.

Incorporating an Approach to Aid River and Reservoir Fisheries in an Altered Landscape

Oklahoma Cooperative Fish and Wildlife Research Unit

Fish production is an important ecosystem service that may be affected by flow alteration. Oklahomans spend more than 8 million angler days per year fishing, many as a means for sustenance. Researchers plan to characterize hydrology/fish-production relations for different ecological groups of fishes living in river and reservoir habitats. Many important fish species have not been well studied in this regard, and existing data suggest that different groups of fishes respond differently to changes in hydrology, suggesting additional study is needed to cover all major ecological groups of fishes.

One of the important water needs that may be affected by flow alteration is the ecosystem service of fish production.

Most of the research at the South Dakota Cooperative Fish and Wildlife Research Unit focuses on fish and wildlife ecology in the prairie pothole region of the upper Midwest, with an emphasis on ecosystem management in agricultural settings. Pictured below: Prairie pothole region photograph by Ducks Unlimited, Inc. Used with permission.

Understanding the Impacts of Surface-Groundwater Conditions on Stream Fishes Under Altered Base-Flow Conditions

Oklahoma Cooperative Fish and Wildlife Research Unit

Balancing human water resource needs and fish and wildlife needs is critical to environmental sustainability. Water managers must take into account a variety of factors in addition to flow volume (for example, water temperature) when making decisions to maximize human water use while simultaneously preserving fish habitats and populations. The purpose of this project is to demonstrate the interaction between water temperature and fish fitness through interactions of surface water and groundwater. Understanding the nexus of these relations can allow future water allocations or managed releases to benefit economic activities while protecting biological diversity.

Evaluation of the James River Conservation Reserve Enhancement Program

South Dakota Cooperative Fish and Wildlife Research Unit

The Conservation Reserve Enhancement Program (CREP) is a valuable tool for wetland conservation, focusing on the enrollment of wetland acreage in regions of priority as determined by individual States. In South Dakota, a CREP project was proposed and approved for the James River watershed; however, few such programs ever receive well-designed and implemented evaluations that allow for quantification of project impact and benefits to environmental parameters and constituents. This project intends to evaluate the potential benefits of the James River CREP program to environmental quality and flora and fauna of South Dakota. The findings from this program can allow managers to understand the relative costs of program delivery with respect to benefits of the effort and also aid in the design of new programs.

Assessment and Monitoring at Texas Parks and Wildlife Department Public River Access Leases to Guide Sustainable Management

Texas Cooperative Fish and Wildlife Research Unit

Healthy, naturally functioning rivers provide clean drinking water, flood abatement, habitats for fish and wildlife, and recreational opportunities such as paddling and fishing, and support numerous other societal and economic benefits. Texas has more than 191,000 miles of rivers and streams, and although the majority of Texans live within a mile of a river or stream, many may not realize the central role these treasured landscapes play in the quality of life for their communities. In order to support sustainable, science-based management of streamside lands and aquatic and fishery resources, monitoring of riparian and instream habitats, biological resources, and public use at existing and planned river access areas are expected to be completed. Decision makers can use the project data to assess impacts and support management (for example, habitat management, special angling harvest regulations).

Interactions of Geoduck Clam Aquaculture Operations With Intertidal Ecosystems in Southern Puget Sound, Washington

Washington Cooperative Fish and Wildlife Research Unit

The geoduck aquaculture industry is rapidly expanding in southern Puget Sound, bringing significant economic benefits but arousing intensive environmental impact concerns among local communities and active responses by State legislative and management authorities. This project assesses the ecological effects of physical disturbances associated with cultured intertidal tracts of geoduck clams in habitats of southern Puget Sound, Washington State. Results from this project serve the interests of managers, legislators, scientists, and NGOs in understanding the effects of marine benthic invertebrate fisheries and aquaculture activities on the world's intertidal sedimentary environments.

Publications

McDonald, P.S., Galloway, A.W.E., McPeek, K.C., and VanBlaricom, G.R., 2015, Effects of geoduck (*Panopea generosa* Gould, 1850) aquaculture gear on resident and transient macrofauna communities of Puget Sound, Washington: Journal of Shellfish Research, v. 34, no. 1, p. 189–202, https://doi.org/10.2983/035.034.0122.

McPeek, K.C., McDonald, P.S., and VanBlaricom, G.R., 2015, Aquaculture disturbance impacts the diet but not ecological linkages of a ubiquitous predatory fish: Estuaries and Coasts, v. 38, no. 5, p. 1520–1534, https://doi.org/10.1007/s12237-014-9909-z.

VanBlaricom, G.R., Eccles, J.L., Olden, J.D., and McDonald, P.S., 2015, Ecological effects of the harvest phase of geoduck (*Panopea generosa* Gould, 1850) aquaculture on infaunal communities in southern Puget Sound, Washington: Journal of Shellfish Research, v. 34, no. 1, p. 171–187, https://doi.org/10.2983/035.034.0121.

Pictured below: A view of the Guadalupe River, looking upstream toward the main river access point in the Guadalupe River State Park, Texas. Photograph by Robert R. Morris, U.S. Geological Survey Volunteer for Science.

Endangered Species Conservation, Recovery, and Proactive Strategies

The Montana Cooperative Fishery Research Unit is leading research on the endangered pallid sturgeon (listed as endangered in 1990 under the Endangered Species Act). The pallid sturgeon is an ancient species that has lived since the days of the dinosaurs.

Population Viability and Reclassification Criteria of the Listed Population of Steller's Eider in Alaska

Alabama Cooperative Fish and Wildlife Research Unit

The Alaska-breeding population of Steller's eider was classified as threatened under the ESA in 1997 based on a substantial decrease in the species' nesting range in Alaska. The reduction in the number of Steller's eiders nesting in Alaska increased the vulnerability of the population. Following listing, a recovery plan was developed that specifies population criteria for reclassification from threatened to endangered and threatened to delisted. This study intends to use recently collected data to estimate extinction probabilities and determine the likelihood of misclassifying the population status based on recent surveys and build upon previous modeling efforts.

Steller's eiders.

Southwestern Species Status Assessment for Candidate Species Under the Endangered Species Act

Alabama Cooperative Fish and Wildlife Research Unit

The primary focus of the species status assessment (SSA) is to base ESA decisions on species viability assessment. The SSA is a new analytical framework being implemented by the DOI for informing decisions and management activities nationwide under the ESA. A core component of the emerging paradigm for endangered SSA is population viability modeling. The SSA framework is emerging as the biological foundation for all ESA listing determinations and is being implemented to aid the preparation of several recovery plans. Development of the SSA is a critical part of ESA decision making as the predictive step within the decision process. The research team plans to develop tools and a framework for assessing species status to inform or support endangered species, including the Sonoran desert tortoise and the headwater or roundtail chub.

Spectacled Eider Listing Status

Alabama Cooperative Fish and Wildlife Research Unit

Spectacled eider populations worldwide were listed as threatened in 1993 under the ESA. The spectacled eider recovery team recognized three distinct subpopulations located in Siberia, the Arctic Coastal Plain (ACP) of Alaska, and the Yukon-Kuskokwim Delta (YKD), Alaska, in the recovery plan. The objectives of this project are to estimate the likelihood that spectacled eiders on the YKD and ACP have met the minimum thresholds for population size, use the updated estimates of population size to determine the relative value of their listing, and explore the effects of uncertainty in population size trend on the Bayesian decision analysis.

Spectacled eider hen.

Development of Prairie Creek Juvenile Salmonid (Smolt) Abundance Project

California Cooperative Fish and Wildlife Research Unit

The Prairie Creek subbasin of Redwood Creek drains an old-growth redwood forest and supports self-sustaining populations of coho salmon, Chinook salmon, steelhead trout, and cutthroat trout. These salmonids, with the exception of cutthroat trout, are listed as threatened under the ESA; therefore, understanding the relative contributions of different stream segments to the overall reproduction of the species in the watershed is critical. Researchers determined that Prairie Creek is a stronghold for coho salmon production within the Redwood Creek Basin and that it produced more coho salmon than Redwood Creek and the other tributaries to Redwood Creek combined. Consequently, the Prairie Creek subbasin is recognized as being critically important for recovery of coho salmon, Chinook salmon, and steelhead trout within Redwood Creek, and continued monitoring can maintain high habitat quality for smolt production.

Rangewide Giant Kangaroo Rat Surveys and Monitoring Optimization

California Cooperative Fish and Wildlife Research Unit

The status of the State and federally endangered giant kangaroo rat is unknown in many parts of its range. Due to the ongoing drought and concerns over long-term permanent changes in climate within giant kangaroo rat habitat, the need to understand population dynamics within all colonies across their range is critical. The goal of this project is to determine the current range and status of the giant kangaroo rat. Acquiring baseline range data are necessary for long-term management and recovery of the species as well as assessing the potential impacts of development projects.

Redwood Creek Life Cycle Monitoring

California Cooperative Fish and Wildlife Research Unit

Steelhead and coho salmon numbers remain below ESA targets for recovered populations. This project plans to use a dual-frequency identification sonar (DIDSON) imaging system to estimate the number of adult steelhead migrating into and out of Redwood Creek. Adult counts from the DIDSON have shown recent strong returns of Chinook salmon to Redwood Creek; counts are close to delisting targets set by the National Marine Fisheries Service (NMFS). Previous research has demonstrated that images captured by DIDSON can be used effectively to enumerate migrating salmonids over a wide range of conditions.

Setting up a dual-frequency identification sonar (DIDSON) system for deployment in the Roanoke River.

Pictured below: Giant kangaroo rat. Photograph by U.S. Fish and Wildlife Service.

Salmon in the Redwood Creek Basin

California Cooperative Fish and Wildlife Research Unit

The Redwood Creek population of coho salmon was listed as threatened under the ESA in 1997 and the California ESA in 2004. To address the ESA listing requirements, the NMFS classified coho populations into reproductively isolated, evolutionarily important groups called Evolutionarily Significant Units (ESUs). Redwood Creek coho salmon were included within the southern Oregon/northern California ESU. For functionally independent, core populations, NMFS recommends performing juvenile distribution surveys during the initial phase of recovery-based monitoring. The study can provide information about the spatial distribution and relative abundance of juvenile coho salmon in the Redwood Creek Basin by conducting snorkel surveys in sections of the stream selected according to a spatially balanced, randomized sampling design.

Upper and Lower Redwood Creek Juvenile Salmon (Smolt) Abundance Project

California Cooperative Fish and Wildlife Research Unit

Redwood Creek supports self-sustaining populations of coho salmon, Chinook salmon, steelhead trout, and other native fishes. These salmonids are listed as threatened under the ESA and are recognized as being important for recovering populations throughout northern California. This study intends to track smolt abundances over time and space, estimate abundance structure, collect data on life history attributes, collect genetic samples of smolts, and play a key role in the life cycle monitoring station by determining smolt abundances in conjunction with operation of the DIDSON, which counts adults entering lower Redwood Creek. This information can be used to identify priority habitats that play an important role in recovering salmon stocks in California.

Chinook salmon. Photograph by U.S. Fish and Wildlife Service.

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

Colorado Cooperative Fish and Wildlife Research Unit

The black-footed and Laysan albatross are long-lived seabirds of conservation concern to the USFWS. Specifically, a petition to list the black-footed albatross under the ESA has recently been submitted to the USFWS. Furthermore, more than 65 percent of the world population of these albatross species nest on remote island refuges in the Pacific. Although Southern Hemisphere albatross species are well-studied through intensive research projects conducted by multiple countries, relatively little is known about the life history, survival, breeding frequency, and reproductive success of Northern Hemisphere albatross species. This study is investigating vital rates for these species, which is important given the variety of threats that these species face (fishery bycatch, plastics ingestions, contaminants, loss of breeding habitat due to sea level rise).

Banded black-footed albatross.

Fish Population Models for the Little Colorado River From Integrated Data Sources

Colorado Cooperative Fish and Wildlife Research Unit

Understanding how animal populations are responding to environmental change often requires monitoring at broad spatial scales and in remote locations. The project intends to focus on applying models to endangered native fish in the Grand Canyon reach of the Colorado River, especially humpback chub, but potentially including bluehead suckers and flannelmouth suckers. Insights gained from the modeling can help inform ongoing AM experimentation in Glen and Grand Canyons.

Movement and Space Use of Pinnipeds in Dynamic Marine Environments of Alaska

Colorado Cooperative Fish and Wildlife Research Unit

Poor fecundity is a central feature of hypotheses underlying Steller sea lion population declines in the western and central Aleutian Islands. Determination of a species spatial habitat use and preferences is a critical component for ecological understanding and hence conservation management decisions. Pinnipeds (seals and sea lions) provide an ideal study platform for understanding a changing marine environment. Various pinniped species use and interact with their environment in different ways and, by developing a common analysis framework and combining datasets, these species can provide powerful insight. Researchers intend to develop a methodology that uses the existing sources of telemetry and spatially explicit habitat data to better understand resource selection for these marine mammals. The results are anticipated to provide important information for making efficient management decisions for recovery of threatened and endangered species.

Effects of Coastal Dynamics and Climate on Loggerhead Turtle Nest Success and Management

Florida Cooperative Fish and Wildlife Research Unit

Situated in the Central Atlantic Bight, the coastline of Georgia undergoes strong tidal fluctuations daily, creating a unique and diverse beach habitat on which loggerhead sea turtles commonly nest. Relocation of these nests is necessary in many areas that suffer from high tidal fluctuations and risk of inundation. The purpose of this project is to develop a better understanding of the effectiveness of relocation techniques as a response to uniquely high tides and seasonal rainfall events experienced on the Georgia barrier islands. Findings from this project can assist in creating a baseline for rainfall effects on loggerhead nesting and relocation management techniques on the population of nesting loggerhead sea turtles in Georgia. This study should also provide an understanding of how differing sand density contributes to tidal washovers and rainfall inundation.

The loggerhead sea turtle is protected under the Endangered Species Act.

Accelerating Conservation of At-Risk Species in the Longleaf System

Georgia Cooperative Fish and Wildlife Research Unit

The USFWS Southeast Region is working actively with State wildlife agencies and other partners, through the Southeastern Association of Fish and Wildlife Agencies, to assess the status of more than 300 species awaiting reviews for listing decision and to implement conservation for these species on public and private lands. The longleaf pine ecological system supports a number of priority at-risk species, including the gopher tortoise, striped newt, gopher frog, southern hognose snake, and Florida pine snake. Major science needs are to analyze and integrate new information from status surveys for this group of species and identify those conservation actions to improve the status of these species. The research can deliver population information on these species to facilitate a future formal decision analysis in which tradeoffs in alternative conservation actions may be explored.

Striped newt. Photograph by U.S. Fish and Wildlife Service.

Demographic Estimation and Conservation Modeling for the Loggerhead Sea Turtle

Georgia Cooperative Fish and Wildlife Research Unit

Successful recovery of the threatened loggerhead sea turtle is expected to hinge on decisions about where to invest limited resources into conservation actions, and these decisions can be informed by predictions of population response to each action. This study focuses on the development of decision or scenario planning models for the northern recovery unit of the turtle. The main purpose of the model is to help State agency resource managers in the northern recovery unit discern the relative efficacy of actions under their control, assess the relative contributions of stressors so that broad scope conservation strategies may be devised, and identify key uncertainties in sea turtle demography to which targeted information gathering would yield more effective conservation delivery.

Integrating Metapopulation Ecology and Landscape Ecology for Improved Population Viability Analysis and Conservation Decision Making

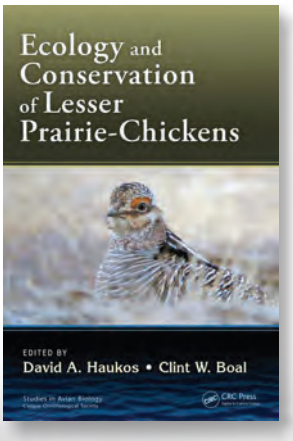
Georgia Cooperative Fish and Wildlife Research Unit

Human activities often increase habitat fragmentation, thereby reducing dispersal, gene flow, and ultimately population viability. In such increasingly common situations, effective management relies on understanding factors affecting population dynamics so that managers can make informed decisions aimed at mitigating fragmentation effects. This study includes SDM and population viability analysis related to recovery planning for the federally threatened Chiricahua leopard frog in southern Arizona. The research can provide tools to enhance conservation efforts for a wide range of species metapopulations.

Landscape Level Population Modeling as a Decision-Support Tool for the Lesser Prairie-Chicken

Georgia Cooperative Fish and Wildlife Research Unit

Spatially explicit population models are being used to characterize the viability of the lesser prairie-chicken under various future conservation scenarios. This modeling effort can be used to predict future conditions for the species following the USFWS SSA framework to support future decisions under the ESA related to drafting recovery criteria, proposing designation of critical habitat, and implementing a range of conservation efforts.



Pictured below: Lesser prairie-chicken. Photograph by U.S. Fish and Wildlife Service.

Diet, Population Connectivity, and Adaptive Differences Among Populations of Northern Idaho Ground Squirrels

Idaho Cooperative Fish and Wildlife Research Unit

Northern Idaho ground squirrels were listed as threatened under the Federal ESA in 2000. Northern Idaho ground squirrels are restricted to meadows and small rocky outcroppings within coniferous forests of central Idaho, and they persist within only a small fraction of their former range. The research team plans to use cutting-edge genomic methods to provide information on diet, population connectivity, adaptive differences, and conservation priority.

Effectiveness of Forest Restoration Treatments on Demography of a Federally Listed Ground Squirrel

Idaho Cooperative Fish and Wildlife Research Unit

Fire suppression over the past century has caused widespread changes to the structure and function of coniferous forests in the Western United States. This study intends to investigate demographic traits of the federally listed northern Idaho ground squirrel and evaluate the effectiveness of different forest restoration options at restoring their habitat and increasing population size. The study addresses a primary research need identified in the species recovery plan and can help restore forests to provide essential habitat for this rare species.

Long-Term Monitoring Protocol for Greater Sage-Grouse Within National Parks

Idaho Cooperative Fish and Wildlife Research Unit

Greater sage-grouse are an iconic western species of national concern. The focus on and importance of this species require that data used for management actions be based on

Greater sage-grouse.

robust, science-based monitoring protocols that are transferable across the species range. For this project, researchers plan to develop a comprehensive, long-term monitoring protocol for detecting and monitoring the status and trends of greater sage-grouse in two National Parks—City of Rocks National Reserve and Craters of the Moon National Monument and Preserve. The robust protocol can be transferable to anywhere within the species range and thus facilitate the collection of standardized data across a large geography.

Stream Fish and Habitat Monitoring in the Boone River Watershed in Iowa

Iowa Cooperative Fish and Wildlife Research Unit

Fish assemblages and habitat conditions in two streams in the Boone River watershed—White Fox Creek and Eagle Creek—are part of a monitoring plan that intends to evaluate their potential as population sources for Topeka shiner and conduits for associated oxbow habitats. Eagle Creek and associated natural oxbows support the only known remnants of the Topeka shiner in the Boone River watershed. Topeka shiners are presumed extirpated from the White Fox Creek subwatershed, but five oxbows have been restored to support Topeka shiners and three of these oxbows have subsurface tile inflow for maintenance of water supply and nitrate sequestration. The success of restored oxbows for Topeka shiners is dependent on the existence of populations in associated streams with suitable habitat. The monitoring and assessment results can help guide present and future oxbow restorations and inform potential future reintroduction of the Topeka shiner to the Boone River watershed.

Identification of Conservation Actions Needed to Preserve Lesser Prairie-Chicken Populations in the Context of Land-Management Practices and Environmental Variation

Kansas Cooperative Fish and Wildlife Research Unit

The lesser prairie-chicken inhabits a unique landscape primarily in the High Plains of the southern and central Great Plains. Additional information on lesser prairie-chicken populations is needed to assist with conservation planning, assessment of species status, measuring responses to management strategies, and restoration techniques. This study, which involves a retrospective analysis of data from two previous 10-year projects, is part of a suite of projects on the lesser prairie-chicken. Ultimately, this and related projects can provide critical information needed for the restoration and management of this iconic species.

Lesser Prairie-Chicken Response to U.S. Department of Agriculture Conservation Practices in Kansas and Colorado

Kansas Cooperative Fish and Wildlife Research Unit

Significant numbers of lesser prairie-chicken in Kansas and Colorado are associated with former croplands as part of U.S. Department of Agriculture (USDA) conservation programs/practices, principally the Conservation Reserve Program (CRP) and Environmental Quality Incentive Program. The overall population response of lesser prairie-chicken to conservation programs needs to be assessed regarding demography of the population to model future population trends. Additionally, more information is needed on the response of lesser prairie-chicken to climate change. This study was designed to quantify the relative importance of the CRP and climate change on lesser prairie-chicken abundance and demographic parameters. Study results can provide a better understanding of the interaction between land use and climate change on population demographics, which is important for future management.

Multiscale Examination of the Distribution and Habitat Use Patterns of the Regal Fritillary Within the Fort Riley Military Reservation, Kansas

Kansas Cooperative Fish and Wildlife Research Unit

The regal fritillary was once an abundant butterfly species of the prairie biome; however, populations have declined by approximately 99 percent in the prairie region, and the species is nearly extirpated in the eastern portion of its former range largely due to habitat loss, habitat fragmentation, and the subsequent breakdown of metapopulation dynamics. The overall objective of this research is to assess the effects of habitat features and management practices on the distribution and density of regal fritillary and their larval host plants. The results can assist land managers in all aspects of conservation.

Pictured below: Regal fritillary. Photograph by Pennsylvania Army National Guard.

Response of Lesser Prairie-Chickens to Patch Burn Grazing in the Red Hills, Kansas

Kansas Cooperative Fish and Wildlife Research Unit

Lesser prairie-chickens primarily inhabit the high plains of the southern Great Plains. Population numbers and range have declined more than 80 percent since European settlement due to habitat loss and degradation. The purpose of this project is to determine the response of the lesser prairie-chicken to patch burn grazing in the Red Hills, Kansas. Researchers plan to incorporate fire to measure the relations between grazing pressure and lesser prairie-chicken use of landscapes. Information from this study can inform managers of the relative value of patch burn grazing as a management tool.

Use of Grazing Management and Prescribed Fire for Conservation of Lesser Prairie-Chickens

Kansas Cooperative Fish and Wildlife Research Unit

Prescribed fire and grazing are often used as management tools in grassland ecosystems. The purpose of this study is to assess aspects of livestock grazing and prescribed fire as management tools in Kansas by quantifying vegetation structure, vegetation composition, and lesser prairie-chicken population response to grazing management and use of fire. This effort is a multiyear assessment that can produce findings needed to improve implementation of the NRCS lesser prairie-chicken initiative.

Reintroduction of Whooping Cranes to Louisiana

Louisiana Cooperative Fish and Wildlife Research Unit

The whooping crane is North America's tallest bird and is arguably one of its most charismatic species. Due to overhunting and agricultural development, whooping crane numbers declined dramatically to only 21 birds in 1954, and the species was classified as endangered under the ESA in 1973. As part of the USFWS International Whooping Crane Recovery Plan, efforts are underway to establish a migratory population that breeds in Wisconsin and winters in Florida. The objectives of this study are to determine habitat use, survival, and behavior of released whooping cranes, refine release methods to enhance project success, and assist land managers in the reintroduction program.

A whooping crane flying over the Louisiana marsh. Photograph courtesy of Gopi Sundar, International Crane Foundation.

Assessing the Influence of Stocking Location and Salinity Acclimation in the Penobscot River on Smolt-to-Adult Return

Maine Cooperative Fish and Wildlife Research Unit

Hatchery supplementation has been a critical component of Atlantic salmon restoration and has likely prevented extinction of the species in rivers in Maine. The majority of adult salmon returning to the Penobscot River are of smolt-stocked origin. The smolt-to-adult return rate, however, has declined steadily over the past 30 years. This research considers stocking manipulations that probe the roles of salinity acclimation and bypassing in river mortality. Results of this project are relevant to an assessment of stocking manipulations.

Passage of Adult Atlantic Salmon in the Penobscot River Before and After Dam Removal

Maine Cooperative Fish and Wildlife Research Unit

Construction of dams often blocks migrations of fish and fragments spawning and juvenile rearing habitats resulting in changes to the structure of fish assemblages throughout the river. The research team plans to use acoustic telemetry, radio telemetry, and PIT tag technology to characterize migration patterns and passage efficiency of adult Atlantic salmon in the Penobscot River in Maine before and after dam removal. Results of this study can inform future decisions regarding dam removal on large rivers.

Atlantic salmon tagging.

Publications

Gorsky, Dimitry, Trial, Joan, Zydlewski, Joseph, and McCleave, James, 2009, The effects of smolt stocking strategies on migratory path selection of adult Atlantic salmon in the Penobscot River, Maine: North American Journal of Fisheries Management, v. 29, p. 949–957, https://doi.org/10.1577/M08-068.1.

Holbrook, C.M., Zydlewski, Joseph, Gorsky, Dimitry, Shephard, S.L., and Kinnison M.T., 2008, Movements of prespawn adult Atlantic salmon near hydroelectric dams in the lower Penobscot River, Maine: North American Journal of Fisheries Management, v. 29, no. 2, p. 495–505, https://doi.org/10.1577/M08-042.1.

Sigourney, D.B., Zydlewski, J.D., Hughes, Edward, and Cox, Oliver, 2015, Transport, dam passage and size selection of adult Atlantic salmon in the Penobscot River, Maine: North American Journal of Fisheries Management, v. 35, no. 6, p. 1164–1176, https://doi.org/10.1080/02755947.2015.1099578.

Regional Effects of Acid and Aluminum Exposure on Atlantic Salmon Juvenile Development

Maine Cooperative Fish and Wildlife Research Unit

The endangered Atlantic salmon has gone through significant population declines throughout its range in North America. Although harvest and habitat destruction have been implicated as major contributors to these declines, various other threats also exist. The project team plans to evaluate the impact of acid and aluminum exposure to determine the role of acid rain in Atlantic salmon declines. Results from this study can provide a clearer picture of all threats to salmon populations and aid in the restoration and management of the species.

Atlantic salmon being tested for aluminum exposure.

Salinity Tolerance and the Physiology of Seawater Entry in Downstream Migrating Atlantic Salmon Smolts

Maine Cooperative Fish and Wildlife Research Unit

The transition from freshwater to seawater for anadromous fish is a critical developmental stage called “smolting.” The seawater competence of Atlantic salmon smolts is associated with changes in physiology, migratory behavior, and salinity preference, but this fundamental association is poorly understood. This project measured performance in a “forced swimming” situation to assess the link between biochemical measures and performance. This work is essential to understanding patterns of movement through the estuary for fish that have been delayed or injured at dams.

Publications

Spencer, R.C., Zydlewski, Joseph, and Zydlewski, Gayle, 2010, Migratory urge and gill Na+, K+ -ATPase activity of hatchery Atlantic salmon smolts from the Dennys and Penobscot River stocks, Maine: Transactions of the American Fisheries Society, v. 139, p. 947–956, https://doi.org/10.1577/T09-063.1.

Zydlewski, G.B., and Zydlewski, Joseph, 2012, Gill Na+, K+-ATPase of Atlantic salmon smolts in freshwater is not a predictor of long-term growth in seawater: Aquaculture, v. 362–363, p. 121–126, https://doi.org/10.1016/j.aquaculture.2011.03.024.

Zydlewski, Joseph, Zydlewski, Gayle, and Danner, G.R., 2009, Descaling injury impairs the osmoregulatory ability of Atlantic salmon smolts entering seawater: Transactions of the American Fisheries Society, v. 139, no. 1, p. 129–136, https://doi.org/10.1577/T09-054.1.

Sea Lamprey Biology and Interaction with Atlantic Salmon in Maine Rivers

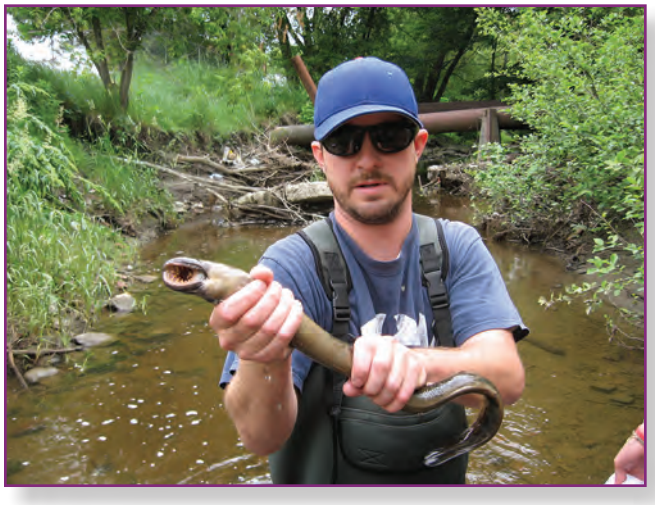
Maine Cooperative Fish and Wildlife Research Unit

Sea lamprey are one of the most abundant anadromous fishes returning to the Penobscot River following barrier removal. The influence of sea lamprey on Atlantic salmon habitat (through nest building) and productivity (through deposition of carcasses) is being assessed. This work is expected to provide additional information on sea lamprey biology and how this species and its ecology influence Atlantic salmon in Maine rivers. This information can be used by fisheries managers to improve restoration efforts for salmon and other species.

Publications

Gardner, C., Coghlan, S.M., Zydlewski, J., and Saunders, R., 2011, Distribution and abundance of stream fishes in relation to barriers—Implications for monitoring stream recovery after barrier removal: River Research and Applications, v. 29, no. 1, p. 65–78, https://doi.org/10.1002/rra.1572.

Gardner, Cory, Coghlan, Stephen, and Zydlewski, Joseph, 2012, Distribution and abundance of anadromous sea lamprey spawners in a fragmented stream—Current status and potential range expansion following barrier removal: Northeastern Naturalist, v. 19, no. 1, p. 99–110, https://doi.org/10.1656/045.019.0108.



Sea lamprey are one of the most abundant anadromous fishes returning to the Penobscot River following barrier removal.

Understanding Downstream Migratory Survival of Atlantic Salmon Smolts in the Penobscot River, Maine: Effects of Dams and Restoration

Maine Cooperative Fish and Wildlife Research Unit

Juvenile anadromous fish can face substantial natural and anthropogenic challenges while en route to marine environments. Understanding the effects of dams and related structures on this migration is essential to managers that wish to maintain or restore anadromous salmonid populations. Survival of endangered Atlantic salmon smolts is being estimated using acoustic telemetry in the Penobscot River. Results from this study can be used to characterize and quantify conditions prior to dam removal and may be used to evaluate passage improvements or costs associated with the Penobscot River Restoration Project.

Atlantic salmon smolt being fitted with a transmitter.

Publication

Holbrook, C.M., Kinnison, M.T., and Zydlewski, Joseph, 2011, Survival of migrating Atlantic salmon smolts through the Penobscot River, Maine, U.S.A.—A pre-restoration assessment: Transactions of the American Fisheries Society, v. 140, no. 5, p. 1255–1268, https://doi.org/10.1080/00028487.2011.618356.

Feasibility and Uses for Freshwater Mussel Culture in Massachusetts

Massachusetts Cooperative Fish and Wildlife Research Unit

Half of the freshwater mussel species native to Massachusetts are listed as endangered or of special concern. Population augmentation and reintroduction programs have been used to restore freshwater mussel populations in other States for more than 20 years and have reported significant success with some species. This research is testing the feasibility of mussel propagation at the USFWS Cronin Aquatic Resource Center in Sunderland, Massachusetts. Siting of a propagation facility in Massachusetts should increase collaboration with other New England States for the management of regional populations, increase collaboration with academic and Federal partners, and increase competitiveness for funding sources. Ultimately, cooperators hope to develop a successful restoration program in Massachusetts.

Pictured below: The Penobscot River in Maine. Photograph by Bruce C. Cooper, licensed under Creative Commons Attribution-Share Alike 3.0.

Inventory and Monitoring for the Federally Endangered Northern Red-Bellied Cooter

Massachusetts Cooperative Fish and Wildlife Research Unit

Research is necessary to inform recovery efforts for the endangered northern red-bellied cooter. This project plans to emphasize on-the-ground management throughout the cooter's range with the objective of downlisting or even delisting the species. In the near term, this information can help evaluate how well decision makers are meeting recovery plan goals. In the future, these deliverables should also help scientists monitor future population changes and direct efforts on the ground.

Investigating Alewife Population Dynamics and Parent-Progeny Relations in the Parker River Toward Determining Landscape Effects On Productivity

Massachusetts Cooperative Fish and Wildlife Research Unit

River herring/alewife and blueback herring have undergone a dramatic decline over the past five decades that has resulted in their petition for listing under the ESA. During the ESA process, many data gaps were identified including a better detailing of species production within freshwater habitat. This project seeks to fill critical knowledge gaps by studying the ecosystem properties and evolutionary mechanisms that interact to control alewife productivity in coastal lakes. Understanding the relation between number of alewife spawners and juvenile production is critical for setting appropriate management goals for either restoration or harvest.

Metapopulation Dynamics of Canada Lynx in the Northern Appalachian/Acadian Ecoregion

Massachusetts Cooperative Fish and Wildlife Research Unit

The genome of Canada lynx is being mapped, and conservation genetics are being applied to understand the relation of lynx in the Northeastern United States to those in eastern Canada and across the species' continental range. The goal of the project is to develop landscape strategies for Canada lynx conservation and to assist managers with conservation efforts.

Canada lynx kitten. Photograph by Marvin Moriarty, U.S. Fish and Wildlife Service.

Entrainment of River Sturgeon From the Lower Mississippi River Into the Atchafalaya River System

Mississippi Cooperative Fish and Wildlife Research Unit

During the early 20th century, channel enlargement of the Atchafalaya River threatened to capture most of the flow of the lower Mississippi River. These activities affect river sturgeons and especially the endangered pallid sturgeon. The research team plans to use acoustic telemetry and external tags to determine the rate and effect of pallid sturgeon and shovelnose sturgeon entrainment. This information can be used in the future to develop population viability analyses for pallid sturgeon and shovelnose sturgeon in the lower Mississippi River.

Habitat Suitability Modeling and Islandwide Rapid Assessment for the Presence of the Endangered Broad-Winged Hawk and Sharp-Shinned Hawk in Puerto Rico

Mississippi Cooperative Fish and Wildlife Research Unit

The broad-winged hawk and sharp-shinned hawk are endemic raptor subspecies inhabiting upland montane forests of Puerto Rico. The actions suggested in this project—islandwide surveys within traditional and nontraditional sites, identification of mortality threats, determination of spatial distribution, and habitat suitability modeling—and subsequent informed implementation of recovery actions are predicted to prevent the extinction of both the broad-winged hawk and sharp-shinned hawk.

Publication

Gallardo, J.C., and Vilella, F.J., 2014, The Puerto Rican sharp-shinned hawk (*Accipiter striatus vennator*)—An endangered insular species on the edge: Spizaetus—Neotropical Raptor Network Newsletter, no. 17, p. 2–13, http://assets.peregrinefund.org/docs/newsletters/Spizaetus-17-English-1.pdf.

Movement and Habitat Use of Pallid Sturgeon in the Lower Mississippi River

Mississippi Cooperative Fish and Wildlife Research Unit

The pallid sturgeon is an endangered riverine sturgeon with historical distribution restricted to parts of the Yellowstone, Missouri, Mississippi, and Atchafalaya Rivers. Although rare, pallid sturgeon in the lower Mississippi River appear to be naturally recruiting, and information about habitat use is important to conserve this species. This study seeks to provide information that can be used to conserve, manage, and restore habitat necessary to restore the endangered pallid sturgeon and conserve the threatened shovelnose sturgeon in the lower Mississippi River. Study results suggest that maintaining diverse habitats, particularly secondary channel-island complexes, can benefit the conservation of these endangered species.

Surgically implanting a sonic tag into this large pallid sturgeon can allow the researchers to monitor its movement and habitat use for 4 years.

Publications

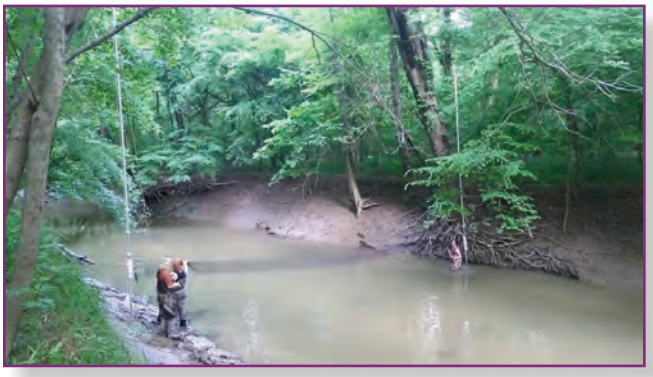
Hartfield, Paul, Kuntz, N.M., and Schramm, H.L., Jr., 2013, Observations on the identification of larval and juvenile *Scaphirynchus* spp. in the lower Mississippi River: Southeastern Naturalist, v. 12, no. 2, p. 251–266, https://doi.org/10.1656/058.012.0202.

Herrala, R.R., Kroboth, P.T., Kuntz, N.M., and Schramm, H.L., Jr., 2014, Habitat use and selection by adult pallid sturgeon in the lower Mississippi River: Transactions of the American Fisheries Society, v. 143, no. 1, p. 153–163, https://doi.org/10.1080/00028487.2013.830987.

Identification of Summer Habitat of the Federally Endangered Indiana Bat and Three Other Bat Species of Special Concern Within the Ozark-Central Recovery Unit With Application for Landscape Distribution Use

Missouri Cooperative Fish and Wildlife Research Unit

Knowledge and understanding of bat habitat associations are critical for effective conservation and management of many species of forest bats, including the federally endangered Indiana bat which uses bottomland forests for both summer foraging and roosting habitat. Current information gaps surrounding summer habitat use and habitat selection limit the ability of management agencies to engage in adaptive resource management and make optimum forest management decisions. This study addresses both Priority 1 Recovery Actions aimed at preventing extinction and Priority 2 Recovery Actions aimed at preventing a significant decline in Indiana bats as identified in the USFWS Indiana Bat Draft Recovery Plan. This research has great potential to provide new insights into landscape forest characteristics, conditions, and management methods for roosting and foraging sites because Indiana bats are being studied at multiple sites, and the same techniques for collection and analysis of habitat data are being used.



Researchers set up a triple-high mist net to catch Indiana bats at Cypress Creek National Wildlife Refuge in the summer of 2015.

Indiana bat. Photograph by U.S. Fish and Wildlife Service.

Occupancy Modeling and Summer Habitat Selection of Bat Species on National Wildlife Refuges Along a Latitudinal Gradient in Northern Missouri

Missouri Cooperative Fish and Wildlife Research Unit

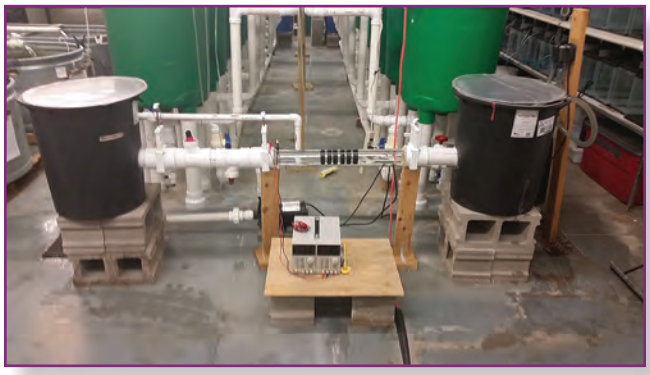
Little is known about the bat species that inhabit most NWRs, and this trend is not unique to Missouri. There is no doubt that refuges provide habitat for a variety of wildlife, including bats. However, challenges have arisen in recent years to add additional concern for increasing the priority of inventory, monitoring, and research of these species on NWR lands. These concerns include habitat loss, white-nose syndrome (WNS), and collision with wind turbines. Researchers intend to develop bat occupancy models on NWR lands across the northern part of Missouri. Monitoring bat population trends and use of habitats that are also used by other wildlife species can help determine if one or more of these bat species can be selected as a surrogate species for future conservation efforts. The information obtained through this research can offer new insight into recovery needs of the northern long-eared and Indiana bats.

Northern long-eared bat. Photograph by Steven Thomas, National Park Service.

Physiology, Behavior, and Tolerances of Missouri Fishes of Conservation Concern With a Focus on Niangua Darter and Topeka Shiner

Missouri Cooperative Fish and Wildlife Research Unit

Understanding the capacity of unoccupied environments to support reintroduction or range expansion of target organisms is a primary objective in the recovery of rare and threatened species in Missouri. Further, it is crucial to understand basic physiological preferences, sensitivities, and tolerances of these species given projected changes in environmental conditions related to land use and climate change throughout the State. This project is investigating the physiology, behavior, and tolerances of Missouri fishes of conservation concern with a focus on the Niangua darter and Topeka shiner. Information from this study can enhance recovery efforts for these species in Missouri.



Water quality influences growth, development, and physiology of aquatic vertebrates.

Missouri River pallid sturgeon.

Density of Pallid Sturgeon and Food Web Dynamics in the Missouri River

Montana Cooperative Fishery Research Unit

Growing concern exists among biologists that too many pallid sturgeon may have been stocked in the Missouri River. The purpose of this project is to research the density of pallid sturgeon and food web dynamics in the Missouri River. The overall goal is to provide inferences regarding the carrying capacity of pallid sturgeon, using two complementary methods (vital rates and production), in the Missouri River and Yellowstone River. This information can be useful in guiding an adaptive conservation propagation program.

Environmental and Endogenous Factors Affecting Egg Quality and Caviar Yield in Farmed Sturgeon

Montana Cooperative Fishery Research Unit

The endangered pallid sturgeon is experiencing high levels of gonadal fat accumulation, which impairs reproductive performance. Environmental, genetic, and developmental factors all can affect gonadal fat accumulation, but as of yet the role of these factors is not well understood. Understanding these effects is essential for conservation propagation of endangered sturgeons and sustained production of high-quality sturgeon caviar. This project involves investigating environmental factors affecting egg quality and caviar yield in farmed sturgeon. Results from this study should be directly applicable to sturgeon conservation propagation programs seeking to understand the influence of culture conditions versus genetic and developmental factors on the reproductive performance of captive populations.

Evaluation of Juvenile Bull Trout Outmigration in Thompson Falls Reservoir

Montana Cooperative Fishery Research Unit

Bull trout are listed as a threatened species by the USFWS. In the lower Clark Fork River, bull trout are affected by three mainstem dams and reservoirs that are significantly altering natural habitats (physical and biological) and influencing upstream and downstream fish movement. The research team plans to investigate outmigration of bull trout in the Thompson Falls reservoir. This research can assist decision makers in understanding how juvenile bull trout use and move through impoundments and how these altered habitats and dam operation can impact downstream migrating juvenile bull trout and accordingly the status of associated populations.

Lake Trout Population Modeling and Annual Assessment of Suppression Netting

Montana Cooperative Fishery Research Unit

Prior to the recent invasion of nonnative lake trout, Glacier National Park (GNP) accounted for about a third of the remaining natural lake habitat supporting threatened bull trout. However, bull trout populations have recently declined and are at high risk of extirpation in several lakes in western GNP because of the establishment of lake trout. In 2009, the USGS and the NPS began suppressing lake trout in Quartz Lake to reduce effects on native bull trout. The objectives of this study are to (1) describe the demography of the lake trout, (2) identify the timing and location of lake trout spawning, (3) determine the most efficient combination of gill net mesh color and twine diameter to capture juvenile lake trout, (4) assess the effects of suppression on the growth rate of the lake trout population, and (5) determine whether suppression negatively affected bull trout. Targeted suppression successfully reduced lake trout abundance, and continued suppression at or above observed exploitation levels is needed to ensure continued population declines and to avoid effects on the bull trout population.

Bull trout populations have recently declined and are at high risk for extirpation in several lakes in western Glacier National Park.

Greater Sage-Grouse Genetics

Montana Cooperative Wildlife Research Unit

The greater sage-grouse population has declined dramatically over the past century due primarily to a loss of habitat over the species' range. Recent conservation efforts have improved the chance of overall species survival, but local populations may still be in danger of extinction. This research is designed to develop a comprehensive understanding of greater sage-grouse genetic connectivity across Montana, North Dakota, South Dakota, and Wyoming using noninvasive collecting techniques and molecular genetics monitoring tools in a landscape genetics framework. The results can provide information on levels of connectivity and other population characteristics such as genetic exchange or dispersal.

The greater sage-grouse population has declined dramatically over the past century due primarily to a loss of habitat over the species' range. Photograph by U.S. Fish and Wildlife Service.

Grizzly Bear Population Status in the Cabinet-Yaak Ecosystem

Montana Cooperative Wildlife Research Unit

The grizzly bear is an iconic species of the American West; however, it is estimated that fewer than 1,500 grizzlies are left in the lower 48 United States. Using hair collected from bear rubs and hair-collecting corrals, genetic analyses allow scientists to identify the species, sex, and individual identity of bears. Further analyses allow estimates of population abundance, distribution, gene flow, and models of regional abundance patterns. The goal of this study is to acquire precise and accurate data on the status of the endangered grizzly bear population in northern Montana and Idaho using noninvasive genetic sampling. These results should provide managers a better understanding of the status of grizzlies in the Cabinet-Yaak ecosystem.

Bat Movements Across Transforming Landscapes

Nebraska Cooperative Fish and Wildlife Research Unit

Nebraska has a diverse mix of resident and migratory bat species. The northern long-eared bat is currently listed as a threatened species under the ESA. Through the deployment of more than 20 ultrasonic acoustic detectors over a period of 2 years, the research team can identify when and where bats are moving in eastern Nebraska during spring and fall migration and summer residence. Decision makers can use the project results to promote sound resource-management practices in regard to wind energy development.

Determining Seasonal Use of Conservation Reserve Program Habitat by the Lesser Prairie-Chicken in Eastern New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

In the southern part of the lesser prairie-chicken's range, native habitats once dominated by mixed grass/shrublands that were converted to agriculture have been restored to nonnative and native grasslands with no shrub component. The value of CRP habitats with no shrub component, however, is largely unknown. This study was designed to evaluate seasonal habitat use and demography of lesser prairie-chicken populations closely associated with both habitats—with or without shrubs—to determine the seasonal importance of CRP lands within the shinnery oak/sand sage ecosystem. Study results indicate a significant preference for native shinnery oak habitat over all available habitats and suggest that this habitat should be the number one conservation priority for this species at the southern extent of its range.

Pictured below: A mother grizzly bear and her cub in Yellowstone National Park. Adult females are the most important segment of grizzly bear populations because they are the reproductive engine. Photograph by Frank van Manen, U.S. Geological Survey.

Development and Validation of a Molecular Screening Tool to Identify the Presence of Asian Tapeworm in Imperiled Southwestern Native Fish Populations

New Mexico Cooperative Fish and Wildlife Research Unit

The bonytail and humpback chub are federally endangered cyprinids that were both once abundant in the Colorado River and its tributaries. Despite successful captive propagation programs, the species remain federally listed due to continued habitat loss, altered streamflow, hybridization, and competition and predation by nonnative fish. The goal of the research is to develop and validate a molecular screening tool to positively identify Asian tapeworm in imperiled native fish populations in the Colorado and Little Colorado Rivers.

Population Dynamics and Reintroduction Characteristics of Mexican Wolves in the Blue Range Wolf Recovery Area in Arizona and New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

The Blue Range population of Mexican wolves, although successfully established in 1998, is not thriving. Over the last 7 years, the population size has remained around the halfway point of the population target of at least 100 wolves. Yet, data from the reintroduction project have not been rigorously analyzed or published in scientific journals to help elucidate potential modifications for the project or describe BMPs for this population. Scientific analysis of the data would help guide future reintroduction efforts in other areas and allow for comparison between disparate populations to further the understanding of Mexican wolf biology across the established range. In addition, other reintroduction efforts of carnivores may benefit from a detailed analysis of the Mexican wolf reintroduction efforts.

Quantifying Habitat Selection and Predicting Habitat Use by Whooping Crane

New Mexico Cooperative Fish and Wildlife Research Unit

Conservation efforts for the endangered whooping crane have led to a limited recovery with a total wild population estimated at about 600 birds. Additional information on crane habitats is essential for the entire annual cycle of the species, including breeding, wintering, and migration. The project is planned to include the collection of field data to validate vegetation metrics derived from light detection and ranging (lidar) and National Agriculture Imagery Program color infrared imagery. This validation can allow for development of vegetation metrics derived from remote sensing to model vegetation structure across the winter grounds. The overall goal of the project is to characterize whooping crane stopover sites in the southern portion of their migration corridor and on wintering grounds, including diurnal use and nocturnal roosting sites.

Assessing Endangered Marsh Rabbit and Woodrat Habitat Use and Feral Cat Population Dynamics Using Photographic, Video, and Capture-Recapture Data

North Carolina Cooperative Fish and Wildlife Research Unit

The Lower Keys marsh rabbit and the Key Largo woodrat are endangered species endemic to the Florida Keys. Their survival is threatened by a variety of factors including habitat change, sea level rise, and introduced predators such as feral cats that thrive in human-dominated landscapes. This research intends to use photographic, video, and capture-recapture methodologies to validate occupancy estimates based on marsh rabbit pellet counts, estimate population size and movement of feral cats, assess the use of artificial structures by woodrats, and estimate the population size and movement of feral cats in woodrat habitat. The information can be used to develop restoration and management strategies for marsh rabbits and the Key Largo woodrat.

Captive Mexican wolf at Sevilleta National Wildlife Refuge, New Mexico. Photograph by Jim Clark, U.S. Fish and Wildlife Service.

Optimal Sampling of Animal Communities

North Carolina Cooperative Fish and Wildlife Research Unit

The USFWS is responsible for the conservation of trust species—endangered species, candidate species, or species at risk. Implementation of a sampling framework would allow the USFWS to inform decision problems and models by focusing on birds and amphibians. This work plans to tap existing occupancy-based models; extensions can be developed, if needed, and the application can be centered around a sound and flexible sampling design for implementation across the Southeastern United States and the Caribbean. Sampling design is often overlooked, but it is undeniably the foundation of reliable estimates and inference about system responses to management and, hence, conservation decisions.

Sicklefin Redhorse Ontogeny, Recruitment, and Priority Habitats in Regulated Rivers

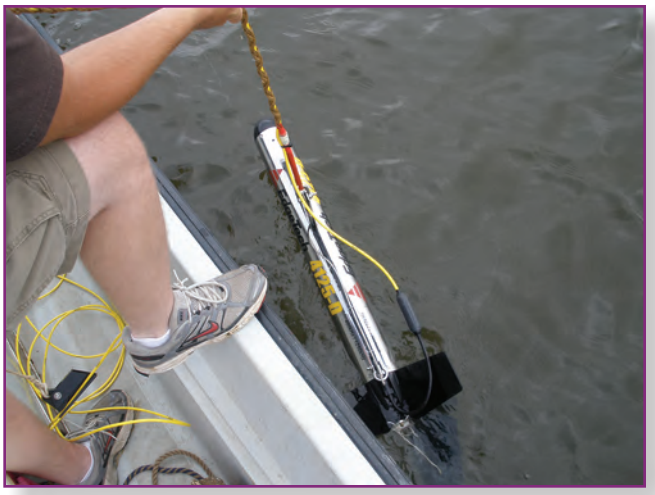
North Carolina Cooperative Fish and Wildlife Research Unit

The sicklefin redhorse is an imperiled fish in the southern Appalachian Mountains. Sicklefin redhorse is a candidate species for protection under the ESA, but little is known about its biology and ecology. The presence of dams, regulated river flows, and other human activity may be detrimental to survival of the species. This research is designed to examine the early life history and ecology of the sicklefin redhorse and its congeners, especially as related to habitat suitability, dams, and invasive predators. Improved knowledge, particularly of the early life history of the species, can inform and guide critical future decisions in river management and dam relicensing that directly affect the survival of this imperiled fish.

Determining the Distribution of State-Endangered Longnose Darter Through Niche Model Transferability

Oklahoma Cooperative Fish and Wildlife Research Unit

The longnose darter is endangered in Oklahoma and currently is known to occur only in Lee Creek because the population that had occurred in the Poteau River system is presumed extirpated. The purpose of this study is to develop an environmental niche model for use in determining the presence of longnose darter in the Poteau River system. The niche model includes a river segment scale, using data from the entire range of the species, and a mesohabitat scale, using a classified habitat. This project should demonstrate the ability of niche modeling to predict occupancy in previously unsampled locations.

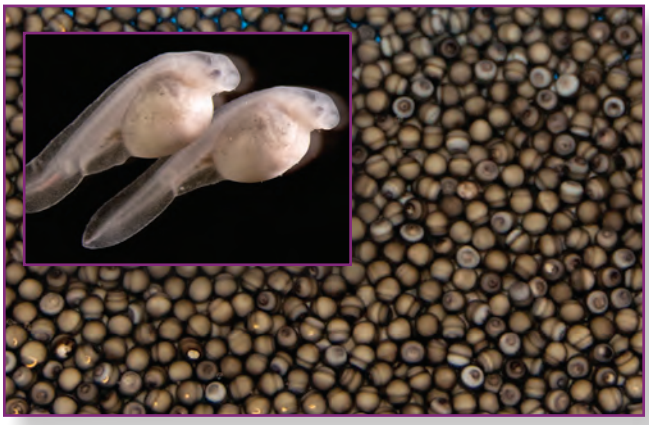


Side-scan sonar survey.

Evaluating the Effects of Shallow-Water Habitat on Age-0 *Scaphirhynchus* sp. Prey Use and Condition

Oklahoma Cooperative Fish and Wildlife Research Unit

The pallid sturgeon was listed as an endangered species by the USFWS in 1990, and loss of habitat in the Missouri River has been identified as a likely contributing factor in sturgeon declines. The Missouri River Biological Opinion and amendments published by the USFWS in 2000 and 2003, respectively, address operation of the main stem Missouri River dams as well as the overall loss of habitat diversity due to channelization and river shortening in the lower Missouri River and provide guidance for improving habitat in the lower 750 miles of the river. The purpose of this study is to assess and compare resource use (prey) of sturgeon that have been collected from reaches representing areas that meet or exceed USFWS targets of shallow-water habitat and areas with little shallow-water habitat. This information can further inform conservation efforts.



Unfertilized pallid sturgeon eggs expressed from a female induced to spawn in the laboratory. Inset: Recently hatched pallid sturgeon free-embryos. Photographs by Aaron DeLonay, U.S. Geological Survey.

Conservation of the Critically Endangered Chinese Crested Tern: Restoration of a Lost Breeding Colony

Oregon Cooperative Fish and Wildlife Research Unit

In the latter half of the 20th century, Chinese crested terns were presumed to be extinct until the species was rediscovered nesting in the Matzu Islands of the Taiwan Strait in 2000. Despite their recent rediscovery, Chinese crested terns are still considered one of the most endangered seabird species in the world and one of the most critically endangered vertebrate species. This restoration project is a collaborative effort of several Chinese and American institutions: Xiangshan County Marine and Fishery Bureau, Zhejiang Museum of Natural History, Oregon State University, USGS, and the Oregon Cooperative Fish and Wildlife Research Unit. Support from the USFWS Wildlife Without Borders program has furthered this international collaboration to save one of the world's most critically endangered animals.

Demographics and Habitat Use of Greater Sage-Grouse in Wildfire-Affected Habitats in Oregon

Oregon Cooperative Fish and Wildlife Research Unit

Southeast Oregon contains part of one of the largest contiguous sagebrush-steppe habitats remaining within the extant range of greater sage-grouse. In the summer of 2012, several wildfires claimed more than 1 million acres of sage-grouse habitat in Oregon. The research team plans to explore demographics and habitat use of greater sage-grouse. The data can inform decision makers of the prioritization of areas for post-fire habitat rehabilitation and restoration and help identify areas requiring further protection and (or) active management to reduce the risk of wildfire and ensure sage-grouse population persistence.

Demography of the Northern Spotted Owl in Oregon and Washington

Oregon Cooperative Fish and Wildlife Research Unit

The northern spotted owl is listed as threatened under the ESA, primarily because of the loss of old-growth forest habitat due to timber harvest. The USDA Northwest Forest Plan was developed in the mid-1990s to conserve the owl and other old-growth species, while allowing greatly reduced levels of commercial timber harvest on Federal land. The plan required the implementation of a regional effectiveness monitoring program for the spotted owl. This research project plans to include collection and analysis of data from six of the eight spotted owl effectiveness monitoring program study areas across the owl's range. Data from this work are used to regularly evaluate population trends of spotted owls, as well as increase the understanding of owl ecology, including dispersal, diet, nest site selection, behavior, genetics, and response to a recent invasive species in the Northwest, the barred owl.

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A pair of northern spotted owl chicks. Photograph by Bureau of Land Management.

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Evaluation of Foraging Behavior, Colony Connectivity, and Predation on ESA-Listed Salmonids from the Upper Columbia River by Caspian Terns Nesting on Goose Island in Potholes Reservoir

Oregon Cooperative Fish and Wildlife Research Unit

Avian predation on juvenile salmonids in the Columbia River is a major natural resource management issue pitting migratory bird managers and those opposed to management interventions in a contentious policy debate over efforts to restore juvenile salmonids. Information is needed on the magnitude of smolt losses to avian predation, the impact of those losses to the demography of salmonid stocks, and the potential benefits to ESA-listed salmonid stocks from the Columbia River Basin of reducing avian predation through management. This research is using state-of-the-art Global Positioning System (GPS) and satellite tracking devices to assess the impact of predation by Caspian terns nesting at Goose Island in Potholes Reservoir on the survival of juvenile salmonids belonging to ESA-listed ESUs from the Upper Columbia River. This information is critical to resource management agencies and stakeholder groups interested in reducing the impact of avian predation on ESA-listed salmonids.

Monitoring and Evaluating Caspian Terns and Their Impacts on the Survival of Juvenile Salmonids in the Columbia River Basin

Oregon Cooperative Fish and Wildlife Research Unit

The Caspian tern is the species of piscivorous colonial waterbird most responsible for losses of ESA-listed juvenile salmonids in the Columbia River Basin. The breeding colony of Caspian terns on East Sand Island near the mouth of the Columbia River is the largest of its kind in the world and represents about 65 percent of the breeding population for the species in western North America. This project is a continuation of previous work (2008–12) in which the nesting ecology and food habits of Caspian terns were investigated at prospective U.S. Army Corps of Engineers (USACE)-constructed Caspian tern sites in interior Oregon and northeastern California to assess the potential impacts of new or larger tern colonies on local stocks of forage fishes, particularly fish species of special concern. This study is important for evaluating the efficacy of the USFWS Caspian Tern Management Plan in reducing predation on Columbia River Basin salmonids and for evaluating impacts to ESA-listed fish outside the basin.

Caspian tern. Photograph by U.S. Fish and Wildlife Service.

Pictured below: Columbia River, Oregon. Photograph from Wikimedia Commons, licensed under Creative Commons Attribution 3.0.

Shorebird Habitat Use During Migration in Cape Romain National Wildlife Refuge

South Carolina Cooperative Fish and Wildlife Research Unit

The coast of South Carolina has not been studied with respect to shorebird use and its relation with horseshoe crab abundance. Regions of the Delaware and Chesapeake Bays are critical stopover sites for migratory shorebirds in part because these regions also support a high density of spawning horseshoe crabs. The goal of the research is to enhance the understanding of the relations between migratory shorebirds, particularly red knots, and spawning horseshoe crabs. The research team plans to collect horseshoe crab eggs and conduct composition and energy density analyses. If migratory shorebirds rely on horseshoe crab spawn as a food source during the energetically costly period of migration, and if certain beaches in the region tend to receive consistent use, then conservation and management actions can more effectively target those locations to benefit migratory shorebirds.

Assessment of Neonicotinoid Exposure on U.S. Fish and Wildlife Service High Diversity Grasslands in the Prairie Pothole Region

South Dakota Cooperative Fish and Wildlife Research Unit

Grassland obligate species are rapidly decreasing due to habitat fragmentation, destruction, and degradation. The Dakota skipper and Poweshiek skipperling, recently listed as threatened and endangered, respectively, under the ESA, inhabit high-quality grasslands. Additionally, due to significant population declines, the USFWS has initiated a status review of the monarch butterfly under the ESA. This study plans to assess neonicotinoid pesticide exposure on remnant native and restored grasslands and also determine the rate of uptake and accumulation of neonicotinoids in native flowering plants through greenhouse trials. Study results should be important to managers working to restore populations of these three species.

Development of a Spatially Explicit Growth Model for Larval Pallid Sturgeon

South Dakota Cooperative Fish and Wildlife Research Unit

In young fishes, growth rate is often positively linked to survival. The goal of this study is to develop a much needed tool for assessing habitat suitability for larval pallid sturgeon in the Missouri River. Because growth rate reflects physiological responses to habitat conditions, it can serve as a surrogate for fitness and an index of habitat quality. Bioenergetics modeling provides a robust approach for quantifying growth rate of fishes and evaluating effects of environmental conditions on growth potential. As a habitat assessment tool, bioenergetics modeling is particularly attractive for rare or endangered species such as the pallid sturgeon, given the near absence of early (larval) life stages in the upper Missouri River. Information from this study can have important implications for the pallid sturgeon recovery plan.

Endangered Species Research Below Green River Dam

Tennessee Cooperative Fishery Research Unit

Dams create discontinuity in streams by changing flow and temperature regimes, fragmenting fish populations, and limiting sediment and nutrient loads downstream. More than 40 mussel species reproduce to some extent in the Green River, a regulated river in Kentucky. Most recruitment, however, occurs downstream from Greensburg, 38 kilometers from the dam. The ecology of endangered and common mussels is being studied in the tailwater of Green River Dam. This study is expected to provide a better understanding of mussel feeding habits and can help resource managers choose the most appropriate sites for mussel reintroduction and augmentation projects.

Propagating Mussels in the Ohio River

Tennessee Cooperative Fishery Research Unit

The Ohio River Aquatic Restoration Natural Resource Damage Assessment and Restoration (NRDAR) Program was employed to reestablish mussel species that were wiped out in 1999 because of the release of hazardous materials from a ferro-alloy manufacturing facility into the river. As part of the USFWS Ohio River Aquatic Restoration Project, three species of freshwater mussels are being reestablished. *Lampsilis abrupta*, *Ligumia recta*, and *Obovaria subrotunda* are being propagated and cultured as part of the restoration efforts. The goal of the project is to produce a total of 5,000 juvenile *Lampsilis abrupta*, 5,000 juvenile *Ligumia recta*, and 2,000 juvenile *Obovaria subrotunda*. Ultimately, the effort should provide cooperators with juvenile mussels for release into the Ohio River and newly metamorphosed juvenile mussels for culturing, which can augment the restoration effort.

Pink mucket. Photograph by U.S. Fish and Wildlife Service.

A Rangewide Assessment of the Influence of Landscape and Environmental Change on Lesser Prairie-Chickens

Texas Cooperative Fish and Wildlife Research Unit

The decline in overall population size and range of the lesser prairie-chickens throughout the High Plains part of the central and southern Great Plains has raised conservation concerns, resulting in their current proposed listing as a threatened species under the ESA. Although numerous studies have recently been, and are currently being, conducted on this species, information regarding the influence of landscape changes on lesser prairie-chicken populations across their distribution is lacking. This study is being conducted to assess historic and contemporary land-use data and climate predictions to predict influences on lesser prairie-chickens. Ultimately, the historical and current relations among environmental conditions, landscape characteristics, and population demography can be used to predict future changes in population size and range under differing landscape, climate, and conservation scenarios.

Understanding the Ecology of Lesser Prairie-Chickens

Texas Cooperative Fish and Wildlife Research Unit

The use of wildlife habitats provided by conservation programs such as the CRP has not been assessed relative to its value for the restoration and management of threatened and endangered species. This project is assessing the use of CRP lands by lesser prairie-chickens as foraging and nesting habitat. Study results should help guide future management decisions by providing a better understanding of the value of CRP to the ecology of the lesser prairie-chicken.

Assessing the State of River Science, Water Resources Management Policies, and Water Resources Planning Tools for the Rio Grande/Rio Bravo

Utah Cooperative Fish and Wildlife Research Unit

Restoration efforts are complicated by numerous species of nonnative fishes in the Rio Grande/Rio Bravo watershed. This project plans to assemble, review, and synthesize the scientific body of research and monitoring studies relevant to the Rio Grande/Rio Bravo watershed, focusing on studies that concern streamflow, groundwater, geomorphology, aquatic ecology, riparian ecology, and human interactions with river ecosystems. The results can help managers identify key scientific and management questions and potential knowledge gaps to enable responses.

Determination of Fort A.P. Hill Bat Community With Emphasis on Occupancy and Detection Probability

Virginia Cooperative Fish and Wildlife Research Unit

With population declines associated with WNS, acoustical survey methods are moving to the forefront for initial bat surveys in terms of establishing species presence. The data should allow managers to use predictive maps to document the decline in bat species affected by WNS.

Disturbance Impacts on the Northern Long-Eared Bat and Indiana Bat at Fort A.P. Hill

Virginia Cooperative Fish and Wildlife Research Unit

For certain Department of Defense (DoD) installations, Indiana bat presence can mean heightened regulatory scrutiny of Integrated Natural Resource Management Plans with the need for formal consultation with the USFWS, seasonal clearing restrictions, and modification of training and range use in or near colonies during the growing season. With the discovery of Virginia's first recorded Indiana bat maternity colony at Fort A.P. Hill along the Fall Line/I–95 corridor, Federal landowners in eastern Virginia need to consider the bat in their management actions. Additional population declines associated with WNS have heightened conservation concern for Indiana bats. Moreover, the precipitous drop in northern long-eared bat numbers from the disease has moved it to the USFWS list as threatened in 2015. Researchers plan to continue documenting the extant bat community by using acoustic and mist-netting survey techniques at Fort A.P. Hill. The resulting information can be shared broadly within the natural resources and scientific community.

Effects of Surveying and Habitat Characteristics on Occupancy of Spruce-Fir Moss Spider in the Southern Appalachian Mountains

Virginia Cooperative Fish and Wildlife Research Unit

The spruce-fir moss spider inhabits high-elevation spruce-fir forests in the southern Appalachians, which are considered one of the most endangered ecosystem types in the United States. The spruce-fir moss spider was listed as federally endangered in 1995. Gaps in knowledge of survey impacts and habitat selection may hinder conservation efforts for this species. No study has been conducted to determine variables that influence spider detection and occupancy on a local to landscape scale, which is important to create predictive

Spruce-fir moss spider. Photograph by U.S. Fish and Wildlife Service.

distribution maps for this species and may help modify survey techniques and priorities. The results from this project can provide critical information for natural resource stewardship needs relative to the endangered spruce-fir moss spider.

Post-Hibernation Emergence of the Northern Long-Eared and Indiana Bats in Virginia and New York

Virginia Cooperative Fish and Wildlife Research Unit

With the onset and spread of WNS in the Eastern United States, several formerly common bat species are now threatened with widespread regional extirpation. For example, the northern long-eared bat has shown precipitous declines, and reproduction in surviving bats appears curtailed, suggesting functional extirpation in some areas. In addition to species facing recent declines, WNS has reduced populations of species already State or federally protected, such as the endangered Indiana bat. This project seeks to enable managers to understand the temporal and spatial distribution/day-roost habitat use of the northern long-eared bat and Indiana bat in Virginia and New York.

Post-White-Nose Syndrome Survey of Bats at Fort Meade

Virginia Cooperative Fish and Wildlife Research Unit

Because of WNS, three species of bats that formerly were common in and around the Fort Meade/Baltimore area of Maryland during the maternity season—northern long-eared bat, little brown bat, and tri-colored bat—are now of high conservation concern. A proposed rule by the USFWS to list the northern long-eared bat as threatened was adopted as regulation in April 2015, and the little brown bat and tri-colored bat currently are undergoing status reviews that might lead to listing proposals. Accordingly, DoD managers responsible for managing military base lands in the region now can assess the presence/absence and habitat associations of these species of bat, particularly the proposed northern long-eared bat, relative to range and land-management activities, such as prescribed burning, right-of-way maintenance, construction, and historical or ecological restoration. The research team can use acoustic monitoring to track changes in population sizes and species assemblages. As WNS continues to spread and bat populations decline further, biologists invariably rely more on acoustic detection.

Little brown bat. Photograph by U.S. Fish and Wildlife Service.

Post-White-Nose Syndrome Survey of Bats at the National Aeronautics and Space Administration (NASA) Wallops Flight Facility

Virginia Cooperative Fish and Wildlife Research Unit

The post-WNS bat assemblage and general foraging habitat associations and current conditions at Wallops Island are being compared with coastal area pre-WNS observations from nearby Assateague Island, Maryland, with particular emphasis on the northern long-eared bat. The research team plans to incorporate Wallops Island bat species presence/absence data into a larger multipartner, mid-Atlantic landscape and smaller forest stand-level predictive modeling effort. The data can help refine acoustic monitoring guidelines.

Spatial and Temporal Characteristics of Northern Long-Eared Bat Maternal Roost Networks and Foraging Relations in a Repeatedly Burned Central Appalachian Forested Landscape

Virginia Cooperative Fish and Wildlife Research Unit

Since 2007, WNS has killed millions of bats in the genus *Myotis* in the Northeast and central Appalachians. Regionally, managers are being challenged to show that burn programs designed to benefit other natural resource components can also benefit bats or at a minimum not exacerbate population reductions from WNS. Understanding the characteristics of post-burn stands whereby stands no longer provide adequate day-roost habitat or are little used for foraging can allow managers to tailor the shifting mosaic of burning to better capture short-term benefits and accomplish prescribed fire goals. The findings of this project should be relevant to forest managers that use prescribed burning as a management tool.

Dynamics and Distribution of Black Abalone Populations at San Nicolas Island, California

Washington Cooperative Fish and Wildlife Research Unit

The black abalone was listed as endangered under the ESA in 2009. In collaboration with NOAA's NMFS, this research plans to provide new information on critical parameters for successful spawning of wild populations of endangered black abalones. The research can contribute to an improved understanding of the linkage of distributions and local reproductive potential of black abalone populations at San Nicolas Island, California. Decision makers can use the

data to develop methods and protocols for populations of black abalones and for the ultimate health of and benefit to California's coastal marine ecosystems.

Publications

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Puget Sound Marine Survival-Size-Selective Mortality and Critical Growth Periods for Juvenile Chinook and Coho Salmon

Washington Cooperative Fish and Wildlife Research Unit

The relation between size, growth, and condition in freshwater and marine life stages to overall life cycle survival is unclear for most stocks of salmon. Linking stage-specific growth performance and size-selective mortality offers a promising avenue for diagnosing the primary factors that affect growth and survival. Researchers plan to diagnose which factors most affect growth during critical periods through modeling simulations that are linked to targeted sampling of diet, growth, and environmental conditions. This approach could potentially improve run forecasting and focus restoration efforts for Chinook and coho salmon.

The Washington Cooperative Fish and Wildlife Research Unit has maintained a consistent record of completed student theses and dissertations as well as technical publications of high quality. The students and staff have received numerous awards for scientific excellence.

A Study of Diamond Darter Macrohabitat Use and Abundance Within the Lower Elk River

West Virginia Cooperative Fish and Wildlife Research Unit

The diamond darter, which was described as a new species in 2008, was listed as federally endangered in 2013. Few studies have been conducted to examine the habitat use of this species, in part, because of difficulties in working with rare fishes, such as obtaining statistically and ecologically relevant sample sizes. As part of this study, a new sampling

approach was developed and published whereby spotlights are used at night to examine the habit use of the species. The new approach has proven to be the only method for consistently sampling the diamond darter. Data collected were integral and essential for decisions made by USFWS for status assessment, critical habitat designation, and ESA listing of the species, and also are critical for management and conservation efforts by natural resource managers.

The diamond darter, which was described as a new species in 2008, was listed as federally endangered in 2013. Photograph by S. Welsh.

Development of eDNA Techniques for Detection of Endangered Purple Cat's Paw Pearlymussel and Snuffbox

Wisconsin Cooperative Fishery Research Unit

Environmental DNA techniques are being developed to detect the presence/absence of the endangered purple cat's paw pearlymussel and snuffbox. The project team at the Wisconsin Research Unit is collaborating with the USFWS Midwest Region on problem solving and conservation actions related to the two species of mussels. Decision makers can use the research data to address today's conservation challenges.

Purple cat's paw pearlymussel. Photograph by U.S. Fish and Wildlife Service.

Rangewide Assessment of the Impacts of Climate Change on the Endangered, Migratory Kirtland's Warbler Population

Wisconsin Cooperative Wildlife Research Unit

A primary concern for managers is the impact of changing climate patterns on the Kirtland's warbler narrow breeding and wintering ground habitat. Currently, little is understood about how climate change could impact Kirtland's warbler or how land management should be adapted to minimize potential impacts. Understanding and assessing the threat of climate change on Kirtland's warbler can be an important component in a defensible delisting decision for this species. Results can help identify where management adjustments (for example, spatial planning) may need to occur throughout its geographic distribution to identify and implement strategies that mitigate climate change impacts. Additionally, project results can be incorporated into the conservation plan, currently under development, which is intended to guide management of the species after delisting.

Pictured below: The Elk River and riparian forest in the Monongahela National Forest, West Virginia. Photograph by Craig Stihler, West Virginia Division of Natural Resources.

Energy

Domestic development of traditional and alternative energy is a national priority. Natural resource agencies have great need for scientific information that will assist them in providing information to regulatory agencies that can be used to minimize impacts to fish and wildlife resources.

Assessing Shorebird Use of Lagoons in Cape Krusenstern National Monument

Alaska Cooperative Fish and Wildlife Research Unit

Population trends for migratory shorebirds show a global pattern of decline. Many shorebird species are vulnerable to declines due, in part, to their dependence on intact networks of wetland habitats to complete long-distance migrations. In Alaska, the coastline of the Cape Krusenstern National Monument includes lagoons and estuaries, which are important areas for breeding and staging activities of migratory birds. Given the potential vulnerability of these areas to effects of offshore energy development, this study plans to assess post-breeding shorebird use. This information may be useful for understanding potential effects from offshore oil and gas development and for the development of resource protection strategies.

Chandalar River Chum Salmon Habitat Assessment and Monitoring

Alaska Cooperative Fish and Wildlife Research Unit

An increase in mining exploration and the effects of climate change have raised concerns about the future of Chandalar River chum salmon among local community members and State and Federal fisheries managers in Alaska. Yukon fall chum rely on systems that are spring fed or have geologically significant hyporheic groundwater upwellings, because these locations provide stable water temperatures for eggs and juveniles throughout the winter months. Limited information, however, is available on the spatial distribution and frequency of these upwellings on the Chandalar River. The research team plans to identify the longitudinal patterns of groundwater upwellings, as measured by thermal variability, and the relation between the spatial distribution of spawning salmon and groundwater discharge patterns. The results can help to advance fisheries conservation in Alaska.

Coastal Lagoon Fish Ecology Along the Chukchi Coast, Alaska

Alaska Cooperative Fish and Wildlife Research Unit

The ecology of coastal lagoons along northwestern Alaska is being investigated. Researchers are interested in understanding what food web species are important for subsistence fishes, what species occur in different types of lagoons, and the seasonal use of lagoons by fishes, with implications for climate change and petroleum development in the Chukchi Sea. This research can guide conservation planning in Alaska.

Pictured below: Sea ice is either absent or discontinuous during summer months in the Chukchi Sea off northern Alaska.

Food Web Dynamics and Productivity on the Susitna River

Alaska Cooperative Fish and Wildlife Research Unit

The proposed Susitna-Watana Hydroelectric project would include construction of a dam, reservoir, and related facilities in a remote part of the Susitna River, Alaska. Baseline information on food webs and salmonid productivity is needed on this large river to better understand how the dam may affect salmon in the river. The goals of this study are to determine major energy and nutrient pathways driving salmonid productivity and assess how the proposed dam may affect these energy/nutrient flow pathways and fishes. The hydroelectric project is a highly visible and controversial issue in Alaska, and findings from this study can help conservationists understand potential impacts to food web function and salmon production.

Shorebirds and Invertebrate Distribution on Delta Mudflats Along the Beaufort Sea

Alaska Cooperative Fish and Wildlife Research Unit

More information is needed about species composition, abundance, or distribution of the microfauna and meiofauna living within the interstitial spaces of the littoral zones along the Beaufort Sea coast. Shorebirds depend on meiofauna for food for premigratory fattening. The research team plans to take core samples along the shorelines for chemical analysis and survey the population structure, numbers of individuals, and diversity of populations from the interstitial spaces within the littoral zone of coastlines along the Beaufort Sea. The information obtained from the project can contribute to the advancement of mitigation measures and strategies to reduce potential impacts from exploration and development.

Publication

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Estimation of Wind Farm Mortality: Development of Super Population Approach to Estimate Cumulative Mortality From Carcass Surveys Accounting for Carcass Removal and Nondetection

Colorado Cooperative Fish and Wildlife Research Unit

The development of wind power has accelerated in the last 20 years, and concern has arisen about the impact of wind development on bird and, more recently, bat populations. Direct mortality of avian species by wind power is considered under the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act (BGEPA), and the ESA. This project intends to focus on estimating the number of bird fatalities at wind turbine projects by integrating the mortality, scavenging, and detection processes into the model. The expected results can provide managers and researchers with guidelines for conducting and analyzing data from studies of avian mortality at wind farms.

Bald eagle.

Uncertainty and the Entanglement of Habitat Loss and Fragmentation Effects in the Management of the Northern Bobwhite and Eastern Meadowlark

Georgia Cooperative Fish and Wildlife Research Unit

Wildlife managers are interested in knowing more about the uncertainty of habitat loss and the effects of fragmentation in the management of the northern bobwhite and eastern meadowlark. This project intends to evaluate threats to important grassland bird habitats of the Gulf Coast Prairie in oil and gas development areas, changes in land ownership patterns, and invasive species. The team plans to build models that project the results of these drivers under future economic scenarios and that predict the consequences of management alternatives intended to ameliorate these drivers. Additionally, the team wants to identify the drivers of habitat fragmentation so that actions can be designed to minimize threats to high-risk areas.

Northern bobwhite. Photograph by A. Unger.

Impacts of Energy Production, Habitat Selection, and Population Size on Resource Selection, Survival, and Recruitment of Lesser Prairie-Chickens in Oklahoma, Kansas, and Colorado

Kansas Cooperative Fish and Wildlife Research Unit

Information is needed to improve the understanding of lesser prairie-chicken ecology in Oklahoma, Kansas, and Colorado. Researchers plan to investigate the effects of energy production, habitat selection, and population size on resource selection, survival, and recruitment of lesser prairie-chickens. The research from this project can guide future management of the species.

Lesser prairie-chicken. Photograph by U.S. Fish and Wildlife Service.

Movements of Coastal Birds in Southern New England

Massachusetts Cooperative Fish and Wildlife Research Unit

Offshore wind energy is one of the fastest-growing segments of the world energy market, offering a clean and abundant source of electricity to meet increasing demands. Offshore wind facilities, however, may have detrimental effects on birds by exposing them to increased mortality through turbine collisions or by altering their behavior, habitat use, and movement patterns. Several wind energy facilities are currently being planned for offshore Atlantic waters of the United States. As part of this project, baseline information collection is planned for the distribution and behavior of coastal birds that can be used for evaluating interactions between birds and offshore turbines. The results from this research should complement other work that is underway or being planned by the Bureau of Ocean Energy Management, USFWS, and other agencies as part of a comprehensive evaluation to understand the potential interactions between wind energy facilities and wildlife within Federal waters of the Atlantic Ocean and to improve siting procedures for future facilities.

Wind turbines. Photograph by Don Becker, U.S. Geological Survey.

Offshore Movements of Migratory Bats in the Gulf of Maine

Massachusetts Cooperative Fish and Wildlife Research Unit

Wind energy development is promoted by both government and nonprofit entities as an environmentally friendly alternative to greenhouse gas-emitting fossil fuels, but the technology can have negative impacts on wildlife, including bats. For example, a recent study estimated 600,000 bats were killed by wind power in the United States in 2012. As wind power facilities expand and multiply, concern is growing that wind farm mortality could have significant effects on bat populations at large. This study plans to provide much needed information about bat migration in coastal and offshore environments to understand how best to site and operate coastal and offshore wind facilities to minimize bat mortality.

Offshore Wind Energy Technology, Environmental Impacts, and Policy

Massachusetts Cooperative Fish and Wildlife Research Unit

The development of offshore wind energy technology is on the rise, but several critical issues inhibit a clear understanding of how the development and operation of offshore wind energy facilities affect a variety of taxa. Researchers are conducting rigorous ecological assessments to evaluate the effects of offshore wind power on birds, bats, fish, and other marine species. Additionally, researchers are identifying critical areas and habitats for marine organisms by using radar, sonar, and spatial modeling to quantify population and community dynamics. The results from this work can increase the understanding of the effects of wind energy development on birds, bats, fish, and other marine species, identify critical areas, and generate monitoring protocols for detecting changes and associated risks.

Distribution and Habitat Selection/Space Use of Migratory and Resident Golden Eagles in Areas With High Potential for Wind Energy Development in New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

Predicting the risk that proposed wind energy developments might have on resident and migratory golden eagles in southeastern and south-central New Mexico is hampered by a lack of information. This research plans to address critical information needs by assessing habitat and space use of migratory and resident golden eagles in BLM managed areas, identifying nest sites and estimating productivity and survival of golden eagles, determining patterns of relatedness for resident and wintering golden eagles, and identifying the origin and migration patterns for golden eagles overwintering in southeastern and south-central New Mexico. The information from this study can strengthen the ability to predict potential risks and help develop effective mitigation strategies to reduce potential effects.

Investigating Impacts of Energy Development on Lesser Prairie-Chicken Reproduction, Survival, Movement, and Habitat Use in Eastern New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

Energy development is threatening the last remaining patches of habitat that lesser prairie-chickens require for long-term survival. It is still unclear, however, what aspect or combination of this disturbance (sound, vertical structure, vehicle traffic) or at what thresholds these disturbances are causing populations of the species to decline. This project involves gathering seasonal movement patterns and demographic data to quantify the impacts of energy development disturbance at both local and larger landscape scales. The results from this study can be used widely on this and other prairie grouse species to guide development within the remaining habitats needed to protect, conserve, and increase species distribution on the landscape.

Landscape Genetic Structure of the Western Continental Golden Eagle Population

New Mexico Cooperative Fish and Wildlife Research Unit

Reports 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. Mortalities at a particular wind energy facility can consequently affect breeding populations of golden eagles at local and continentwide scales. Information is needed to understand the distribution of breeding populations of eagles, the level of connectivity that exists among them, and where individuals from these populations migrate in the winter. Information from this study can improve the understanding of the movement ecology and landscape genetic structure of golden eagles in the Western United States.

Golden eagle fitted with a global positioning system backpack.

Eastern Brown Pelicans: Dispersal, Seasonal Movements, and Monitoring of Polycyclic Aromatic Hydrocarbons (PAHs) and Contaminants in the Northern Gulf of Mexico

South Carolina Cooperative Fish and Wildlife Research Unit

The ongoing exploration and development of oil and gas resources in the Gulf of Mexico, as well as potential renewable energy and alternate use projects, require continued and enhanced data to support a variety of decision documents, including but not limited to the National Environmental Policy Act, ESA, and MBTA. Nearshore seabirds, such as brown pelicans, can serve as a valuable indicator species for ecosystem

Brown pelican attending nest, Crab Bank, South Carolina.

health in marine, coastal, and estuarine systems because they are transboundary in nature, and information about the species can be integrated across a range of systems. Furthermore, pelicans are a species of conservation concern for most States in the Gulf region and the Southern Atlantic States. This research plans to address information gaps relative to brown pelicans in the Gulf of Mexico and provide baseline ecological information for the species in the region.

Publications

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Assessment of Surveys for Golden Eagles and Other Raptors

Texas Cooperative Fish and Wildlife Research Unit

Researchers are assessing survey protocols for eagles and other raptor species. This research is being conducted to provide reliable information to the USFWS to aid decisions regarding the issuance of incidental take permits of eagles at energy development sites. This research is critical, because wind energy development facilities are increasing dramatically across much of the range of golden eagles. The USFWS is charged with implementing the BGEPA, which prohibits the take of eagles unless authorized by the USFWS. An Eagle Permit Rule was issued by the USFWS in 2009 to authorize limited issuance of permits to take bald and golden eagles. The USFWS subsequently developed a draft "Eagle Conservation Plan Guidance" intended to provide a means of compliance with the BGEPA and guidance to permit applications. The draft guidance calls for scientifically valid surveys, monitoring approaches, risk assessments, and research designs proportionate to the risk to eagles. This guidance has become critical, because wind energy development facilities are increasing dramatically across much of the range of golden eagles.

Development of a Decision Tool for Eagle Take Permit Issuance Based on Detection and Occupancy Models of Migrant and Overwintering Golden Eagle in the Southern Great Plains

Texas Cooperative Fish and Wildlife Research Unit

Mortality caused by collision with wind turbine blades may have population-level effects on the golden eagle. The southern Great Plains generally is thought to experience an influx of golden and bald eagles during the migration and winter periods. The research team plans to develop a decision analysis tool to directly support sound risk assessment and robust construction surveys at wind energy projects. No quantitative data exist for eagle presence, densities, or landscape use during migration and winter periods in the southern Great Plains, a region undergoing rapid wind energy development. The research team anticipates the development of a tool that can be used by the USFWS to evaluate permit requests and help design and implement novel strategies to avoid eagle fatalities at wind energy projects in the southern Great Plains.

Influence of Wind Energy on Swainson's Hawk Ecology

Texas Cooperative Fish and Wildlife Research Unit

Wind energy development is becoming common in the United States, but wind turbines pose dangers for birds and bats. This project is focused on identifying how wind energy development may pose a mortality risk from direct collision for birds of prey as well as potential behavioral influences such as avoidance of areas and, therefore, net loss of habitat. Scientists use GPS transmitters to assess sex-specific movements, habitat use, reproductive success, and foraging efficiency of Swainson's hawks in or adjacent to wind energy centers compared to those distant from wind energy centers. Results from this project can be used to assess the potential risk to Swainson's hawks (also applicable to other raptor species using the same migration route) from wind energy

Swainson's hawk. Photograph by U.S. Fish and Wildlife Service.

developments throughout the multinational migration route of the species as well as wintering and summering ranges. This information is critical to decisions relative to wind energy development.

Winter Abundance and Habitat Associations of Golden Eagles

Texas Cooperative Fish and Wildlife Research Unit

The golden eagle is a large, apex predatory bird that typically has low densities, a long life span, delayed maturity with low reproductive rates, and no natural predators. These life history attributes make golden eagles vulnerable to additional mortality caused by collisions with wind turbines and may result in population-level effects. The USFWS has established regulations that limit the number of permits for the take of golden and bald eagles and provides guidance for comprehensive plans to avoid and offset mortality of eagles at wind energy projects. This study can improve future plans and the subsequent issuance of permits by providing quantitative information to guide survey methods used to predict effects prior to wind farm construction and can optimize detection rates across different landscapes and seasons in post-construction monitoring surveys.

Dr. Clint Boal, Texas Cooperative Fish and Wildlife Research Unit, observing a golden eagle nest in the caprock canyon country of west Texas.

Impact of Mining Effluent on Fish Populations

Virginia Cooperative Fish and Wildlife Research Unit

As part of the Appalachian Research Initiative for Environmental Science, changes in stream water quality are being studied as related to activities of the energy sector. Specifically, researchers are examining the effects of coal mining on stream fishes at individual, population, and community levels of organization. This project plans to quantify the potential effects of mining on downstream water quality and help decision makers understand potential tradeoffs between mining activities and the abundance and diversity of the downstream fish community.

Cheat Lake Biomonitoring Study

West Virginia Cooperative Fish and Wildlife Research Unit

Cheat Lake, a recreational fisheries reservoir in northern West Virginia, experiences seasonal lake level fluctuations attributed to hydropower production. The research team intends to monitor fish, assess physical and chemical water quality, map vegetation, and create a bathymetric map of Cheat Lake. The West Virginia Division of Natural Resources can use the project data to address the impacts of lake level fluctuations on recreational fisheries.

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

West Virginia Cooperative Fish and Wildlife Research Unit

Shale gas is being developed over large landscapes and is affecting many headwater streams. The research team examined the effects of shale gas development on Louisiana waterthrush and benthic macroinvertebrate communities in 12 West Virginia headwater streams. The project goal is to better understand the effects of shale gas development on headwater stream plant communities. Although the study spanned only one season, the results suggest that shale gas development affected waterthrush and benthic communities in the headwater streams studied. Thus, the ecological effects of shale gas development warrant closer examination.

Regionwide Songbird Response to Gas Well and Infrastructure Development of Marcellus Shale

West Virginia Cooperative Fish and Wildlife Research Unit

Extraction of natural gas from Marcellus Shale has increased exponentially in the central Appalachian region. Researchers plan to quantify how the size, shape, age, and placement of gas well pads and pipelines in the landscape impact the abundance and diversity of forest songbirds across the Marcellus Shale region. These results can inform conservation professionals as well as industry regarding the effects of Marcellus development on forest birds and can provide baseline data that can be used to monitor bird populations and assess the effects of development over a long period of time.

Genetic Assessment of Seven Fish Species Above and Below the Wisconsin River Dam at Prairie Du Sac

Wisconsin Cooperative Fishery Research Unit

Dams can separate fish from resources or habitat needed during critical life stages. Therefore, fragmented river systems are of increasing concern to fish managers, because the seclusion of local and migratory fish populations may contribute to a greater risk of population decline or extirpation. The Wisconsin River is intensively controlled by dams to generate hydroelectric power or to regulate water levels in lakes and reservoirs or during flood events. These structures likely restrict or eliminate upstream and downstream fish movement, resulting in habitat fragmentation and localized isolation of fish populations. The research team plans to compare the genetic structure of seven species above and below Prairie du Sac Dam. This information can be used for developing strategies for management of the dam and other similar systems, if warranted, and for conserving genetic diversity.

Demography and Habitat Use of Moose in Sublette County, Wyoming

Wyoming Cooperative Fish and Wildlife Research Unit

The moose herd in Sublette County accounts for 55–65 percent of all moose counted in Wyoming. This herd represents the largest population of Shiras moose in the lower 48 States and carries great economic and cultural significance to the State of Wyoming. Unfortunately, information on the basic life history and ecology of this herd is lacking. This project plans to provide baseline information on the interacting influences of nutritional condition, disease, and predation for this important Wyoming moose herd prior to energy development. The study results can provide critical information for predicting and quantifying potential effects of future energy development projects.

Effects of Wyoming Range Energy Development for Native Fish Communities

Wyoming Cooperative Fish and Wildlife Research Unit

Wyoming has experienced a significant increase in energy development over the last two decades, and the eastern front of the Wyoming Range has been impacted by this increase. Oil and gas are currently being extracted throughout the southern extent of the Wyoming Range, and proposed expansion to the northern extent threatens to undermine the area's ecological integrity and biodiversity. This study plans to address the effects of energy development on native fish communities. Specifically, the research team intends to assess habitat and water-quality characteristics and evaluate how the presence and intensity of energy development influence habitat and water quality in Dry Piney Creek and Beaver Creek in the Green River Basin. This research can contribute to knowledge of current ecological impacts that are affecting fish assemblages as well as anticipate how future development might impact presently undisturbed areas.

Influence of Energy Development on Mule Deer Migrations

Wyoming Cooperative Fish and Wildlife Research Unit

As habitat loss and fragmentation increase across ungulate ranges, identifying and prioritizing migration routes for land-use planning and conservation has taken on a new urgency. Currently, much conservation attention is focused on determining whether continued energy development, without consideration for migration routes, will lead to the loss of ecological functions and population-level declines (including local extirpations) of harvested ungulate populations. The results of this research can provide an understanding of threshold levels of development and allow resource managers to properly manage Wyoming's ungulate populations while designing a sustainable energy development plan.

Influence of Energy Development on Nongame Sagebrush Birds

Wyoming Cooperative Fish and Wildlife Research Unit

One of the most influential sources of ongoing sagebrush loss and change in Wyoming is oil and natural gas development. Researchers plan to continue simultaneously monitoring avian nest success, nest predation by different predators, and the abundance of nest predators across gradients in energy development and test alternative hypotheses for why nest predation and the abundance of some important nest predator species increase with well density. This research dovetails with ongoing Wyoming Landscape Conservation Initiative efforts for other taxa and can clarify the extent to which songbird populations are impacted by gas wells versus other co-varying factors. This project can also provide a basis for generating specific management and mitigation recommendations to minimize reproductive impacts to already declining sagebrush and songbird populations.

Mule Deer Fitness and Nutrition

Wyoming Cooperative Fish and Wildlife Research Unit

Linking population-level changes of ungulates to behavioral changes resulting from human development remains a key knowledge gap that inhibits effective mitigation. Researchers are conducting a 3-year study of nutrition and fitness of mule deer exposed to a gradient of human disturbance associated with natural gas development across three winter ranges in western Wyoming: the Pinedale Anticline Project Area and two distinct winter ranges occupied by Wyoming Range mule deer. This work incorporates 12 years of detailed research on the behavioral responses of mule deer to energy development in the study area and provides a mechanistic evaluation of the cumulative effects of energy development on a large spatial scale.

Wyoming Range Native Fish and Energy Development

Wyoming Cooperative Fish and Wildlife Research Unit

The habitat and water-quality factors that influence the presence and abundance of native fishes such as Snake River and Colorado River cutthroat trout, mountain sucker, mottled sculpin, and speckled dace are poorly understood. This study plans to address the potential effects of energy development on native fish communities. The research team intends to explore the abundance and distribution of species to habitat and water-quality parameters and develop predictive models to relate changes in habitat and water quality to the presence and intensity of energy development. The results of this study can provide fisheries managers with a tool to balance potential energy development with the maintenance of native fish populations across a broad geographic range.

Pictured below: A male Brewer's sparrow singing from his sagebrush perch. Nests are located on the basis of adult territoriality behaviors and systematic searching.

Human Dimensions

Feeding wildlife by the shore. Understanding the relations between humans and wildlife is one aspect of human dimensions research.

Doris Duke Conservation Scholars Program Partnership Through the University of Florida

Florida Cooperative Fish and Wildlife Research Unit

Although the cultural and racial demographics of the U.S. society are changing, representation and participation in the natural resources field by traditionally underrepresented groups continue to lag. The Doris Duke Conservation Scholars Program pairs graduate student mentors with undergraduate students to engage the undergraduates in meaningful field experiences and participation in research studies with the goal of advancing their interests in pursuing a natural resource-related career. This initiative is expected to be a model for conservation and perhaps other professions and to make a substantive, diverse contribution to the future pool of natural resource academics and professionals. This program is currently active at five universities and Cooperative Fish and Wildlife Research Units.

Assessment of Trout Management in Georgia

Georgia Cooperative Fish and Wildlife Research Unit

The Georgia Cooperative Fish and Wildlife Research Unit is collaborating with the Georgia Department of Natural Resources to formulate a trout management strategy. The overarching goal for this project is to increase the amount and usability of social-ecological information available to managers for making fisheries management decisions. The research team plans to develop and conduct a survey of trout anglers to help the Georgia Department of Natural Resources assess stakeholders' expectations and preferences for fishing experiences. Researchers plan to work with the Department to determine the availability of suitable habitat for trout and identify options for supplying trout fishing opportunities now and into the future.

Environmental Stressors and Priority Plant Communities on Jekyll Island, Georgia

Georgia Cooperative Fish and Wildlife Research Unit

Jekyll Island, Georgia, is a barrier island that supports developed tourism amenities and a residential community as well as a State park. Resource managers are committed to conserving and managing most of the island's area as natural habitat. Natural areas on Jekyll Island are facing a multitude of environmental stresses, the root causes of which are mostly anthropogenic. Sea level rise, climate change, altered surface and groundwater hydrology, fire suppression, invasive species, land development, and altered wildlife abundances can all affect the dynamics of vegetation communities. To surmount these complexities, this project combines three suites of scientific studies to (1) investigate the effects of multiple stressors on vegetation structure and dynamics in three high-priority plant communities, (2) integrate field and existing data on expected management outcomes into a decision support framework, and (3) evaluate stakeholder views toward management options. This approach should deliver relevant, novel ecological information on the consequences of ecological stressors on high-priority natural areas and may leverage ecological conservation strategies and the values held by diverse stakeholders.

Latham River at Jekyll Island State Park, Georgia.

A Case Study of the AmeriCorps Volunteer in Service to America Program

Iowa Cooperative Fish and Wildlife Research Unit

The Iowa Department of Natural Resources uses AmeriCorps volunteers to expand the number of wildlife habitat improvement projects that can be accomplished. In order to determine the value of using the AmeriCorps program, the

Iowa Department of Natural Resources requested an independent evaluation of the effectiveness of the program. The case study suggested that the number of acres of habitat improvement increased with AmeriCorps volunteers compared to previous years without the volunteers. Additionally, the amount of habitat improvement by AmeriCorps volunteers was comparable to the amount of habitat improvement by Iowa Department of Natural Resources Private Lands Project staff. The Iowa Department of Natural Resources can use the case study data to make habitat conservation decisions.


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Teach Fish and Wildlife Management at the Iowa State College at Ames

Poverty or Conservation Your National Problem

In 1932, Ding Darling's recognition of the need for biological information, trained wildlife managers, and dissemination of information to management agencies led to his negotiation of an agreement among the Iowa State College, the Iowa Fish and Game Commission, and Darling to form and support the first cooperative wildlife research unit.

Assessing Attitudes and Impacts to Society Associated With the Use of Alternative Ammunition for Hunting on National Wildlife Refuges

Massachusetts Cooperative Fish and Wildlife Research Unit

A study is being conducted in collaboration with the USFWS to assess a voluntary approach to using nontoxic ammunition for hunting white-tailed deer on targeted NWRs in the Northeastern United States. This study intends to address the human dimensions associated with converting to the use of nontoxic ammunition by identifying key stakeholders and their attitudes and beliefs on the topic. The research team plans to gather baseline data and quantify stakeholder attitudes regarding the use of nonlead-based ammunition. Facilitating stakeholder involvement allows managers to incorporate stakeholder interests in the management decision process. This process can benefit managers by increasing the potential for a successful transition to alternative ammunition use by cultivating stakeholder interest and increasing resilience of management decisions.


Hunters at dawn on a National Wildlife Refuge. Photograph by U.S. Fish and Wildlife Service.

Assessing the Values, Expectations, and Satisfaction of Hunters Regarding Controlled White-Tailed Deer Hunts in Suburban Eastern Massachusetts

Massachusetts Cooperative Fish and Wildlife Research Unit

The Blue Hills Deer Management Program in suburban Boston presents an ideal opportunity for investigating the motivations, expectations, and satisfaction of deer hunters through the use of a survey. The objectives of this survey effort are to assess an individual's motivations for hunting deer, and more specifically, at the Blue Hills in order to understand why hunters are interested in controlled hunts and to what extent they are interested in participation. Additionally, the research team intends to explore what, if any, prior expectations hunters have for controlled hunts. The data from this project can inform wildlife management decisions in Massachusetts.

Assessing the Preferences of Stakeholders and Waterfowl Management Professionals to Inform Implementation of the North American Waterfowl Management Plan

Minnesota Cooperative Fish and Wildlife Research Unit

Key research activities, associated with a broad proposal by the USFWS National Flyway Council's Human Dimensions Working Group, are being conducted to research the involvement of key stakeholders in the United States and Canada that can inform implementation of the North American


The North American Waterfowl Management Plan was signed in 1986 by the United States and Canada and in 1994 by Mexico. Photograph by U.S. Fish and Wildlife Service.

Waterfowl Management Plan (NAWMP). The research team plans to assess the preferences of stakeholders and waterfowl management professionals regarding waterfowl population management alternatives. Results from this project can assist managers in developing management alternatives that are most responsive to stakeholder desires.

Deer Hunter Attitudes

Minnesota Cooperative Fish and Wildlife Research Unit

Developing hunting regulations that help reduce deer numbers and balance deer sex ratios is a challenge throughout the eastern half of the United States. These challenges are exacerbated by the need to maintain hunter and landowner satisfaction and trust. The research team plans to use mixed mode survey methods to enhance the understanding of deer hunter attitudes and perceptions of deer populations, hunter motivations and satisfaction, agency trust, and governance statewide. Results from this study can be used to assist Minnesota Department of Natural Resources managers in selecting regulations that can be effective and supported by landowners and hunters.

Landowner Attitudes Toward Elk

Minnesota Cooperative Fish and Wildlife Research Unit

Through restoration efforts and immigration from Manitoba and North Dakota, there are currently about 150 elk in northwest Minnesota. The long-term vision for elk management in Minnesota is to enhance the population size and range extent of elk while maintaining coexistence with private landowners. Although multiple States east of the Rocky Mountains have initiated elk restoration efforts, the primary literature lacks information pertinent to understanding the preferences of private landowners for elk management in an agricultural landscape. The objective of this study is to determine the attitudes of landowners within the elk range toward elk and their preferences for future elk management.

Long-Term Research and Monitoring of Human Dimensions Information on Fisheries and Wildlife Management Issues in Minnesota

Minnesota Cooperative Fish and Wildlife Research Unit

The Minnesota Cooperative Fish and Wildlife Research Unit is continuing a long-term research effort to collect timely information to assist in the evaluation of fish and wildlife management programs in Minnesota. This project provides a consistent process to develop a long-term database of what factors influence angler and hunter experience, satisfaction, and level of support for management programs to improve the understanding of factors influencing trends in both recreational participation in fisheries and wildlife-based activities. As part of the project, researchers also plan to examine how attitudes and beliefs about fish and wildlife management issues are changing over time.

Minnesota Fish Habitat Survey

Minnesota Cooperative Fish and Wildlife Research Unit

Angler beliefs and perceptions about fish habitats in Minnesota are being studied. The research team intends to survey respondents on fishing habits, species preferences, and satisfaction with their overall fishing experience. This information can inform how managers can better connect the importance of habitat to sustainable fisheries management.

Minnesota Northern Pike Regulations

Minnesota Cooperative Fish and Wildlife Research Unit

The northern pike is the most widely distributed and one of the most popular game fish in Minnesota, with more than a third of resident anglers indicating that they specifically target pike. In 2010, a survey was conducted for the Minnesota Department of Natural Resources to understand the regulatory and site experiences and preferences of pike anglers and spearers. This study plans to update information from the previous survey and collect additional preference information concerning size and bag limit regulations for northern pike in different regions of Minnesota.

Family fishing. Photograph by U.S. Fish and Wildlife Service.

Minnesota Waterfowl Hunter Survey

Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota generally has been in the top three States for number of waterfowl hunters in the United States. In recent years, researchers have expanded efforts to obtain quantitative information about opinions and motivations for this important clientele. A series of surveys were completed between 2005

and 2010 that analyzed hunter motivation, satisfaction, and retention. Information from these studies has been used to inform management decisions. The current study can allow continued long-term monitoring of trends in hunter satisfaction and attitudes toward management.

Waterfowl hunting in Minnesota. Photograph by U.S. Fish and Wildlife Service.

Visitor Use of Wildlife Management Areas

Minnesota Cooperative Fish and Wildlife Research Unit

Hunting and wildlife watching are a combined $1 billion industry in Minnesota. The Minnesota Department of Natural Resources manages more than 1,400 wildlife management areas (WMAs) totaling more than 1.3 million acres. These WMAs are part of Minnesota's outdoor recreation system and are established to protect those lands and waters that have a high potential for wildlife production, public hunting, trapping, fishing, and other compatible recreational uses. The objective of this project is to conduct a visitor use survey of WMAs. These data are particularly important to determine not only how the WMAs are used, but also what species are hunted, the distribution of uses, and economic considerations.

Wild Turkey Hunter Study

Minnesota Cooperative Fish and Wildlife Research Unit

To successfully manage the turkey harvest in Minnesota, wildlife managers need to consider the satisfaction of turkey hunters. However, hunter attitudes and perceptions of regulatory alternatives are unknown. Consequently, this study is designed to include an evaluation of Minnesota's spring turkey hunting season and the examination of alternatives that might provide opportunities for improving hunter satisfaction while sustaining the turkey population. Results from this study can be used to implement regulatory harvest changes that achieve both hunter satisfaction and turkey population objectives.

Evaluation of Nontoxic Ammunition Outreach Efforts on Midwest Region National Wildlife Refuges

Missouri Cooperative Fish and Wildlife Research Unit

In April 2014, the USFWS Midwest Region chartered a working group to reduce the risk of lead exposure to bald eagles caused by spent lead ammunition from deer hunting on NWR lands in the region. Scientific evidence links hunting with lead ammunition to lead poisoning and mortalities for wildlife. This project focuses on evaluating the outreach strategies used to determine if the Midwest Region NWRs are succeeding in convincing hunters to switch to nontoxic ammunition. Information about the attitudes and beliefs of hunters, as well as other factors that may contribute to a hunter's ability or decision to use nontoxic ammunition, can be explored. A better understanding of the influences on behavior and the impact of outreach strategies can guide outreach efforts in the region.

Angler Behavior in Response to Management Actions on Nebraska Reservoirs

Nebraska Cooperative Fish and Wildlife Research Unit

A fishery is a complex social-ecological system in which there are continual feedback loops between the social and ecological components, and in which there are multiple states for both social and ecological components, with unknown thresholds between states. The goal of this project is to understand the interactions and associated thresholds and feedback mechanisms between angler behavior and fish behavior in response to angling on local and regional levels. Quantifying and understanding these interactive influences on multiple scales can allow for more informed management of recreational fisheries.

Assessment of Angler Use and Catch During 2016 at Sutherland Reservoir, Nebraska

Nebraska Cooperative Fish and Wildlife Research Unit

Recreational fishing provides many socioeconomic and ecological benefits. These benefits are derived in different forms that can improve the quality of life and income generated for stakeholders. This importance has increased demands on these fisheries, often leading to overexploitation, selective harvest, sublethal effects, and disturbance or harvest during critical reproductive periods. Consequently, there is a need for better understanding social-ecological relations and the effects of interactions between humans and fish populations.

The purpose of this study is to estimate angler use and catch at Sutherland Reservoir, Nebraska, during April through October 2016. Specifically, plans are to obtain monthly and yearly estimates of angler pressure, catch, and harvest. This information can enable the Nebraska Public Power District in evaluating angler use and the influence of the fishery at

Sutherland Reservoir. Data collected could also be used to guide management efforts in balancing hydropower use and maintaining a quality fishery at this multiuse reservoir.

Comprehensive Evaluation of the Nebraska Outdoor Enthusiast

Nebraska Cooperative Fish and Wildlife Research Unit

Participation by outdoor enthusiasts is a central component of wildlife and fisheries management in Nebraska and throughout the United States. Fishing and hunting license sales and taxes on fishing and hunting equipment are vital sources of funding for wildlife management agencies, and in many cases, management objectives are met under the stewardship of sportspersons. The purpose of this project is to understand what differentiates participating outdoor enthusiasts by compiling available fishing and hunting license datasets and merging them with larger sociodemographic data. These data can then help identify key demographic factors among license holders and subsequently be used to develop decision-support tools that give insight into how fish and wildlife managers can direct management, recruitment, and retention efforts.

Human Dimensions of Habitat Loss in the Plains and Prairie Pothole Region

South Dakota Cooperative Fish and Wildlife Research Unit

The Plains and Prairie Potholes Landscape Conservation Cooperative (LCC) identified habitat loss as a priority research need. The grassland wetland ecosystem provides essential habitat for an array of wildlife, especially waterfowl. The research team plans to measure attitudes and behaviors of landowners relative to participation in conservation programs, future changes in farming practices, and wildlife value. Understanding how a private landowner responds to economic incentives or pressures may identify strategies to reduce habitat loss in the plains and prairie pothole region.

Social and Economic Impact of Fishing in Selected Small Lakes and Impoundments in South Dakota

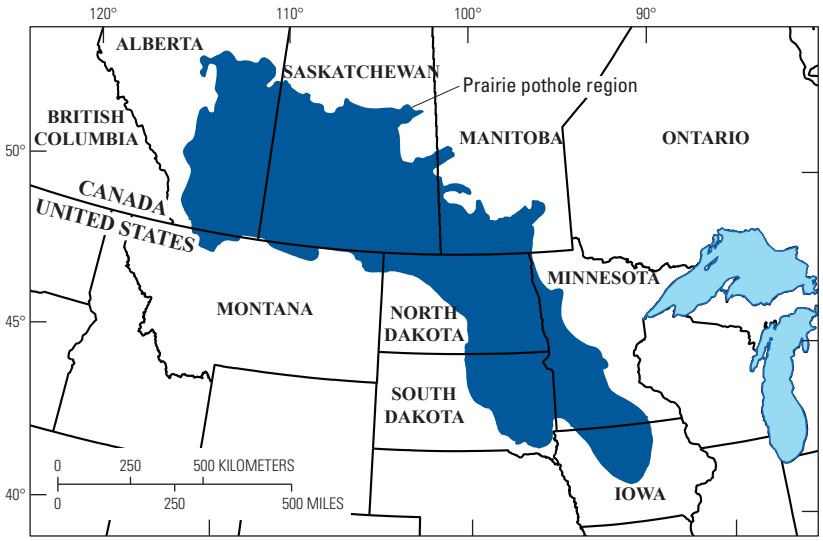
South Dakota Cooperative Fish and Wildlife Research Unit

South Dakota Game, Fish and Parks uses information on fishing in selected small lakes and impoundments to determine the local economic impact of fishing activities on the surrounding communities. This study intends to estimate angler use and associated expenditures in several areas that are expected to require expensive habitat renovation projects to improve or maintain quality recreational services in the future. The economic information on the value of fishing can help managers prioritize decisions regarding expensive habitat renovation projects.

Valuing Wildlife in the United States

Wisconsin Cooperative Wildlife Research Unit

Based in large part on the North American Model of Wildlife Conservation, free-ranging wildlife has always been considered a public trust resource and not a marketable commodity. Although there are many merits to this model, it is extremely difficult to economically value wildlife when necessary. This study is designed to conduct a preliminary assessment of the economic value of free-ranging wildlife resources in the United States. The research team plans to evaluate levels of participation, direct expenditures, indirect economic benefits, and expenditures of wildlife management. The goal is to provide a basic summary of the economic importance of wildlife resources for use in policy and management decisions.



Lambert Conformal Conic projection. Standard parallels 33°N. and 45°N. Central meridian 96°W. North American Datum of 1983

Location of the prairie pothole region.

Prairie wetland at The Nature Conservancy's Samuel H. Ordway Memorial Preserve, South Dakota. Photograph by W. Carter Johnson, U.S. Geological Survey.

Invasive Species

The economic, environmental, and health-related costs of invasive species exceed those of all other natural disasters combined.

Development of Decision Analysis Tools for Controlling New Zealand Mudsnails in Fish Hatcheries

Idaho Cooperative Fish and Wildlife Research Unit

The successful colonization of invasive New Zealand mudsnails in waters in Europe, Australia, Japan, and North America has caused concern for management agencies. Invasive New Zealand mudsnails can displace native macroinvertebrate communities and alter dynamics in rivers and streams. In the United States, Federal and State executive orders mandate risk assessments be conducted and measures be taken to limit the introduction of invasive species through operations and activities. Researchers plan to complete a draft decision control manual that summarizes the state of the science of invasive New Zealand mudsnails.

New Zealand mudsnail. Photograph by U.S. Fish and Wildlife Service.

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Stockton, K.A., and Moffitt, C.M., 2013, Disinfection of three wading boot surfaces infested with New Zealand mudsnails: North American Journal of Fisheries Management, v. 33, no. 3, p. 529–538, https://doi.org/10.1080/02755947.2013.768569.

Sampling Designs and Population Dynamics of Burbot in the Green River System: Tools for Management

Idaho Cooperative Fish and Wildlife Research Unit

Although burbot are a species of high conservation concern over much of their distribution, they are an invasive species in the Green River, Wyoming, where they were illegally introduced. Researchers intend to evaluate a number of different sampling approaches across multiple systems and habitats to determine the best methods for removing burbot from the system. Results can provide managers with information on the distribution, habitat associations, and population dynamics of burbot in the Green River.

Synthesis of Measures for Controlling Invasive Mollusks at Hatcheries

Idaho Cooperative Fish and Wildlife Research Unit

Aquatic invasive species, by their very definition, pose significant threats to the economy, environment, and personal health. An infestation of Asian clams in Lake Pend Oreille was identified in April 2012 near marinas in Ellisport Bay, Idaho. Rapid control or eradication of this infestation is critical to lake management, because infestations of Asian clams in other lakes have affected water column chemistry, nutrient dynamics, energy flow, and food web structure. This project can provide guidance documents for risk assessment and control measures for invasive mollusks in fish hatchery operations and synthesize tools used for control.

Publications

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Asian Carp Population Ecology in Tributaries of the Upper Missouri River

Iowa Cooperative Fish and Wildlife Research Unit

Asian carp are expanding throughout the Upper Missouri River Basin and are of great concern because of their numerous impacts. Asian carp reproduce and grow quickly and compete with early life stages of native species and, thus, have reduced abundances of native and economically important species where the Asian carp have become established. The research team plans to investigate population ecology of Asian carp in the Upper Missouri River Basin. Specifically, the team intends to evaluate the influence of environmental conditions, population characteristics, and patterns of large-scale spatial synchrony of recruitment, growth, and reproduction. Natural resource managers in the Upper Missouri River Basin can use the study results to control the abundance and spread of Asian carp.

Asian carp breaking the water surface behind a research boat.

Wildlife Response to the Restoration of Tall-Grass Prairie Infested With *Lespedeza cuneata*

Kansas Cooperative Fish and Wildlife Research Unit

Two factors in the long-term management of the Great Plains ecosystems are to assess the restoration of prairie and wetland ecosystems and to measure conservation benefits. This project is designed to measure wildlife response to restoration of grasslands infested with an invasive plant by using fire and grazing. Results from this and related studies can enable better quantification of the effectiveness of conservation efforts in the Great Plains.

Marshbird Response to Invasive Cattail Control Using Grazing, Mowing, and Herbicide Application in the Prairie Pothole Region of Minnesota

Minnesota Cooperative Fish and Wildlife Research Unit

Secretive marshbirds are a group of birds that is poorly understood in North America and elsewhere. Many of the wetlands where they are found have been altered by invasive vegetation, and the effects of management to control invasive vegetation on marshbirds have not been studied extensively. This project is designed to evaluate the response of bird communities to the control of invasive vegetation by developing protocols to assess the effects of several treatments to remove invasive vegetation. Land managers can use the results to inform management of prairie wetlands across central North America.

Contrasting the Thermal Ecology of the Native Coldwater Crayfish and the Native Ringed Crayfish: Do These Species Have Similar Thermal Tolerances and Preferences?

Missouri Cooperative Fish and Wildlife Research Unit

Resource managers are interested in knowing if coldwater crayfish and native ringed crayfish have similar thermal tolerances and preferences. Researchers plan to investigate the thermal preference and tolerance of coldwater crayfish and native ringed crayfish in a laboratory setting to enhance the understanding of invasive species dynamics. This research can help inform decisions on invasive species management.

Annual Evaluation and Development of Benchmarks for Lake Trout Suppression in Yellowstone Lake

Montana Cooperative Fishery Research Unit

The NPS's Native Fish Conservation Plan proposed a framework for conserving native fish in Yellowstone National Park from 2011 to 2031. An important component of the Native Fish Conservation Plan is to continue suppression of nonnative lake trout in Yellowstone Lake for the conservation benefit of native Yellowstone cutthroat trout. The NPS desires to restore Yellowstone cutthroat trout abundance to the level present at the early stages of lake trout invasion. Targets for fishing efforts are included in the Native Fish Conservation Plan; however, results from population models that provide these targets change as new data are incorporated, so fishing targets must be evaluated annually.

Effects of Water Chemistry on Lake Trout Embryos

Montana Cooperative Fishery Research Unit

Introductions of nonnative lake trout into lakes of the Northwestern United States pose serious threats to native fish because lake trout are keystone predators that directly or indirectly affect all other fishes as well as other taxa. The illegal introduction of lake trout into Yellowstone Lake in Yellowstone National Park is the most highly publicized instance of this fishery resource issue. The native Yellowstone cutthroat trout of Yellowstone Lake are threatened with extirpation by the presence of this large piscivore. The objectives of this study are to conduct controlled laboratory and field experiments to evaluate the effects of chemical and mechanical methods on mortality of lake trout embryos.

Pictured below: Yellowstone Lake, Yellowstone National Park. Photograph by Neal Herbert, National Park Service.

Evaluation of Methods to Introduce Mortality in Lake Trout Embryos

Montana Cooperative Fishery Research Unit

Lake trout have been intentionally or inadvertently introduced into many lakes throughout the West, and the establishment of nonnative lake trout populations often causes declines in native species abundance. For example, introduced lake trout threaten to extirpate native Yellowstone cutthroat trout in Yellowstone Lake. Gillnetting is the primary method used to suppress lake trout in Yellowstone Lake; however, some Yellowstone cutthroat trout are captured in gillnets and die. The exploration of alternative methods to suppress lake trout to minimize bycatch of the targeted species is gaining momentum. This project plans to evaluate the efficacy of the suction dredge in inducing mortality in lake trout embryos and help inform management decisions in Yellowstone National Park.

Identifying the Threats of Smallmouth Bass to Yellowstone Cutthroat Trout in the Yellowstone River

Montana Cooperative Fishery Research Unit

The current extant populations of Yellowstone cutthroat trout occupy less than 50 percent of the historical range for this species. This range and population reduction has largely been attributed to habitat degradation and displacement by nonnative salmonids; however, recently there has been growing concern of the effects of rapidly spreading invasive fishes such as smallmouth bass. Using radio telemetry and modeling, this project is designed to specifically identify the current and likely future threats of smallmouth bass to Yellowstone cutthroat trout in the Yellowstone River, a high priority conservation watershed. The results can help identify and prioritize potential management actions to control and reduce the effects of smallmouth bass, thus allowing more effective use of resources to enhance the conservation of Yellowstone cutthroat trout.

Mobile Tracking of Lake Trout on Yellowstone Lake

Montana Cooperative Fishery Research Unit

Invasive lake trout in Yellowstone Lake have decimated the native Yellowstone cutthroat trout population, and lake trout removal has grown into a multimillion dollar operation. Targeting known spawning grounds has proven to be a successful strategy for removing large quantities of mature fish, but information is needed on spawning locations. This study intends to monitor the movements of lake trout in Yellowstone Lake with the objective of confirming previously unknown spawning locations.

An Estimate of the Abundance and an Assessment of the Efficacy of Sterilization Techniques for the Control of Wild Burro Populations

New Mexico Cooperative Fish and Wildlife Research Unit

Feral burro populations have increased in numbers and are impacting fragile desert plant communities. Additionally, feral burros are reducing forage availability for domestic livestock and wildlife. The feral burros are seeking forage and water near human populations. Fort Irwin, California, has a relatively large population of burros (approximately 1,000) that enter into the cantonment area, which results in human-wildlife conflicts. This research is designed to estimate the size of the burro population, examine patterns of space use, and employ methods to reduce recruitment. Overall, the research is of particular interest to Fort Irwin personnel who can use the results for evaluating management options for the feral burro population to minimize conflicts.

Assessment of the Invasion of the Asian Swamp Eels in the Chattahoochee River National Recreation Area

Oklahoma Cooperative Fish and Wildlife Research Unit

The Asian swamp eel has been introduced into five broad areas of the United States (encompassing four States—Hawaii, New Jersey, Florida, and Georgia), primarily through the live food market or aquarium trade. The first introduced population in the Chattahoochee River National Recreation Area has persisted for more than 20 years with recent captures of fish in marshes adjacent to the river, but it is unclear if these fish represent successful spawning in the marsh or emigration from connected ponds. The purpose of this study is to assess the extent and reproduction potential of this population. The data can enable managers to better understand the scope of the invasion and plan for future control or eradication measures.

Juvenile Asian swamp eel captured from a backwater marsh adjacent to the Chattahoochee River, Georgia.

Preliminary Determination of Density and Distribution of Flathead Catfish in the Susquehanna River and Selected Tributaries

Pennsylvania Cooperative Fish and Wildlife Research Unit

Invasive flathead catfish have become established in the Susquehanna River, but little information exists on their abundance. The research team plans to develop models based on population vital rates and habitat use of the species. The goal of this project is to estimate the relative abundance and age and growth characteristics of flathead catfish. Additionally, the models can be developed to evaluate potential impacts to areas where flathead catfish have not yet invaded. The data can be used to inform management decisions throughout the Susquehanna River Basin.

Economic Impacts of Feral Hogs on Agriculture in South Carolina

South Carolina Cooperative Fish and Wildlife Research Unit

Feral hogs are an invasive species presently found in at least 36 States in the United States, including South Carolina, and can negatively affect native species, agricultural systems, domestic livestock, and human health. Researchers plan to conduct feral hog damage assessments on South Carolina farms. Information from this study should be important to natural resource managers who are developing management strategies.

Effects of Asian Carp Invasion on the Food Web of a Mussel Biodiversity Hotspot in Tennessee

Tennessee Cooperative Fishery Research Unit

Asian carp continue to spread throughout the Mississippi River Basin and have recently become established in the lower Tennessee River watershed. Silver carp have now entered the Duck River, a tributary to the Tennessee River, which is a hotspot for fish, crayfish, and mussel biodiversity and is considered "North America's richest river" in aquatic biodiversity by The Nature Conservancy. The research team plans to evaluate diet niche overlap between native mussels and silver carp in the Duck River over three seasons. The project results can inform Asian carp removal efforts across Tennessee.

Asian carp.

Invasive Asian Carp in Tennessee Rivers

Tennessee Cooperative Fishery Research Unit

The invasive bighead carp and silver carp (collectively referred to as Asian carp) both were introduced into the United States in the 1970s to control algae blooms and improve water quality in aquaculture ponds and wastewater systems. Some Asian carp subsequently escaped and established wild populations throughout the Mississippi River Basin. Whereas other States (notably Mississippi, Illinois, and Arkansas) have initiated investigations into Asian carp biology, range expansions, and methods of control, no such work exists in Tennessee. The research team can evaluate population characteristics of Asian carp, initiate studies into recruitment mechanisms, and investigate how larvae relate to environmental factors such as river flows and water temperature.

Movements and Lock and Dam Passage of Asian Carp in the Tennessee River

Tennessee Cooperative Fishery Research Unit

Silver carp are spreading in the Ohio River Basin and many of its tributaries which has created concerns for the five States that manage fisheries within the Tennessee River Basin. Populations of Asian carp have become well established in the lower reaches of the Tennessee River, especially below Pickwick Dam. Multiple agencies are interested in the movement of Asian carp in the Tennessee River Basin. The research team plans to use acoustic telemetry to study the movement of Asian carp. The results can inform removal efforts in the Tennessee River Basin and the Tennessee-Tombigbee Waterway.

Relative Population Densities of Asian Carp in the Tennessee River and Cumberland River Drainage Basins

Tennessee Cooperative Fishery Research Unit

Asian carp are expanding in Tennessee river systems, and information is lacking on where to direct commercial fishing. Additionally, information is needed to slow the spread of carp and reduce their potential impact on native fish and mussel assemblages. The research team is investigating the density of Asian carp in the Tennessee River and Cumberland River drainage basins. Study results can assist fisheries managers who make decisions on Asian carp in two Tennessee River impoundments (Kentucky and Pickwick Lakes) and two Cumberland River impoundments (Lake Barkley and Cheatham Lake).

Pictured below: Silver carp below Barkley Dam on the Cumberland River.

Assessing the Risk of Dreissenid Mussel Invasion in Texas on the Basis of Lake Physical Characteristics and Potential for Downstream Dispersal

Texas Cooperative Fish and Wildlife Research Unit

Zebra mussels were first reported in Lake Texoma, which is on the border between Texas and Oklahoma, in about 2009 and have since spread further into the State of Texas. Researchers plan to assess the risk of the invasion of zebra mussel and a related invasive species, quagga mussel, in Texas by (1) predicting the general distribution of suitable habitat in Texas using Maxent models, (2) refining lake-specific predictions via collection of physiochemical data from identified high-risk lakes, and (3) assessing the potential for the downstream spread of zebra mussels by using eDNA. The results can provide information to help drive management decisions in Lake Texoma.

Distribution of the Golden Alga in Brazos River and Rio Grande Basins

Texas Cooperative Fish and Wildlife Research Unit

Golden algae release unique toxins that affect gill-breathing aquatic organisms, and information is needed to help resource managers control this highly toxic and harmful species. This study can determine the distribution of the golden alga in streams and reservoirs of the Brazos River and Rio Grande Basins (Texas and New Mexico), including ecologically key sites previously unexplored. Knowledge derived from this study may be useful for controlling the further spread of the highly toxic golden alga and for remediation of affected habitat.

Dead fish washed ashore during golden alga toxic bloom.

Influence of Environmental Variables on Growth of Toxigenic Golden Algae: A Laboratory Test of Field-Generated Hypotheses

Texas Cooperative Fish and Wildlife Research Unit

Resource managers are interested in information on the influence of environmental variables on growth of toxigenic golden algae. Although new information has recently become available regarding the association of environmental variables with the highly toxic golden alga, this information is based mostly on descriptive observations in the field. The research team intends to conduct tests of field-generated hypotheses under the controlled environment of a laboratory. Knowledge obtained may be useful in efforts to curb the further spread and mitigate the toxic effects of golden algae on aquatic natural resources.

Effects of Treatments to Control Eurasian Watermilfoil on Fish and Zooplankton in Northern Wisconsin Lakes

Wisconsin Cooperative Fishery Research Unit

Eurasian watermilfoil is one of the most problematic aquatic invasive species in North America because it can outcompete native macrophytes, negatively affect fish and wildlife, and interfere with recreational activities. Herbicides, specifically 2,4-Dichlorophenoxyacetic acid (2,4-D), are commonly applied as a means to control or eradicate Eurasian watermilfoil, but little is known regarding the effects of 2,4-D on fish and zooplankton communities outside of a laboratory setting. This study plans to investigate the effects of 2,4-D on fish and zooplankton in lakes in northern Wisconsin. These data are important to fisheries managers across North America.

Eurasian watermilfoil. Photograph by U.S. Fish and Wildlife Service.

Landscape Ecology

Contemporary conservation challenges require inquiry and management in larger geographic scales. Landscape ecology is the field of science that explores spatial patterns and interrelations of ecological processes across ecosystems.

Evaluating Moose on the Kanuit National Wildlife Refuge

Alaska Cooperative Fish and Wildlife Research Unit

As the climate warms, particularly in arctic regions, resource managers are faced with the challenge of achieving preexisting management goals for important resources such as moose. Meeting this challenge should require AM strategies based on an improved understanding of changing environmental conditions and concomitant animal responses. The goal of this project is to evaluate the effect of fire history, plant community composition, and landscape characteristics on moose overwinter forage resources and use. Identifying changes in habitat quality over large areas and through time would enable land managers to predict and appropriately respond to consequent changes in moose populations.

Dr. Mike Mitchell, Montana Cooperative Wildlife Research Unit.

Process-Based Model Assessment of Historical and Projected Changes in Carbon Storage in Alaska

Alaska Cooperative Fish and Wildlife Research Unit

The dynamic organic soil version of the Terrestrial Ecosystem Model is being used to assess historical (1960–2009) and projected (2010–99) changes in carbon storage in Alaska. Historical simulations are to be driven by downscaled climate information prepared by the International Arctic Research Center, University of Alaska Fairbanks, Scenarios Network for Alaska and Arctic Planning (SNAP), observed atmospheric concentrations of carbon dioxide, and historical observations of wildfire in Alaska. Projected simulations are to be driven by downscaled future scenarios of climate prepared by SNAP, associated atmospheric concentrations of carbon dioxide, and associated projections of wildfire simulated by the Alaska Frame Based Ecosystem Code, which is part of SNAP, and by the U.S. Forest Service (USFS) First Order Fire Effects Model, which is a model that is used to predict fire effects.

Landscape-Climate-Riverine Linkages and Climate Change

Alaska Cooperative Fish and Wildlife Research Unit

Reliable scientific information on landscape-climate-riverine linkages and climate change is vital to decision making. This project is a synthesis that will tie together information on landscape change with changes in river flow and fish habitat on the Kenai River in Alaska.

Social-Ecological Systems on the Kenai Peninsula

Alaska Cooperative Fish and Wildlife Research Unit

Landscape changes associated with social-ecological systems on the Kenai Peninsula in Alaska and the effects on salmon are being studied. The research team plans to investigate how land use and development affect fish and wildlife and relate those effects to social and economic needs of the human population in Alaska. These data are needed to inform and support the sound management and conservation of Alaska's salmon.

Kenai National Wildlife Refuge celebrated 75 years of conservation in 2016. Image by U.S. Fish and Wildlife Service.

Quantification of Hydrologic Alteration and Relations to Biota in Arkansas Streams: Development of Tools and Approaches for Ungaged Streams

Arkansas Cooperative Fish and Wildlife Research Unit

Hydrologic alteration is an important issue affecting stream ecosystems globally, and the effects of flow alteration are likely to vary temporally and be flow regime dependent. This study is designed to examine flow alteration in seven natural flow regimes of the U.S. Interior Highlands. Additionally, the team plans to investigate temporal variation in flow alteration related to climate change. This study is important because altered hydrology is likely to affect ecosystem structure and the function of intermittent streams and may influence the vital role these streams play in material transport and biological connectivity.

Publication

Leasure, D.R., Magoulick, D.D., and Longing, S.D., 2016, Natural flow regimes of the Ozark-Ouachita Interior Highlands region: River Research and Applications, v. 32, p. 18–35, https://doi.org/10.1002/rra.2838.

Evaluating Dynamics of Grassland and Wetland Ecosystems in the Northern Great Plains

California Cooperative Fish and Wildlife Research Unit

Landscape modifications to support agriculture, habitat fragmentation, chemical runoff, climate change, and invasive species affect ecosystem health. The USGS Northern Prairie Wildlife Research Center (NPWRC) is engaged in ongoing research to better understand grassland, wetland, and riverine ecosystems and their associated biotic communities in the northern Great Plains. The NPWRC research programs specifically focus on identifying and understanding threats to northern Great Plains ecosystems and developing and evaluating conservation measures that can be implemented to abate those threats. This project encourages stakeholder collaboration to expand research efforts in these diverse prairie ecosystems.

In 2015, the USGS Northern Prairie Wildlife Research Center celebrated its 50th year of conducting research for the management of natural resources on the Great Plains.

Assessment of Field- and Landscape-Level Effects of NRCS Conservation Practices on Gopher Tortoise Habitat

Georgia Cooperative Fish and Wildlife Research Unit

The NRCS Working Lands for Wildlife program provides financial incentives for private landowners to manage their lands in ways that enhance habitat suitability for wildlife species of conservation concern, including the gopher tortoise. This project is designed to assess habitat and population metrics of enrolled properties and develop enhancements in population assessment technology to more sensitively gauge how tortoise populations respond to conservation actions in short timeframes.

Bottomland Hardwood Composition Change as Controlled by Regeneration and Hydrologic Processes

Louisiana Cooperative Fish and Wildlife Research Unit

Bottomland hardwood forests are distributed along rivers and streams in the Southeastern United States, with the greatest concentration in the Mississippi Alluvial Valley. Recent research has indicated that hydrologic alterations are leading to broad-scale changes in forest species composition. In this study, the research team plans to quantify changes in selected bottomland hardwood forests and determine the effects of hydrologic processes on seed germination and seedling establishment of select tree species.

Evaluation of Representative Bird Species Landscape Capability Models

Maine Cooperative Fish and Wildlife Research Unit

As part of the University of Massachusetts Designing Sustainable Landscapes project, researchers are evaluating the capability of the landscape in the North Atlantic LCC region to sustain wildlife populations under alternative climate change and urban growth scenarios. Researchers propose to evaluate

The University of Massachusetts Designing Sustainable Landscapes Project is evaluating the capability of the landscape in the North Atlantic LCC region to sustain wildlife populations under alternative climate change and urban growth scenarios. Image by North Atlantic LCC.

relations between the occurrence and abundance of recorded species in the study landscapes for a suite of forest birds and habitat data collected from the mixed coniferous-deciduous Acadian Forest Region of Maine, New Hampshire, and Vermont and the hardwood-dominated forests of Pennsylvania, Virginia, and West Virginia. Results from the project can be used to inform conservation and land-management planning.

Native Bees and Crop Production in Maine

Maine Cooperative Fish and Wildlife Research Unit

The increasing risk of relying on honey bees for crop pollination has led to growing interest in native bees as a potential alternative to honey bees for successful crop production. The team is leading research on bees found in powerline rights-of-way and examining the use of powerline easements for nesting and foraging by native bees. The research can enhance knowledge on the value of powerline rights-of-way for native bees in Maine's blueberry crop landscape.

Small and Meso Mammals and Forest Community Dynamics

Maine Cooperative Fish and Wildlife Research Unit

Small and meso mammals are key components in forest communities, but information is needed on how mammals use forested habitats and how mammals affect forests. This study is designed to address how habitat context (structure, tree species composition, and seed-energy production) shapes the strength of interaction within and among the mammal community and, further, how the mammal community affects forest ecological processes. These results can inform management of Maine's forests and address broad ecological questions.

Red squirrel eating a spruce pollen cone.

Small Mammal Community Stability

Maine Cooperative Fish and Wildlife Research Unit

The small mammal community is an integral part of Maine's forest ecosystems, yet we know very little about the community's overall ecological stability. Species decline can have dramatic effects on ecosystem function. Given a rapidly changing climate and increasing human demands on the land, it is important to understand how ecosystems respond to stress. This project intends to survey the small mammal community and the environments in which they are found along elevational gradients representing different climates in the mountains of Maine. Findings from this study can help inform the Maine Department of Inland Fisheries and Wildlife and land managers in Maine of the stability of the small mammal community and the potential impacts of environmental change on key components of the larger ecosystem.

Small Natural Features With Large Ecosystem Functions in Urbanizing Landscapes

Maine Cooperative Fish and Wildlife Research Unit

The value of natural landscape features is not necessarily reflective in the size of the feature, and some small features play a significant role in maintaining biodiversity or providing ecosystem services. Developing tools that help reconcile property rights and rules of environmental protection across scales and jurisdictions provides unique opportunities for resource managers. The project team is prepared to investigate the biophysical and socioeconomic components of vernal pools. The results of this study can be used to improve strategies for conserving vernal pools and other small natural features with large ecosystem functions.

The Gulf of Maine Coastal Ecosystem Survey: An Integrated, Multidisciplinary Effort to Map Biological Hotspots in the Waters of Maine, New Hampshire, and Massachusetts

Maine Cooperative Fish and Wildlife Research Unit

The Gulf of Maine coastal marine ecosystem is one of the most ecologically and economically productive ecosystems in the world. This coastal marine ecosystem faces threats on multiple levels, including climate change, wind energy development, and competing uses of the system's natural resources. The research team plans to collect data needed to inform these immediate management needs and increase the understanding of the Gulf of Maine coastal marine ecosystem. Additionally, this information can support spatial planning efforts and on-the-ground habitat management by delineating ecologically important areas.

Understanding the St. Croix River Food Web

Maine Cooperative Fish and Wildlife Research Unit

In the past several hundred years, the St. Croix River in Maine has experienced considerable fluctuations in management and ecology. The construction of dams, fluctuating water levels, increased water temperature, restriction of upstream and downstream passage, conversion of riverine habitats to lakes, introduction of nonindigenous species, and industrial pollution represent impacts that have affected the system. The research team plans to provide a synthesis of species and model the food web to document conditions in the watershed. This information is needed because managers are conducting river herring reintroductions and other management actions.

Biological Effects of Urbanization and Impervious Cover on Massachusetts Streams

Massachusetts Cooperative Fish and Wildlife Research Unit

Recent papers have synthesized the negative effects of urbanization and impervious cover on streams. Although these responses to urbanization are widely documented and often strong, there are so many possible mechanisms that specific proximate causes are often difficult to distinguish, partly because both natural and anthropogenic factors influence the responses at different locations and also because the specific stressors are poorly understood. The project is designed to investigate fish and macroinvertebrate responses to regional, local, and instream environmental factors. Overall, the research can help to better understand the mechanisms of impairment and stream response and recovery trajectories.

Stream surveying.

Comparative Ecology and Conservation of Bears in North and South America

Massachusetts Cooperative Fish and Wildlife Research Unit

The spectacled bear, also known as the Andean bear, is considered a representative landscape species; large-scale conservation benefits can result from conservation efforts for the species and areas it inhabits. The American black bear is also considered a representative landscape species. The research team plans to explore how land-use patterns have influenced population status and habitat use of Andean bears. In addition, researchers expect to investigate land-use change to provide input into the National Forest and Wildlife Service Andean Bear Conservation Plan in Peru. Conservation challenges associated with the two representative landscape species differ, and comparative analyses of landscape ecological factors affecting populations and distribution of both species can help inform management and strengthen the capacity of stakeholders to develop proactive conservation strategies.

An Integrated Population Model for the American Woodcock

Minnesota Cooperative Fish and Wildlife Research Unit

The American woodcock is a species of special conservation concern and a focal species for the USFWS. Woodcock are managed in two units—the Eastern and Central Management Regions—and have experienced population declines in both regions. Researchers are using radio-marked juveniles to assess juvenile survival with data from both regions being included in a single population model to help guide woodcock management. Results are being used by the USFWS to revise management plans on Federal lands with considerations for woodcock and other species that use early successional cover types and to provide guidance for monitoring woodcock populations at landscape scales.

American woodcock.

Grasslands, Conservation Reserve Program Enrollments, and Greater Prairie-Chicken Populations in Minnesota

Minnesota Cooperative Fish and Wildlife Research Unit

The greater prairie-chicken is closely associated with the native prairies of central and eastern North America. These native prairies have largely disappeared, causing a dramatic reduction in greater prairie-chicken range and abundance. The CRP compensates farmers for removing sensitive land from agricultural production and installing native species to improve environmental quality. This project can examine the relation between grasslands, CRP enrollments, and greater prairie-chicken populations in northwest Minnesota.

Establishing Ground Cover in Reservoir Mudflats to Promote Recreational Fish Assemblages

Mississippi Cooperative Fish and Wildlife Research Unit

A limited number of research efforts has suggested that seeding exposed shorelines with annual terrestrial grasses can produce lush stands of vegetation that can grow through fall and winter. Researchers plan to seed 250–500 acres of mudflats of the flood control reservoirs of northwest Mississippi. Seeding is expected to include multiple plant species seeded at diverse time periods (such as, late summer, fall, or late winter just before mudflats are re-flooded) to promote plant survival and structural diversity. Researchers intend to seed selected plant species in monocultures and as suites of multiple harmonious species (polycultures) that have demonstrated synergistic effects on plant survival and growth or on the benefits the plants provide fish. This diversity of plantings can promote planting success and allow evaluation of best practices regarding the timing of planting and associated costs relative to the resulting improvement in the fish assemblages and in relation to water management strategies.

Inventory and Classification of Oxbow Lakes in the Mississippi Alluvial Valley

Mississippi Cooperative Fish and Wildlife Research Unit

The Lower Mississippi Alluvial Valley includes about 1,500 floodplain lakes that represent the largest concentration of oxbow lakes in North America. Water quality and environmental degradation are a primary concern in most of these lakes, stemming from disturbances associated with agriculture, regulation of discharges from major flood-control reservoirs, and stream channelization. To support restoration efforts, the research team plans to evaluate water quality and fish assemblages. The study results can be of value to various State and Federal agencies with jurisdiction over the alluvial valley.

Conservation and Management of Mid-Sized Rivers in Missouri: Development of Sampling Protocols and Application to Priority Watershed Rivers

Missouri Cooperative Fish and Wildlife Research Unit

Substantial monitoring and research are conducted on large, main stem rivers, such as the Mississippi and Missouri, and on smaller, wadeable streams; however, little information exists for the mid-sized rivers in Missouri. These rivers can be important for fisheries management and conservation. This study can help determine the ecological role of mid-sized rivers. Knowing how mid-sized rivers are used by big-river and small-stream fishes and to what degree these rivers have their own unique fish communities should help the Missouri Department of Conservation identify important rivers to target for conservation and restoration.

Evaluation of Grassland Restoration Efforts on Invertebrate Communities in Missouri

Missouri Cooperative Fish and Wildlife Research Unit

The tallgrass prairie is one of the most endangered ecosystems in North America, and as a result, thousands of acres of prairie reconstruction plantings have been established in Missouri to augment the remaining fragments of native grassland. It is unclear, however, how grassland invertebrates respond to prairie reconstruction and whether these invertebrates are capable of recolonizing restored prairies. The goal of this study is to compare invertebrate communities in restored prairies to nearby remnant prairies and evaluate the effects of restored prairie area and age of restoration on invertebrate species richness and community composition. Results of this research can provide information to managers on whether invertebrate communities in restored prairies are similar to those in remnant prairies and whether dispersal constraints may limit invertebrate colonization in restored prairies.

Science to Inform Management of Floodplain Conservation Lands Under Nonstationary Conditions

Missouri Cooperative Fish and Wildlife Research Unit

Large tracts of Mississippi and Missouri River floodplains have recently been converted to conservation status through purchase or easements, and questions have arisen about how these lands can best be managed under land-use and climate change. Managers face uncertainties ranging from site-specific designs for water infrastructure to long-term land-acquisition strategies. The objective of this project is to formalize understanding of science information needs for management of conservation lands on large-river floodplains. The work is necessary to establish a firm foundation for development of cost-effective, relevant floodplain science to inform management.

Publication

Bouska, K.L., Lindner, G.A., Paukert, C.P., and Jacobson, R.B., 2016, Stakeholder-led science—Engaging resource managers to identify science needs for long-term management of floodplain conservation lands: Ecology and Society, v. 21, no. 3, 12 p., https://doi.org/10.5751/ES-08620-210312.

Evaluating Sediment and Nutrient Contributions From Unpaved Forest Roads to Headwater Streams

Montana Cooperative Fishery Research Unit

Unpaved forest roads remain a pervasive disturbance on public lands, and mitigating sediment from road networks remains a priority for management agencies. Landscape restoration is becoming increasingly important for many native coldwater fishes that disproportionately rely on public lands for persistence. Effectively targeting restoration opportunities requires a comprehensive understanding of the effects of roads across different ecosystems. As part of this indepth field study, researchers intend to investigate how roads and sediment delivery influence sediment and water quality in aquatic habitats. Study results can be used by the USFS in consideration of restoring roads in the 6,070 square-kilometer southwestern Crown of the Continent ecosystem in Montana.

Amphibian Occupancy, Functional Connectivity, and Resilience of Rainwater Basin Wetlands

Nebraska Cooperative Fish and Wildlife Research Unit

Both the quantity and quality of wetlands have declined globally. Many remaining wetlands exist in landscapes dominated by agricultural production. The Rainwater Basin in Nebraska is characterized by shallow wetlands in an agricultural matrix. This project is designed to assess how agricultural land use may affect resilience of a large wetland complex. Specifically, researchers plan to investigate occupancy of amphibians, functional connectivity of remaining wetlands, and acute and chronic effects to amphibians from commonly applied agrichemicals. This information can be used to facilitate conservation planning for amphibians in the Rainwater Basin.

Modeling Effects of Environmental Change on Crucial Wildlife Habitat

New Mexico Cooperative Fish and Wildlife Research Unit

Climate change is adversely affecting biotic communities. Society is asking important questions about how future shifts in environmental conditions will affect areas prone to change in a variety of variables such as temperature, precipitation, housing density, and energy development. The primary objective of this project is to assess the impact that varying climate and land-use change scenarios for the South-Central United States is expected to have on the distribution of key species. The results of this assessment can be integrated into decision support tools.

Responses of Large Mammals to Forest Restoration Treatments in the Southwest Jemez Mountains, New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

The responses of large mammals to forest restoration treatments in the southwest Jemez Mountains, New Mexico, is important to resource managers. The research team plans to monitor the responses of mule deer, elk, black bear, and mountain lion to forest restoration treatments associated with the USFS Southwest Jemez Mountains Collaborative Forest Landscape Restoration Project. Moreover, the team intends to assess resource selection and space use of large mammals in relation to forest restoration treatments to guide wildlife conservation across the Jemez Mountains.

The responses of large mammals to forest restoration treatments in the southwest Jemez Mountains, New Mexico, is important to natural resource decision makers. Photograph by Sally King, National Park Service.

Publications

Kindschuh, S.R., Cain, J.W., III, Daniel, David, and Peyton, M.A., 2016, Efficacy of GPS cluster analysis for predicting carnivory sites of a wide-ranging omnivore—The American black bear: Ecosphere, v. 7, no. 10, e01513, 17 p., https://doi.org/10.1002/ecs2.1513.

Roberts, C.P., Cain, J.W., III, and Cox, R.D., 2016, Application of activity sensors for estimating behavioral patterns: Wildlife Society Bulletin, v. 40, no. 4, https://doi.org/10.1002/wsb.717.

Landscape Conservation in the Choco-Andean Biological Corridor

New York Cooperative Fish and Wildlife Research Unit

Ecuador's famous cloud forests are home to the Andean bear and scores of other endangered animals and plants—yet more than 50 percent of these biodiversity hotspots are now deforested, threatening both habitats and rural livelihoods. Working with local stakeholders, researchers plan to develop a conservation program that connects existing forest reserves with the newly created Andean bear corridor. An optimal corridor design can ensure landscape connectivity for endangered species, while maintaining critical ecosystem services and sustainable ways of life for the human inhabitants of South America's biodiversity epicenters.

Publication

Morin, D.J., Fuller, A.K., Royle, J.A., and Sutherland, Chris, 2017, Model-based estimators of density and connectivity to inform conservation of spatially-structured populations: Ecosphere, v. 8, no. 1, e01623, 16 p., https://doi.org/10.1002/ecs2.1623.

Sustainable Forest Communities: Integrated Land Stewardship Strategy for Native American Land Claims

New York Cooperative Fish and Wildlife Research Unit

In partnership with the Saint Regis Mohawk Tribe, an integrated land stewardship strategy for existing and newly settled Native American lands in the Northern Forest is being developed. Specifically, the project can (1) undertake a comprehensive land-use study of existing lands and newly settled land claims of the Saint Regis Mohawk Tribe in the Northern Forest that is based on social-ecological mapping of hotspots where geographical areas of human and ecological values overlap; (2) develop an innovative, comprehensive, and culturally relevant stewardship strategy; and (3) create audiovisual curriculum material on sustainable forest management and land stewardship for use in high school and undergraduate environmental science education. This research combines Native American ecological knowledge and scientific understanding to achieve sustainable forest management.

Pictured below: Landscape conservation research in the Choco-Andean biological corridor.

Research and Applications in Support of the National Gap Analysis Program

North Carolina Cooperative Fish and Wildlife Research Unit

The threats posed by climate change, urbanization, and invasive species underscore the need for proactive management. Conservation planning at regional and national extents has been limited by a lack of consistent, detailed, and current data, and decision makers can no longer consider management decisions without understanding a broader regional context. As part of the National GAP, researchers have been working to address this problem by creating national datasets to support analysis and resource management. Results from this project can help natural resource managers develop better monitoring protocols.

Mapping Physical Characteristics of the Mouth of the Columbia River By Using Transmitters on Diving Waterbirds

Oregon Cooperative Fish and Wildlife Research Unit

The mouth of the Columbia River, shared between Oregon and Washington, is a dynamic coastal environment where hydrological forces produce evolving physical characteristics. Enhancing the physical characterization at the mouth of the Columbia River is a primary objective of the New River Mouth and Inlet Departmental Research Initiative. The research team plans to investigate the use of diving water birds (double-crested cormorants and Brandt's cormorant) as sensor platforms to collect physical oceanographic data. Waterbirds may offer unique sampling opportunities in coastal waters, including areas difficult to access. Nesting cormorants are attractive candidates for this type of sampling because archival tags can be recovered by recapturing the bird when it returns to the nest after foraging. Additionally, the team intends to map a variety of physical characteristics (for example, temperature, conductivity, depth, and bedform morphology) at the mouth of the Columbia River to inform management decisions.

A Macrosystems Ecology Framework for Continental-Scale Understanding and Prediction of Nutrients in Lakes

Pennsylvania Cooperative Fish and Wildlife Research Unit

During the past decade, data on inland waters have changed. Researchers recognize ecosystems as significant hotspots for the storage and transformation of nitrogen, phosphorus, and carbon; however, there are substantial gaps in knowledge. New approaches are needed to reduce uncertainty in extrapolating site-level estimates to larger geographical scales. The goal of this research is to explore nutrient patterns for all continental U.S. lakes to inform estimates of lake contributions to continental and global cycles of nitrogen, phosphorus, and carbon. This research can improve the overall understanding of inland water nutrient cycling and provide locally valuable information about unsampled lakes.

The Effects of Cross-Scale Interactions on Freshwater Ecosystems Across Space and Time

Pennsylvania Cooperative Fish and Wildlife Research Unit

Understanding cross-scale interactions is a critical research component in macrosystems ecology that extends across environmental science. A cross-scale interaction exists where a driver at one scale, such as local land use, interacts with a driver at another scale, such as regional climate. These cross-scale interactions can lead to nonlinear and unexpected relations between drivers and responses. Unfortunately, properties of cross-scale interactions, such as the conditions in which they occur, are largely unknown, partly because they have been quantified in only a few instances. Researchers plan to use lakes and their major nutrients (phosphorus, nitrogen, and organic carbon) as a model system, because lakes are affected by many drivers and because there is a wealth of existing data and knowledge from small-scale studies regarding possible mechanisms through which drivers could interact across scales. The project results can guide the management of freshwater ecosystems in Pennsylvania.

Dynamics of Wetland and Grassland Ecosystems in the Northern Great Plains

South Dakota Cooperative Fish and Wildlife Research Unit

Habitat fragmentation, climate change, invasive species, and how chemical and sediment runoff affects native plants and animals are a central focus of research across the United States. This project intends to use and update a historical dataset from the 1960s to quantify the dynamics of wetlands and plant communities in the northern Great Plains. Researchers plan to investigate drivers affecting the biota and function of wetland and grassland ecosystems, including land use and climate change. The project results can contribute to priority information needs and conservation programs, such as the Prairie Pothole and Northern Great Plains Joint Ventures.

Publication

Cressey, R.L., Austin, J.E., and Stafford, J.D., 2016, Three responses of wetland conditions to climatic extremes in the prairie pothole region: Wetlands, v. 36, supplement no. 2, https://doi.org/10.1007/s13157-016-0818-8.

Evaluating Wetland Ecosystem Health in the Prairie Pothole Region of South Dakota Using Real-Time Nutrient Dynamics of Waterfowl

South Dakota Cooperative Fish and Wildlife Research Unit

Wetland drainage and upland conversion for agriculture has significantly altered the landscape of the prairie pothole region of North America. Previous studies suggested that waterfowl are indicators of landscape or wetland condition. This project intends to use the blood plasma metabolites of blue-winged teal and lesser scaup as indicators of wetland and landscape condition. This large-scale approach would be the first of its kind to document the effects of agriculturally driven landscape change on waterbirds and wetlands and quantify the influence of consolidation drainage.

Understanding the Role of Muleshoe National Wildlife Refuge

Texas Cooperative Fish and Wildlife Research Unit

The role of Muleshoe NWR and the surrounding landscape in Texas is being assessed for the overwintering of sandhill cranes. Researchers intend to develop a model that incorporates the role of the refuge for species conservation in the context of a changing landscape related to climate change and its effects on land use in the High Plains. Information obtained can allow the assessment of what constitutes sustainable landscapes for sandhill cranes and what possible management strategies can be put into place to protect these landscapes.

San Rafael River Restoration Science

Utah Cooperative Fish and Wildlife Research Unit

Like many rivers in the Southwest, the San Rafael River in east-central Utah has been affected by hydrological alterations, habitat fragmentation, and nonnative woody riparian vegetation establishment. Three native species found in the San Rafael River—the bluehead sucker, flannelmouth sucker, and roundtail chub—are currently protected under a conservation agreement. However, the three species occur in low abundance in the lower river because of poor habitat quality and the presence of nonnative fish species. Researchers combined hydrological and geomorphological analyses of channel change with data on current fish distributions and habitat needs to help guide restoration efforts on the lower San Rafael River. The outcomes of the San Rafael restoration project can help inform restoration efforts throughout the Southwest.

West Virginia's Corridor H Stream Monitoring Project

West Virginia Cooperative Fish and Wildlife Research Unit

Corridor H, a highway under construction in eastern West Virginia, is expected to affect streams in the area. As part of this study, the environmental impacts of road construction on streams within eastern West Virginia are to be monitored, with a focus on stream health and stream sedimentation within a before-after-control-impact study design. The results can provide an assessment of the effectiveness of mitigation strategies, erosion controls, and other BMPs for future large-scale highway projects.

Pictured below: Sandhill cranes take flight at Muleshoe National Wildlife Refuge, Texas. Photograph by Christena Stephens, U.S. Fish and Wildlife Service.

Density and Nest Success of Grassland Birds in Warm Season Conservation Reserve Program Fields in Southwestern Wisconsin

Wisconsin Cooperative Wildlife Research Unit

The vast majority of land in the Central United States is privately owned and actively farmed. These lands provide small areas of protected grasslands, which are valuable habitats for many species of birds. Conservation Reserve Program grasslands serve as replacements for natural grasslands; however, CRP grasslands are becoming increasingly disturbed, and information regarding the value of CRP grasslands as bird habitats is needed. The research team plans to investigate the density and nest success of grassland birds in warm season CRP fields in southwestern Wisconsin. Information from this study can help decision makers manage grassland bird habitats in the face of potential large-scale habitat change.

Evaluating Wisconsin's Bird Conservation Areas

Wisconsin Cooperative Wildlife Research Unit

The Wisconsin Bird Conservation Initiative (WBCI) has created a strategic grasslands-implementation plan to use grassland bird conservation areas (BCAs) in focal grassland landscapes. The distribution of public lands and identification of BCAs on the landscape has provided an opportunity to evaluate and refine State management actions. Restoring and protecting BCAs are especially difficult in Wisconsin because most of the existing grassland bird habitat is on private land. The objective of this project is to design and implement an evaluation program for the WBCI strategic grasslands-implementation plan. This evaluation plan can test assumptions behind BCAs and allow for the tracking of bird populations and habitat work within BCAs and focal landscapes.

Monitoring Wildlife Population Change and Data Management for the Chequamegon-Nicolet National Forest

Wisconsin Cooperative Wildlife Research Unit

Wildlife inventory and monitoring (I&M) programs provide important data and tools to help assess how management may be influencing wildlife populations across distance and time. Conservation of species has shifted from single-site efforts to landscape-scale approaches due to the scale at which many drivers of change (for example, disturbance) operate. Researchers plan to work collaboratively with the USFS Northern Research Station to evaluate two long-term projects: amphibian use of ephemeral ponds and wetlands within forested systems and beaver colony activity along trout streams.

Publication

Donner, D.M., Ribic, C.A., Beck, A.J., Higgins, Dale, Eklund, Dan, and Reinecke, Susan, 2015, Woodland pond salamander abundance in relation to forest management and environmental conditions in northern Wisconsin: Journal of North American Herpetology, v. 2015, no. 1, p. 34–42, https://www.fs.fed.us/nrs/pubs/jrnl/2015/nrs_2015_donner_001.pdf.

Greater Yellowstone Ecosystem Mule Deer Project

Wyoming Cooperative Fish and Wildlife Research Unit

Healthy ungulate populations are essential to sustaining the ecological, economic, and cultural values of western U.S. landscapes. Increasingly, scientists and wildlife managers are recognizing that the productivity of western herds of mule deer depends on the ability of the animals to migrate seasonally across vast expanses of public and private lands. Mule deer are especially important to the ecology and economy of northwest Wyoming. This project can help decision makers manage these high-value herds and assist conservation and easement planning efforts.

Identification of Priority Conservation Areas for Native Aquatic Species

Wyoming Cooperative Fish and Wildlife Research Unit

Establishing protected areas has long been an effective conservation strategy. The development of aquatic protected areas typically is based on more readily surveyed species such as fish, and the potential of any freshwater taxa to be a surrogate of other aquatic groups has not been fully explored. Researchers compiled occurrence data on 72 species of freshwater fish, amphibians, mussels, and aquatic reptiles for the Great Plains, Wyoming. The research team used hierarchical Bayesian multispecies mixture models and MaxEnt models to describe species distributions as well as program Zonation to identify conservation priority areas for each aquatic group. Researchers found that the development of conservation priorities based on a single freshwater aquatic group would protect common species in the other aquatic groups but not the rare species that often need the most protection.

Migration Corridors and Landscape Connectivity Project

Wyoming Cooperative Fish and Wildlife Research Unit

Human disturbances (such as grazing, oil and gas development, transportation, and rural development) affect migrating ungulates in the West. Scientists are conducting research using geospatial modeling to determine existing ungulate migration corridors, landscape connectivity, and integrity patterns throughout Wyoming. The research team plans to use a

combination of radio collar data and spatial data maintained by the Wyoming Game and Fish Department. Future considerations for this work include evaluation of how migration corridors are considered in energy, agriculture, and rural development management decisions in Wyoming.

Platte Valley Mule Deer Project

Wyoming Cooperative Fish and Wildlife Research Unit

The Platte Valley mule deer herd is facing considerable stresses, and informational gaps challenge the efficient management of the mule deer by the Wyoming Game and Fish Department. Wildlife managers currently have insufficient information on the status and abundance of this herd. The purpose of this project is to provide land managers with data on the status and abundance of the Platte Valley herd. Changes in winter and summer habitat, predators, human development, migration barriers, competition from other ungulates, and diseases are all factors potentially influencing the Platte Valley herd. The Platte Valley herd is important to the State of Wyoming because of hunting interests, wildlife viewing opportunities, and proximity to major population centers.

Relating Mule Deer Corridors to Sage-Grouse Conservation

Wyoming Cooperative Fish and Wildlife Research Unit

In the spring of 2010, USDA NRCS introduced the Sage-Grouse Initiative (SGI), a highly targeted and science-based landscape approach to delivering conservation practices to elicit a positive greater sage-grouse population response to management. This initiative has yielded substantial improvements benefiting greater sage-grouse on 2 million acres in 2 short years. This project is designed to assess the outcomes of SGI benefits to mule deer and target existing Farm Bill resources to mutually benefit both deer and grouse. The SGI is committed to maintaining large and intact grazing landscapes capable of supporting world-class wildlife populations.

Stable Isotopes to Delineate Seasonal Range Use for Wyoming Ungulates

Wyoming Cooperative Fish and Wildlife Research Unit

For more than a century, wildlife ecologists have sought to describe animal movements and differentiate populations across the vast landscapes these animals occupy. Understanding the movement biology of terrestrial mammals, especially large ungulates, is important for conserving migratory corridors. The project team intends to develop a method to determine the migratory movement paths and seasonal range use of Wyoming ungulates by using the strontium isotope values recorded in the teeth of these animals. The analyses have the potential to decrease overall costs, manpower, and time associated with tracking and describing animal movement patterns.

The Wyoming Migration Initiative Assessment

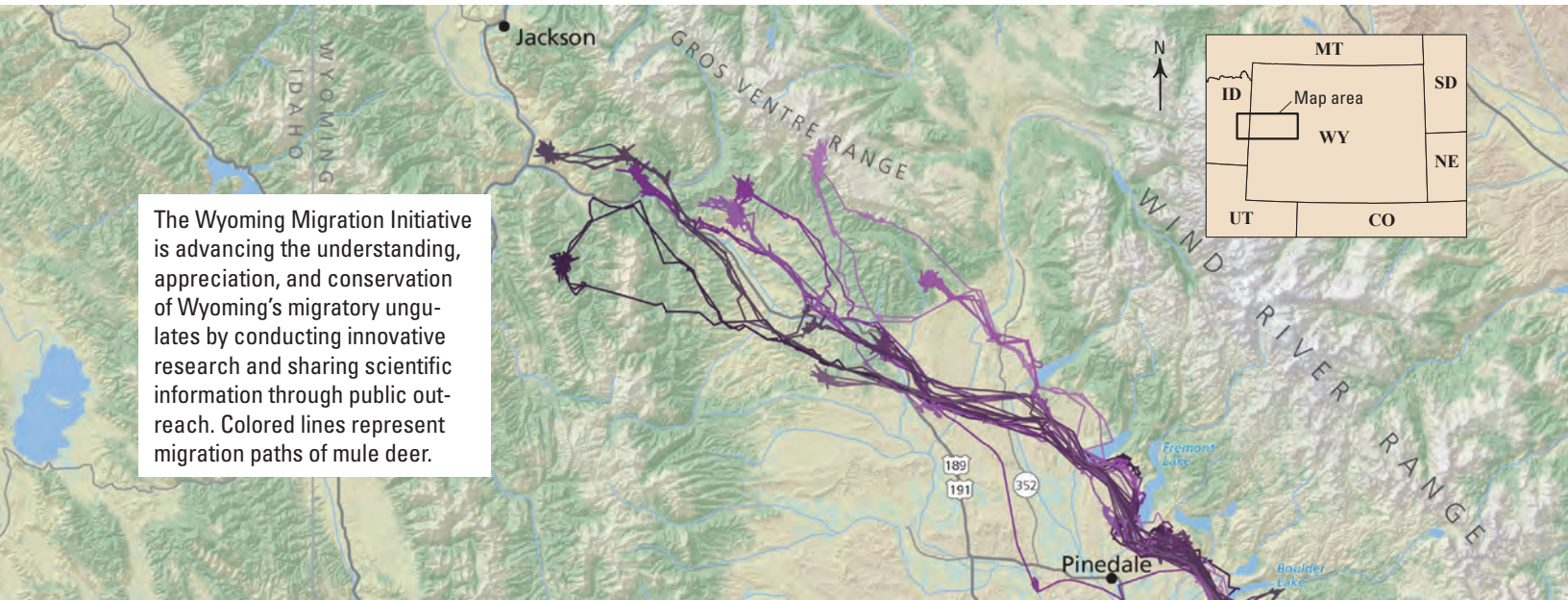
Wyoming Cooperative Fish and Wildlife Research Unit

The Wyoming Migration Initiative research team developed a migration assessment program, which seeks to conduct a detailed evaluation of big game migrations in Wyoming. This effort is patterned after the 150-mile "Red Desert to Hoback" mule deer migration assessment, which identified a top-10 list of threats (such as oil and gas leasing, road crossings, and areas of future rural development). This project seeks to assess the migration corridors of the elk herds that migrate into and out of Yellowstone National Park from winter ranges in Cody, Dubois, and Jackson, Wyoming. The assessments can be available to the public through the web and social media, and are intended to guide on-the-ground conservation for years to come.

Wyoming Migration Initiative

Wyoming Cooperative Fish and Wildlife Research Unit

Conserving ungulate migration routes is of considerable interest to wildlife managers in Wyoming and the West. Nearly



The Wyoming Migration Initiative is advancing the understanding, appreciation, and conservation of Wyoming's migratory ungulates by conducting innovative research and sharing scientific information through public outreach. Colored lines represent migration paths of mule deer.

every State and Federal agency that manages wildlife in Wyoming, and the many environmental NGOs and land trusts that work in the State, list "conserving ungulate migration routes" as a top priority. Still, no comprehensive story has been developed for Wyoming's extraordinary ungulate migrations. Researchers initiated a project to create the "Atlas of Wildlife Migration" to help draw attention to the amazing journeys of Wyoming's migratory ungulates, synthesize disparate spatial data on migration, and elevate awareness of this ecological phenomenon as a means of advancing conservation and management efforts. The atlas is planned for publication as a large-format reference book and to be made accessible online in an interactive format.

Wyoming Mule Deer Migration Patterns

Wyoming Cooperative Fish and Wildlife Research Unit

Most mule deer research efforts over the last decade and a half have been focused on does. Researchers learned a lot about the timing, distance, stopover use, and migration routes of mule deer does; however, data are lacking on the migration routes of bucks. The research team plans to evaluate how migrating deer respond to different types of fences. This project can lead to a comparison of the migration patterns of mule deer bucks and does, data that can be useful in refining the timing of hunting seasons. Additionally, the data can guide efforts to make fences more "mule deer friendly."

Wyoming Range Mule Deer Project

Wyoming Cooperative Fish and Wildlife Research Unit

The Wyoming mule deer working group is one of the most active and productive working groups sponsored by the Western Association of Fish and Wildlife Agencies. The overall goal of the Wyoming Range Mule Deer Project is to address important research and management needs identified by the mule deer working group. For this project, researchers plan to investigate the nutritional relations between mule deer population dynamics, energy development and disturbance, habitat conditions, and climate to provide a mechanistic approach to monitoring and management of mule deer.

Pictured at left: Scientists with the University of Wyoming and the Wyoming Game and Fish Department transport a captured mule deer in the Wyoming Range of Wyoming. The deer was fitted with a global positioning system tracking device, its body fat was assessed, and other biological samples were taken before the deer was released. Photograph by Mark Gocke, Wyoming Game and Fish Department. Used with permission.

Wyoming Red Desert-to-Hoback Migration Assessment

Wyoming Cooperative Fish and Wildlife Research Unit

Given increasing levels of energy development and recreation on public lands, sprawling housing development on private lands, and increasing traffic volumes on the roadways, the persistence of the longest mule deer migration ever recorded (and second longest land migration in North America), where deer travel a one-way distance of 150 miles from Wyoming's Red Desert to the headwaters of the Hoback River, is uncertain. Migrations like this are unique to Wyoming's undeveloped open spaces and are an important part of the cultural, hunting, and conservation heritage of the State. There is value in continuing to educate the public and policy makers on the biological value of intact migrations and the complexities of conserving such migration routes in areas outside of national parks. Although this work highlights the importance of Wyoming's Red Desert landscape and the Big Sandy Foothills, the challenge of conserving long-distance migration is symbolic of public lands conservation and management across the West.

The Wyoming Cooperative Fish and Wildlife Research Unit is studying deer, moose, pronghorn, elk, wolves, and bighorn sheep to understand the influences on these species from human disturbance, habitat conditions, climate change, and energy development.

Species of Greatest Conservation Need

State Wildlife Action Plans identify species of greatest conservation need (SGCN) in their State and identify information needs and management actions necessary to keep these species common. Photograph by Michael Park. Used with permission.

Determination of Species-Specific Dissolved Oxygen and Temperature Requirements for Nongame Riverine Fishes

Alabama Cooperative Fish and Wildlife Research Unit

The Southeastern United States has the richest aquatic biodiversity and highest degree of endemism in North America; the Southeast region also has some of the highest imperilment rates on the continent. In fact, more than 40 percent of the federally listed animals in the Southeast region are freshwater mussels, snails, and fishes that are found in Alabama. Large- and small-scale dams are prevalent on the landscape, many of which affect water quality. The research team plans to quantify the dissolved oxygen and temperature requirements of several nongame fish SGCN in order to identify patterns that can be used to increase the effectiveness of water-quality regulations and conditions below impoundments.

Ecology of Smith's Longspurs in Northern Alaska

Alaska Cooperative Fish and Wildlife Research Unit

The Alaska Cooperative Fish and Wildlife Research Unit is contributing to conservation strategies for Smith's longspurs by further refining knowledge of their breeding ecology in Alaska. Using the unique availability of individually marked birds and baseline data at the Arctic NWR, this study is designed to document natal and breeding site fidelity, estimate and analyze nest survival and covariates that influence nest survival (for example, habitat and temporal factors), and collect and analyze life history information. Study results can allow managers to better understand breeding parameters such as breeding phenology, adult survival and movements, nesting chronology, habitat preferences, and nest site requirements, all of which are important when developing management alternatives.

A male Smith's longspur. Photograph by National Park Service.

Publications

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

Alaska Cooperative Fish and Wildlife Research Unit

Most of the king and common eiders and yellow-billed loons that nest in northern Alaska and northwestern Canada migrate twice annually past Point Barrow, Alaska, during their northward spring migration and their southward fall migration. In 1996, spring and fall counts indicated both eider species experienced population declines of approximately 50 percent between 1976 and 1996. The Wildlife Conservation Society and the North Slope Borough, Alaska, successfully completed a spring count in 2015 and 2016. Researchers plan to assess migration trends of eider and loon populations. Such data are critically needed to assess the conservation needs of these species now and in the future.

Relation of Riparian and Instream Habitat With Presence of Native and Nonnative Fishes in Intermediate-Sized Arizona Rivers

Arizona Cooperative Fish and Wildlife Research Unit

Streams of the Southwestern United States contain some of the most unique and endangered fish species on the planet. Conserving these species requires knowledge of what physical and biological conditions enable them to live, even thrive, at a particular location. Researchers plan to analyze fish habitat use in the rivers traversing the Mogollon Rim, Arizona. The goal of this project is to identify specific physical and biological habitat needs of select native fish species that would allow for improved habitat management, provide information to aid in protection of instream flows, and contribute to recovery of endangered and sensitive native fish species. This knowledge is necessary to manage riparian areas, to inform fish stocking decisions, and to protect instream flow rights.

Graduate student holding a razorback sucker.

Effects of Wetland Management Strategies on Habitat Use of Fall Migrating Rails on Intensively Managed Wetland Complexes in Mississippi

Arkansas Cooperative Fish and Wildlife Research Unit

The Association of Fish and Wildlife Agencies Migratory Shore and Upland Game Bird Support Task Force for rails and snipe identified priority information needs, one of which was "estimate vital rates to support population modeling, targeting the estimation of survival rates of rails, using the sora as a surrogate." This project is designed to address key planning, management, and research questions that need to be addressed before vital rates can be estimated. In addition, the study is expected to lay the groundwork for developing a telemetry study that can be used to develop models focused on vital rates.

Invasive Species Effects, Population Status, and Population Genetics of Crayfish: Species of Greatest Conservation Need in the Ozark Highlands of Arkansas and Mississippi

Arkansas Cooperative Fish and Wildlife Research Unit

Multiple crayfish SGCN are found in the Ozark Highlands of Arkansas and Mississippi. The Mammoth Spring crayfish and the coldwater crayfish, two of the most geographically restricted stream crayfish, are considered imperiled in Arkansas and Mississippi—and globally—and are candidates for listing by the USFWS under the ESA. Hubbs' crayfish is another narrow range endemic species occurring in north-central Arkansas and south-central Mississippi. This study intends to determine the population status of crayfish SGCN by comparing abundance and occupancy rates from 1998 to 1999 to those from a recent study from 2010 to 2011. The threat of an advancing invasive species, along with potential habitat loss and fragmentation, makes determining potential invasive species effects, population status, and the population genetics for these species extremely important for developing appropriate conservation measures.

Assessing Humboldt Marten Prey Availability and Predator Abundance in Advance of Population Restoration

California Cooperative Fish and Wildlife Research Unit

The Humboldt marten, a subspecies of marten endemic to the redwood region of California, was detected for the first time in recent history in Redwood National and State Parks in

Arkansas Cooperative Fish and Wildlife Research Unit graduate student, holding a Virginia rail.

2009 (after presumed extirpation from its historic range). In 1996, the subspecies was detected in a national forest 20 miles east of the Redwood National and State Parks location. Long-term persistence of the population is likely to be successful with restoration of the Humboldt marten to currently suitable old-growth habitat in the short term and restoration of old forest characteristics preferred by the marten in extensive second-growth regions of Redwood National and State Parks over the coming decades. However, before steps can be taken to assist marten recolonization of suitable old-growth habitat and design restoration actions to accelerate the return of suitable habitat conditions for marten, prey availability and abundance and marten predator abundance must be assessed.

Export of Invertebrate Drift From Headwater Streams

California Cooperative Fish and Wildlife Research Unit

Fishless headwater streams are critical components of a river network, serving as a source of sediments, water, woody debris, nutrients, and invertebrates for downstream waters. Unfortunately, resource managers rarely consider the importance of the invertebrate subsidies provided by fishless headwater streams. To address this issue, scientists plan to assess the role of fishless headwater streams as donors to downstream food supplies for coastal cutthroat trout in headwater systems of the lower Klamath River. A greater understanding of how these subsidies are used by fish and contribute to biological production in downstream reaches is needed to enhance management practices.

Pictured below: A headwater stream in California.

Giant Kangaroo Rat Population Monitoring in Panoche Valley

California Cooperative Fish and Wildlife Research Unit

Giant kangaroo rats are a keystone species throughout their range, including the Carrizo Plain; however, drought and the associated lack of vegetative growth have resulted in precipitous population declines. The objective of this project is to test the effectiveness of a supplemental feeding program to increase giant kangaroo rat survival and production in the Ciervo-Panoche Natural Area. If supplemental feeding is beneficial to giant kangaroo rat populations, the approach may be used to benefit other species, such as the San Joaquin kit fox and San Joaquin antelope squirrel.

Townsend's Big-Eared Bat Statewide Assessment

California Cooperative Fish and Wildlife Research Unit

The Townsend's big-eared bat population has declined in recent years and is a species of conservation concern. The goal of this project is to quantify the current status of the Townsend's big-eared bat in California. This project can provide the first statewide assessment of the number and status of Townsend's big-eared bat colonies in California in more than two decades. The project can also provide a comprehensive report on the distribution, abundance, and condition of historically and currently occupied sites, a regional assessment of the species' status, and suggestions for maintaining or enhancing existing populations, as well as a discussion of likely future threats.

Environmental Effect on Harbor Seal Movement and Resource Selection

Colorado Cooperative Fish and Wildlife Research Unit

Harbor seals are found throughout the coastal waters of southern Alaska; however, seal populations have declined 80–90 percent in past decades. Understanding how the environment motivates harbor seal resource selection and behavior is a critical step toward understanding the precipitous decline of the species and managing the species toward recovery. Researchers are investigating the effects of a dynamic environment on harbor seal movement and resource selection. This research can provide insights into the environmental drivers of harbor seal behavior.

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

Florida Cooperative Fish and Wildlife Research Unit

American oystercatchers are breeding at about 50 sites in Florida, with more than 90 percent of the population concentrated on the Gulf Coast. The spoil islands at the Cross Florida Greenway State Recreation and Conservation Area in Citrus County support the largest concentration of nesting oystercatchers along the Nature Coast region. The purpose of this project is to provide data on annual productivity of oystercatchers nesting in the area. Research data can inform decisions about the productivity of American oystercatchers nesting on spoil islands at the Cross Florida Greenway State Recreation and Conservation Area.

Effects of Spring Cattle Grazing on Demographic Traits of Greater Sage-Grouse

Idaho Cooperative Fish and Wildlife Research Unit

The greater sage-grouse was once widespread within the sagebrush-grassland ecosystems of western North America; however, populations have declined substantially. A major concern is the possible effect that spring cattle grazing may have on demographic parameters and habitat use. This project intends to evaluate the effects of spring cattle grazing on (1) sage-grouse demographic and behavioral traits, (2) the density and diversity of insects common in sage-grouse diets, and (3) nest concealment and other vegetation features that contribute to sage-grouse habitat suitability. Understanding the effects of spring cattle grazing on sage-grouse can allow managers to develop management and grazing strategies that minimize negative effects that are identified.

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

Idaho Cooperative Fish and Wildlife Research Unit

The DoD is responsible for managing species found on DoD lands. The burrowing owl, a declining species, is found on numerous DoD installations throughout the Western United States, but scientific information on burrowing owls is needed to successfully manage owl populations. Researchers plan to attach "geolocators" to 200 burrowing owls on numerous DoD installations throughout the West to identify their migratory routes and wintering grounds. Study results can be used to identify priority management needs for this species and help reduce conflict with the military mission on DoD installations.

Burrowing owls. Photograph by U.S. Fish and Wildlife Service.

Kokanee Population Dynamics, Mysid-Kokanee Interactions, and Sampling Techniques in Idaho Lakes

Idaho Cooperative Fish and Wildlife Research Unit

Kokanee (land-locked sockeye salmon) suffered significant declines in the late 1960s in Lake Pend Oreille, but the exact cause or causes have not been identified. Despite considerable research, numerous questions remain regarding the appropriate management of kokanee in Idaho. The goals of the research are to (1) evaluate the biases of mid-water trawling, (2) investigate interspecific competition between mysids and kokanee, and (3) evaluate the performance of kokanee breeding groups (early run, late run) in Idaho. The results can be used to inform fisheries management decisions in Idaho.

Movement Dynamics, Distribution, Habitat Use, and Species Associations of Juvenile Burbot in Tributaries of the Kootenai River

Idaho Cooperative Fish and Wildlife Research Unit

Although common in large portions of their range, the Kootenai River population of burbot has declined significantly in past years. The research team plans to investigate the survival, movement, and habitat use of burbot that are stocked in tributaries of the Kootenai River. In addition to using PIT tag detectors in a novel manner to answer research questions, the team plans to sample fish and habitat to understand the fish assemblage associations and habitat available for juvenile burbot. Results of this research can be used to guide stocking practices associated with the management and conservation of burbot in western river systems.

Population Dynamics of Alaskan Seabirds

Idaho Cooperative Fish and Wildlife Research Unit

The remoteness of Alaska has not spared it from conservation threats related to climate change and other environmental stressors. The incredible biological productivity of the Aleutian and Bering Sea Islands region is reflected in the prolific commercial fisheries that account for 50 percent of the total U.S. seafood landings. The project team plans to analyze seabird population dynamics and environmental drivers at a regional scale to improve the understanding of complex linkages in the marine system and guide monitoring efforts.

Farmed and Conservation Reserve Enhancement Program Wetland Amphibian Populations in the Des Moines Lobe of Central Iowa

Iowa Cooperative Fish and Wildlife Research Unit

Loss of habitat caused by land-use change has resulted in widespread declines in amphibian communities throughout the United States. The Des Moines Lobe in Iowa historically has contained a high density of small depressional wetlands embedded in a prairie grassland landscape, which typifies the prairie pothole region of North America. However, 95–99 percent of these wetlands have been lost since the conversion of Iowa's landscape to intensive row-crop agriculture in the late 19th century. Remaining wetlands have been exposed to agricultural chemical inputs that represent a potential source of physiological stress for amphibians. Chytrid fungus, a disease that has been proposed as another contributing factor in worldwide amphibian declines, has also been documented in this region. The research team plans to compare several amphibian life history parameters and potential stressor covariates in CREP and natural wetlands. Understanding the potential utility of restored and constructed wetlands for amphibian conservation is important to land managers and to the agricultural community.

Habitat Improvement Projects for Stream and Oxbow Fish of Greatest Conservation Need

Iowa Cooperative Fish and Wildlife Research Unit

Stream fishes are among Iowa's most imperiled animals due primarily to habitat and water-quality degradation associated with the State's extensive agricultural land use. This project plans to review habitat restoration efforts and the responses of stream fishes of greatest conservation need, specifically Topeka shiners and plains topminnows. An extensive geographic information system (GIS) analysis using a new, state-of-the-art framework is to be undertaken to assist in guiding current and future restoration efforts. Monitoring of the fish populations in an AM approach is necessary for ensuring fish are responding as expected to efforts to increase and improve their habitat.

A researcher identifies and counts fish collected in an oxbow lake.

Parasitemia, Health, and Reproduction in a Migratory Waterfowl

Kansas Cooperative Fish and Wildlife Research Unit

Lesser scaup populations have been experiencing a continentwide decline since the 1980s. To identify factors that may be responsible for recent declines, it is important to have complete understanding of the critical factors influencing population growth and decline. The objectives of this research are to provide baseline information on scaup health and parasitemia and relate parasitemia prevalence and indices of health to body condition and breeding status. Results from this study can help managers better understand what factors are influencing the population dynamics of scaup.

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

Maine Cooperative Fish and Wildlife Research Unit

The Bay-breasted warbler, Blackburnian warbler, and Cape May warbler are affected by forest harvest practices. The goal of this study is to examine the effects of Maine's forest harvest practices on diversity and abundance of the forest bird community. The research team plans to document bird communities within the larger landscape. The study results can improve the understanding of avian responses to stand age and structure as it relates to habitat quality. Furthermore, the results can provide guidance on managing forest stands to improve habitat conditions for species of conservation interest.

Conserving Wood Turtles and Associated Riparian Species

Massachusetts Cooperative Fish and Wildlife Research Unit

The wood turtle is listed as an SGCN in the State Wildlife Action Plans (SWAPs) of all 13 of the northeastern States and has twice been proposed for Federal listing by independent petitioners. Researchers plan to investigate habitat loss, fragmentation, and other anthropogenic sources of mortality that contribute to population decline. Successful management of this highly sensitive and at-risk species is expected to require aggressive coordination and strategic planning, with a strong emphasis on sustained implementation. Successful conservation and management of riverine and riparian habitats for wood turtles can also benefit several dozen SGCN across the Northeast region.

A researcher is tracking the wood turtle, which is listed as a species of greatest conservation need in the State Wildlife Actions Plans of all 13 northeastern States and has twice been proposed for Federal listing by independent petitioners.

Rangewide Migratory Connectivity for Full-Cycle Conservation of the Golden-Winged Warbler, Climate Sensitive Songbird of the Highest Conservation Concern

Minnesota Cooperative Fish and Wildlife Research Unit

Golden-winged warblers are an SGCN because they have experienced dramatic population declines in the eastern portion of their breeding distribution, in spite of relatively high nest success. Migratory connectivity is a research frontier that is essential for understanding population dynamics, informing global conservation plans, and building a framework to address ecological questions about speciation, energetics, and disease transmission. This study is designed to evaluate movements and spatial affiliations of golden-winged warblers outside of the breeding season. The data from this research can facilitate targeted management efforts for full-life-cycle conservation plans.

Avian Conservation in Native and Afforested Habitats of North-Central Uruguay

Mississippi Cooperative Fish and Wildlife Research Unit

The Rio de la Plata grasslands represent the most extensive grassland ecosystem of the Neotropics but have been severely modified by humans. These grasslands serve as breeding and (or) wintering grounds for a variety of migratory bird species of conservation concern that breed in the United States. This study is expected to quantify avian communities of grasslands, wetlands, native forests, and timber plantations in the northern Campos grasslands of Uruguay and develop bird/habitat relation models. Results from this project can establish the baseline of a long-term research and monitoring program for AM of bird responses to habitat conditions and silvicultural practices in native habitats and timber plantations in northern Uruguay.

Methods for Sampling Freshwater Mussels in Missouri: Evaluation of Factors Influencing Capture Probability, Occupancy Estimation, and Community and Population Metrics

Missouri Cooperative Fish and Wildlife Research Unit

The Southeastern United States is known worldwide as a hotspot for freshwater aquatic diversity, including native freshwater mussels. Missouri is steward to a particularly diverse mussel fauna, with 69 species within State boundaries, including 8 Ozark endemic species, 10 federally endangered or threatened species, and 29 species of conservation concern. Despite their status as the most endangered taxonomic group in the State, mussel ecology, distribution, and population numbers remain poorly understood. This project is designed to develop models that identify factors affecting the capture probability of individual mussel species and metrics

of assemblage characteristics. This information is needed by managers to develop a statewide, strategic monitoring plan that maximizes the probability of detection of population and (or) distributional changes in mussel species while minimizing costs.

State-Level Mussel Management and Conservation: Current Status and a Strategic Path Forward

Missouri Cooperative Fish and Wildlife Research Unit

A strategic framework is needed to guide State-level mussel conservation programs. Researchers intend to document current State-level management actions, strategies, and resources used to manage freshwater mussels through an online survey of personnel from State natural resource agencies. The information can be synthesized into a comprehensive mussel conservation assessment strategy with a proposed implementation plan for Missouri. Incorporating resource limitations and other challenges identified into the developed approach can improve the effectiveness of mussel conservation efforts through strategic planning and implementation of restoration actions.

Prairie Stream Inventory

Montana Cooperative Fishery Research Unit

The pearl dace and the northern redbelly dace (hereafter hybrid dace) are both BLM-sensitive species and Montana Fish, Wildlife, and Parks species of special concern. These two species are facing existing threats, appear to have undergone substantial range contractions, and are at risk of extirpation from Montana. This research is intended to include inventory surveys that can identify the current distribution, threats, and habitat conditions of pearl dace and hybrid dace. This information can enable land managers to identify and prioritize potential areas and opportunities for long-term conservation.

Evaluation of the Effects of Rest-Rotation Grazing on Greater Sage-Grouse Habitat and Population Dynamics in Central Montana

Montana Cooperative Wildlife Research Unit

Grazing management enhances important components of sagebrush and grassland habitat for a wide range of species, but the scale and magnitude of benefits for avian species remain unclear, especially in the big sagebrush-steppe systems of eastern Montana. This project intends to evaluate the effects of rest-rotation grazing on greater sage-grouse habitat and population dynamics in central Montana. This project is a continuation of an ongoing, long-term study developed by the NRCS.

Wolverine Monitoring Analysis and Reporting

Montana Cooperative Wildlife Research Unit

Monitoring wolverines across large spatial areas is difficult. This research project plans to analyze a large body of data collected from a collaborative multi-State wolverine monitoring program. Researchers intend to analyze wolverine camera-trapping data to estimate occupancy and distribution as functions of environmental covariates and spatial autocorrelation. Understanding the density and distribution of wolverines across their range can provide critical information necessary for making management decisions.

Wolverine. Photograph by National Park Service.

Ecology of Swift Fox in Nebraska

Nebraska Cooperative Fish and Wildlife Research Unit

In Nebraska, shortgrass prairie is highly altered due to the removal of native grazers and natural fire regimes, the introduction of invasive species, and, more recently, the increasing exploration for oil, gas, and wind energy resources. As such, grassland-obligated species have experienced significant reductions in habitat availability and suitability, including the swift fox, identified by the Nebraska Natural Legacy Project

Swift fox. Photograph by National Park Service.

as an SGCN. The swift fox currently occupies only 21 percent of its historical range and fails to occupy the 42 percent of Nebraska that continues to contain seemingly high-quality swift fox habitat. Researchers plan to conduct population and genetic studies to improve understanding of swift fox distribution, abundance, and conditions in Nebraska in order to develop BMPs for this species.

Impacts of Drought on Southwestern Cutthroat Trout: Influences of Changes in Discharge and Stream Temperature on the Persistence of Rio Grande Cutthroat Trout Populations

New Mexico Cooperative Fish and Wildlife Research Unit

Rio Grande cutthroat trout are the southernmost subspecies of cutthroat trout and currently occupy only 12 percent of its historical range. Loss of habitat due to competition and hybridization with introduced trout and habitat alteration has restricted the remaining 122 populations to small (5.8 kilometer median length) isolated habitat patches. Although Rio Grande cutthroat trout are not currently considered to be at immediate risk of extinction—recent 12-month finding by the USFWS determined listing under the ESA was not warranted—climate concerns, such as increasing air temperatures and drought, are expected to have significant impacts on the persistence of the subspecies. This research can inform stakeholders of short-term and long-term drought impacts on sensitive coldwater fishes.

Applying Downscaled Climate Projections to Inform Decisions on Strategic Habitat Conservation for Amphibians in Puerto Rico

North Carolina Cooperative Fish and Wildlife Research Unit

Key partners in the Caribbean LCC are implementing a habitat conservation strategy that ensures the long-term persistence of amphibians in the advent of climate change. The stakeholders seek to recover 4 species of amphibians with Federal or State designations and also prevent listing 14 additional species that might become at-risk. As part of the project, researchers plan to conduct an SDM process and focus on tree frogs and species with similar life history traits to determine how a changing climate affects species in Puerto Rico.

Puerto Rican crested toad. Photograph by J.P. Zegarro, U.S. Fish and Wildlife Service.

Assessing the Effects of the National Park Service Predator and Vehicle Management Practices on Nesting Shorebirds at Cape Hatteras National Seashore

North Carolina Cooperative Fish and Wildlife Research Unit

The American oystercatcher is listed as a species of high concern by the U.S. Shorebird Conservation Plan; in North Carolina it is considered a species of special concern and is listed as threatened in Georgia and Florida. Disturbance during the breeding season can be particularly harmful to birds, and the effects of anthropogenic disturbance on breeding behavior and breeding success are particularly relevant for species of conservation concern, such as the American oystercatcher. Using the American oystercatcher as a focal species, this study is designed to evaluate the effectiveness of current predator and vehicle management practices at Cape Hatteras National Seashore, North Carolina. Findings can provide National Seashore managers with the information necessary for evaluating current management practices as required for the 5-year review of the NPS Off-Road Vehicle Management Plan.

The American oystercatcher is listed as a species of high concern in North Carolina.

Population Status and Genetic Structure of the Carolina Madtom

North Carolina Cooperative Fish and Wildlife Research Unit

The Carolina madtom is a small catfish endemic to a restricted range in the Neuse and Tar River Basins of North Carolina, and populations appear to be declining. This research seeks to define the distribution and populations of the Carolina madtom and quantify sampling bias and efficiency toward understanding and modeling the species distribution and abundance. The study can also estimate critical parameters of genetic isolation and diversity within and among populations. These findings can provide critical, timely information for the USFWS SSA, inform protective listing decisions, and guide conservation planning for the species.

Robust Redhorse Recovery and Habitat Restoration: Assessing Water-Quality Stressors and Food Web Contaminant Dynamics

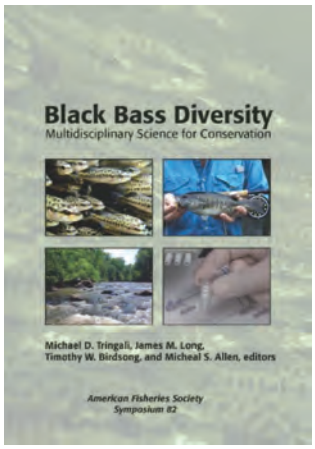
North Carolina Cooperative Fish and Wildlife Research Unit

The robust redhorse is a rare and imperiled fish found in only three regulated river basins in the Southeastern United States. The robust redhorse has been negatively affected by habitat modification and fragmentation from hydroelectric dams, introduced species, sedimentation, and water pollution and is protected by State endangered status in Georgia and North Carolina. This study is designed to further elucidate the impact and potential threat of water quality and contaminant dynamics on the robust redhorse in the Pee Dee River of North Carolina and South Carolina. The data can help managers guide management objectives and goals for species recovery and habitat restoration.

Assessment of Genetic Integrity, Population Status, and Long-Term Viability of Isolated Populations of Shoal Bass in the Upper Chattahoochee River

Oklahoma Cooperative Fish and Wildlife Research Unit

The shoal bass is an endemic species of black bass native to the Apalachicola-Chattahoochee-Flint River system of Alabama, Georgia, and Florida. The shoal bass is considered vulnerable to extinction throughout its distribution and, within the upper Chattahoochee River Basin, is known to inhabit this location. As part of this project, researchers are assessing the genetic integrity and population stability of shoal bass as the species is being influenced by fragmentation and nonnative congeners. Results of the assessment can support conservation efforts targeted at this endemic fish species.



This book's 47 chapters cover the biological, ecological, genetic, and management concerns of endemic bass within the genus *Micropterus*.

Pigeon Guillemot Restoration Research in Prince William Sound, Alaska

Oregon Cooperative Fish and Wildlife Research Unit

The pigeon guillemot is now the only marine bird species injured by the 1989 *Exxon Valdez* oil spill that is listed on the *Exxon Valdez* Oil Spill Trustee Council's Injured Resources List as "not recovering." Since 1989, the population of pigeon guillemots in PWS has declined by an alarming 47 percent, and there is no sign of population stabilization or recovery. The goal of this project is to conduct research to document the recovery of pigeon guillemots after suppression of the mink population on the Naked Island group (Naked, Storey, and Peak Islands). This research can inform recovery and restoration alternatives designed to facilitate the population recovery of pigeon guillemots.

Pigeon guillemots. Photograph by Ron LeValley, U.S. Fish and Wildlife Service.

Snowshoe Hare Habitat Relations in Response to Northern Forest Management

Pennsylvania Cooperative Fish and Wildlife Research Unit

The snowshoe hare is a species of conservation need in Pennsylvania's SWAP due to its sensitivity to habitat changes and its importance for gene flow between States to the north and south in the Appalachian Mountains. The current limited distribution of snowshoe hares in western north-central Pennsylvania and the Pocono Mountains is thought to reflect the limited availability of critical habitat components in snowshoe hare range. This study intends to characterize hare habitats in northern hardwood forests in northwestern Pennsylvania and the scrub oak barrens in the Poconos region. These data can aid in developing a comprehensive spatial understanding of snowshoe hare habitat relations to better understand factors affecting snowshoe hare abundance and distribution in Pennsylvania.

Analysis of Black Scoter Population Count Data

South Carolina Cooperative Fish and Wildlife Research Unit

The black scoter is of special concern among the sea ducks because it is the least studied and least common of the three scoter species. Researchers are collaborating with USFWS to analyze the wintering distribution of black scoter from North Carolina to Georgia using previously collected aerial survey data. Tracking scoters through these aerial surveys and relating movements and distribution to habitat characteristics can provide new insights for managing the species.

South Carolina Alligator Adaptive Management Strategies: Population Dynamics, Habitat Use, and Conservation Threats

South Carolina Cooperative Fish and Wildlife Research Unit

Alligators are often simultaneously viewed as a keystone species of ecological importance, a controversial public safety nuisance, and a valuable economic resource. Intensive development on South Carolina's coastal plain, within the alligator's core range, presents challenges to effective conservation and management decision making to satisfy multiple stakeholder groups. This research is designed to estimate current population structure, abundance, and habitat requirements for American alligators in South Carolina. Results from this study can be used to develop a management strategy for alligators that accounts for tradeoffs to best meet the multiple objectives of the stakeholders.

Spatial Ecology of Brown Pelicans in the South Atlantic Bight

South Carolina Cooperative Fish and Wildlife Research Unit

Nearshore seabirds, such as brown pelicans, can serve as a valuable indicator species for ecosystem health in marine, coastal, and estuarine systems because they are transboundary in nature and integrate information across a range of trophic systems. Furthermore, pelicans are a species of conservation concern for most States in the Gulf region (as well as the southern Atlantic States). Prior to the *Deepwater Horizon* oil spill, however, little research effort was invested on examining the foraging ecology, reproductive success, movement patterns, or health of brown pelicans in the Gulf. This research can address information gaps relative to brown pelicans in the South Atlantic Bight and provide baseline ecological information for the species in the region.

Nearshore seabirds, such as brown pelicans, can serve as a valuable indicator species for ecosystem health.

Pictured below: Female alligator at Yawkey Wildlife Reserve, South Carolina.

Assessing the Current Status of Reintroduced Swift Fox in Southwestern South Dakota

South Dakota Cooperative Fish and Wildlife Research Unit

Plague is now evident within black-tailed prairie dog towns throughout western South Dakota. No information on the status of swift foxes in western South Dakota has been collected since 2011. Consequently, the status of swift fox in areas where prairie dog towns have been decimated by plague, including the Badlands region, is unknown. The purpose of this study is to determine the current status of swift fox as it relates to the Badlands National Park area and the historic population in Fall River County in southwestern South Dakota. Data collected can inform restoration efforts for the species.

Determining the Distribution of Imperiled Mussels in Tennessee Waters

Tennessee Cooperative Fishery Research Unit

Tennessee is home to one of the most diverse freshwater fish and mussel communities in the world, including numerous endangered species. Unfortunately, freshwater mussels are one of the most endangered animals in North America. Fisheries managers are interested in improving the status of imperiled mussels in Tennessee waters. The purpose of this study is to assess sites throughout Tennessee that historically harbored at-risk mussel species to determine their current distribution. These data can inform management of fisheries conservation efforts throughout the State.

Accessing Occupancy and Reproductive Status of Golden Eagles at Historic Areas in Texas

Texas Cooperative Fish and Wildlife Research Unit

Wind-energy development in areas of Texas occupied by golden eagles poses a unique challenge to land managers because of the vulnerability of the species to collisions with wind turbines and its sensitivity to human land use. The breeding population of golden eagles in the State is largely unknown. Researchers plan to compile detailed records of known historical golden eagle nest locations in Texas and collect occupancy data on nests. Agencies or industry concerned with assessing potential influences of wind energy development on eagles in the Trans-Pecos and southern Great Plains regions of the United States are expected to benefit from the research results.

Golden eagle in flight. Photograph from Pixabay.com, licensed under Creative Commons CC0.

Assessing the Effects of Flow Regime Variation on Blue Sucker Spawning Movements, Habitat Use, and Recruitment in the Lower Colorado River, Texas

Texas Cooperative Fish and Wildlife Research Unit

The blue sucker is a State-listed threatened species in Texas and is considered vulnerable throughout its range due to a combination of its habitat requirements and life-history traits. The life-history strategy of the blue sucker is poorly understood, but it has been hypothesized that its propensity to undertake long-distance upstream migrations to spawning habitat renders it particularly vulnerable to flow alterations. The primary objective of this research is to provide information to assess the effects of varied streamflow levels, as regulated by water releases from upstream reservoirs, on habitat use and reproductive success of the blue sucker in the lower Colorado River.

Recruitment Dynamics and Reproductive Ecology of Blue Sucker in Texas, With a Focus on the Big Bend Region of the Rio Grande

Texas Cooperative Fish and Wildlife Research Unit

The Rio Grande blue sucker is identified as an SGCN in the Texas Conservation Action Plan. Although recent surveys suggest that blue suckers are consistently undertaking spawning migrations and accessing spawning habitats in the lower Sabine River, a successful attempt to characterize recruitment in this population has not been made. This study intends to provide data on current demographic characteristics, habitat use patterns, and recruitment dynamics of the Rio Grande blue sucker in the lower Sabine River. This information can be incorporated into conservation planning efforts for the species in Texas.

Variation and Plasticity and Their Interaction With Urbanization in Guadalupe Bass Populations On and Off the Edwards Plateau

Texas Cooperative Fish and Wildlife Research Unit

The Guadalupe bass is a native black bass species endemic to Texas. It is found primarily in the Edwards Plateau ecoregion, but its habitat also extends downstream into the Blackland Prairie and Coastal Plains ecoregions in the lower Colorado River. Guadalupe bass populations have declined across much of their range, and the species has been identified as an SGCN by the Texas Parks and Wildlife Department. Researchers intend to investigate how urbanization and other anthropogenic factors have affected stream fishes and, in particular, Guadalupe bass. This information represents a significant information gap in the understanding of the threats to Guadalupe bass and can inform management strategies in the Edwards Plateau.

Survey for Sensitive Species in Utah

Utah Cooperative Fish and Wildlife Research Unit

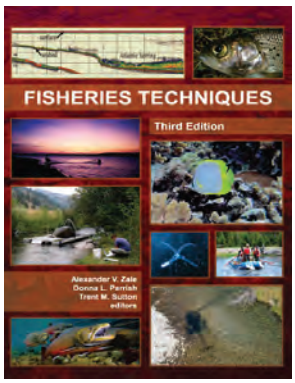
The Intermountain West is undergoing dynamic demographic changes accompanied by changing land uses and increasingly diverse and often conflicting demands on limited natural resources. The goal of this project is to gather information to better define the habitats of sensitive species in Utah and help in future surveys for rare plants throughout the State. The research team plans to use models to investigate rare and sensitive plant distributions and energy development in the Colorado Plateau region. This project can help improve the accuracy and efficacy of future sampling surveys and assist decision makers with establishing and prioritizing appropriate management activities.

The Colorado Plateau of western North America—especially Utah's Uinta Basin—contains numerous rare and sensitive plant species.

Assessment of Stonecat Populations in the Missisquoi and LaPlatte Rivers of Vermont

Vermont Cooperative Fish and Wildlife Research Unit

The stonecat, a North American catfish, is known to populate two rivers in Vermont—the Missisquoi and LaPlatte Rivers located in the Lake Champlain watershed—and is a State-listed endangered species and SGCN. Little is known about stonecat populations in Vermont, including their abundance and other population parameters in the Missisquoi and LaPlatte Rivers, distribution and habitat availability and use, and population viability and persistence. This project intends to assess stonecat populations in both rivers to estimate population parameters necessary for assessing risks to the populations. The project also plans to identify risk assessment models that can provide guidance on activities that mitigate possible sources of mortality and increase the likelihood of sustaining stonecat populations in Vermont.



This new edition describes the techniques used to collect and analyze fisheries samples and data. Image from American Fisheries Society.

Methods to Assess Lake Sturgeon Populations in Lake Champlain

Vermont Cooperative Fish and Wildlife Research Unit

Lake sturgeon populations have declined because of factors including habitat loss and overfishing, and they are listed as extirpated, endangered, threatened, or of special concern in 12 States. The State of Vermont listed the species as endangered in 1975 due to low abundances in Lake Champlain. Successful reproduction is occurring in multiple rivers in the Lake Champlain basin; however, an understanding of the current population status in the system is lacking. This study intends to document adult and juvenile movements, identify suitable spawning and nursery habitat, investigate age structure, and develop a method to estimate the population of lake sturgeon in Lake Champlain.

Movements of Lake Sturgeon After Upstream Passage Through Two Dams on the Menominee River

Wisconsin Cooperative Fishery Research Unit

Lake sturgeon populations in the Great Lakes have undergone major declines over the last two centuries for a variety of reasons, including dam construction. These declines led to closures of commercial, recreational, and Tribal subsistence fisheries and the listing of lake sturgeon as threatened, endangered, or a species of special concern in many States in the Great Lakes region. As a part of this study, acoustic telemetry is planned to be used in describing the movement of lake sturgeon in the Menominee River. Results from the study can provide fishery managers around the Great Lakes with information that can be used to formulate passage strategies and possibly help design passage facilities for lake sturgeon.

Avian Community Response in Grand Teton National Park

Wyoming Cooperative Fish and Wildlife Research Unit

Currently, little information is available on bird responses to restoration in sagebrush-steppe ecosystems. Although there are studies reporting restoration treatments of sagebrush steppe with the aim of creating or improving greater sage-grouse habitat, the actual effects of restoration on sage-grouse populations have seemingly not been fully evaluated. This research is expected to contribute to a better understanding of the effects of restoration treatments on sagebrush-steppe birds and their habitats; these data could be used in building state-and-transition models as a way of determining when ecological functions, such as the provision of wildlife habitat, are intact.

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

Wyoming Cooperative Fish and Wildlife Research Unit

The black rosy-finch has a fairly restricted geographic range within the U.S. Intermountain West and is one of the most understudied avian species in North America. This finch has been designated an SGCN in Wyoming, reflecting the lack of information available on the species. This research project is being conducted to obtain data currently lacking on breeding habitat selection and requirements and to identify key characteristics of summer breeding habitat to build a predictive model. Results of the study can be used to address conservation actions as identified in the SWAP including the establishment of long-term monitoring sites, which could be used for tracking population trends and changes in habitat use.

The black rosy-finch has been designated a species of greatest conservation need in Wyoming.

Boreal Toad Habitat Selection and Survival in Relation to Grazing Intensity and Disease Prevalence

Wyoming Cooperative Fish and Wildlife Research Unit

In Wyoming, boreal toads are found in the western and southern parts of the State and are listed as an SGCN. A large proportion of the Wyoming boreal toad species range is found in the Bridger-Teton National Forest. A better understanding of the effects of livestock grazing on boreal toads is needed to guide management. Researchers plan to evaluate boreal toad movement, habitat selection, survival, and disease status across a gradient of livestock grazing intensity to understand how grazing individually and in conjunction with disease may affect boreal toad populations. Results can provide a better understanding of boreal toad habitat use and quality in relation to grazing management practices and disease prevalence.

Boreal toad with transmitter.

Columbia Spotted Frog Investigations in Wyoming

Wyoming Cooperative Fish and Wildlife Research Unit

Columbia spotted frog.

The Columbia spotted frog was identified in the Wyoming SWAP as an SGCN. One of the conservation actions identified in the species account in the SWAP is "A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming." This study is designed to meet this information need and be conducted in the Bighorn Mountains, where spotted frog populations are most susceptible to extirpation.

Conservation and Recovery of Hornyhead Chub

Wyoming Cooperative Fish and Wildlife Research Unit

The main threats to hornyhead chub populations are habitat degradation and interactions with nonnative species. In the Laramie River, hornyhead chubs coexist with nonnative salmonids that could prey on hornyhead chubs. The extent of predation by brown trout (and to a lesser extent rainbow trout and brook trout) on hornyhead chubs is not known. A better understanding of the potential role of predation on hornyhead chub populations is needed to ensure the success of management and restoration efforts. The goal of this project is to evaluate habitat suitability at potential introduction sites and explore the effects of predation by nonnative salmonids. Results from the study can aid the development of potential management strategies for hornyhead chub population restoration and expansion.

Hornyhead chub from the Laramie River.

LaBarge Creek Cutthroat Trout Investigations

Wyoming Cooperative Fish and Wildlife Research Unit

Hatchery-reared Colorado River cutthroat trout have failed to establish or reproduce in LaBarge Creek. Translocation success rates for cutthroat trout are often less than 50 percent, with habitat quantity and quality being the most common causes of failure. The goal of this project is to evaluate post-stocking survival and emigration of hatchery-reared Colorado River cutthroat trout and determine factors contributing to low survival and establishment. Knowledge of stocked fish survival and movement post-stocking is needed to understand why Colorado River cutthroat trout are failing to establish in LaBarge Creek.

The main stem of LaBarge Creek, Wyoming.

Resource Selection, Area Requirements, and Monitoring of Bighorn Sheep in Northwest Nebraska

Wyoming Cooperative Fish and Wildlife Research Unit

Female desert bighorn sheep.

Although bighorn sheep are found throughout the Western United States, they often occur in small, isolated herds that are especially prone to periodic die-offs from disease, low genetic diversity, and random population fluctuations. These effects reduce the potential for sustained harvest and the long-term maintenance of viable wild bighorn sheep populations. The Nebraska Game and Parks Commission is interested in understanding the habitat requirements of sheep in northwest Nebraska, with the goal of growing larger, self-sustaining populations. This project plans to use data from individually identified sheep to understand habitat requirements, resource selection, and movement dynamics of Nebraska sheep. Indirect outcomes expected from this analysis include identifying future data needs and monitoring requirements for these populations and providing a framework (for example, databases, code) for quickly managing and analyzing data in the future.

Sage-Grouse: Effectiveness as an Umbrella for Nongame Sagebrush—Species of Greatest Conservation Need

Wyoming Cooperative Fish and Wildlife Research Unit

The greater sage-grouse is an umbrella species for the management of species within North American sagebrush steppe. Sage-grouse are well-studied habitat specialists that have large home ranges and are already the target of extensive conservation and management efforts. However, much less is known about other nongame, focal species that co-occur with sage-grouse. As part of this study, researchers plan to model the spatial and habitat overlap of nongame sagebrush focal species with proposed sage-grouse core areas and evaluate the reproductive success of the three other sagebrush-obligate birds (Brewer's sparrow, sagebrush sparrow, sage thrasher) across habitats. The results can help inform the decision making of wildlife managers in Wyoming who use sage-grouse as an umbrella species.

Small Mammals (Species of Greatest Conservation Need): The Influence of Exotic Grassland Plants

Wyoming Cooperative Fish and Wildlife Research Unit

Grassland habitats and the species that occupy those habitats have become the focus of tremendous conservation concern due to widespread loss, fragmentation, and conversion to nonnative monocultures. As a result, many small mammal species that use grassland habitats are classified as SGCN in the Wyoming SWAP. Researchers plan to examine and compare small mammal abundance, diversity, reproductive status, sex ratios, population age structure, productivity, and morphometrics in native mixed-grass prairie compared to areas with exotic grass (cheatgrass) encroachment and develop recommendations for grassland management in eastern Wyoming.

Prairie dog family. Photograph by U.S. Fish and Wildlife Service.

Species Population, Habitat, and Harvest Management

Deer Density and Recruitment in Alabama

Alabama Cooperative Fish and Wildlife Research Unit

In Alabama, managers and wildlife biologists work to increase the white-tailed deer population density and improve harvest rates. The deer population densities have not responded as expected and harvest opportunities declined, leading to dissatisfaction among hunters. This study uses time-lapse photography to estimate white-tailed deer demographic rates for use in a population model that can inform harvest management decisions.

Characterization of Resident Rainbow Trout Seasonal Habitats in Willow Creek, Alaska

Alaska Cooperative Fish and Wildlife Research Unit

Rainbow trout are important ecological and fishery resources in the Alaska Susitna River Basin, yet the distribution of their seasonal habitats is poorly understood. The objective of this project is to assess the availability and use of seasonal habitats by rainbow trout and link the habitat characteristics (physical habitat, water temperature, and flow) to fish location and movement. Habitat availability is assessed by mapping geomorphic channel types and water temperature. The research results can be used to prioritize habitat protection efforts considering anticipated land use and climate change.

The eft stage of a red-spotted newt in the Crockford-Pigeon Mountain Wildlife Management Area, Walker County, Georgia.

Chinook and Coho Salmon Productivity on the Unalakleet River

Alaska Cooperative Fish and Wildlife Research Unit

Resource subsidies (for example, nutrients, prey, detritus) can significantly affect Alaskan freshwater ecosystems, and there are clear nutritional and growth benefits to consumers that have access to terrestrial and marine subsidies. Some salmon species indirectly and strongly affect the productivity and body condition of others. This project is designed to help better understand how marine subsidies from pink and chum salmon runs affect the productivity of Chinook and coho salmon. Results from this study can illustrate a broader and more cohesive understanding of how marine, freshwater, and terrestrial ecosystems are linked via resource subsidy exchanges among ecosystems and the role that prey and nutrients play in regulating food webs and fishes.

Pictured below: Rainbow trout.
Photograph by U.S. Fish and Wildlife Service.

Development of an Alaska-Based Research Framework for Migratory Waterfowl

Alaska Cooperative Fish and Wildlife Research Unit

The effects of climate and land use on the survival and productivity of migratory waterfowl breeding in Alaska vary, and population trends result from the cumulative effects of habitat quality and climate across the annual range. It is unlikely that the direction or strength of climate and habitat change are consistent across ranges and, as a result, it is difficult to determine the central influences on population size. A large-scale research framework or strategy is needed to ameliorate the complexities of this problem and improve the accuracy, efficiency, and effectiveness of research studies and resulting management strategies. Using intensive reviews of scientific literature to identify knowledge gaps and surveying the expert opinions of researchers and managers, this project identifies the types of information most critical for developing a focused, integrated, multiregional research program and determining the best ways for researchers and managers from seasonal ranges to communicate using common terms.

Distribution and Use of Rearing Habitats by Juvenile Chinook Salmon in the Chena River Basin, Alaska

Alaska Cooperative Fish and Wildlife Research Unit

Most Chinook salmon in Alaska follow the stream-type life history, in which adults return from the ocean and spawn in summer and fall, eggs hatch in early spring, juveniles oversummer and over-winter in tributaries, and smolt outmigrations occur the following spring. The extent of movement and the distribution of rearing habitats in interior Alaska stream networks are not well-quantified. Digital models for predicting the distribution of rearing habitats are available for southern populations (the Columbia and Copper River Basins) but are not parameterized for interior Alaska. The researchers in this study conduct semicontinuous surveys in the main channel of the Chena River, sampling randomly selected channel units. The results can be used to predict the upstream and downstream limits of juvenile Chinook salmon rearing habitats. Expanding the habitat prediction models to interior Alaska allows managers to incorporate habitat availability into management strategies for those systems.

Genetic Diversity and Population Relations of Resident Kokanee and Anadromous Salmon in Copper Lake (Wrangell-St. Elias National Park and Preserve)

Alaska Cooperative Fish and Wildlife Research Unit

Copper Lake in the Wrangell-St. Elias National Park and Preserve, Alaska, is thought to be the home of a population of kokanee salmon, a nonmigratory type of sockeye salmon. Field surveys identified small sockeye salmon specimens in reproductive condition; whether these fish belong to a self-perpetuating population of resident salmon or to a sockeye population that expresses both migratory and nonmigratory variants remains unclear. This project seeks to produce a baseline assessment of sockeye salmon genetic variability in Copper and Tanada Lakes using suites of genetic markers deployed widely for sockeye salmon assessments in the State. The resulting diversity measurements can be summarized by indices of variation within and between groups (specifically lakes, resident versus migratory, drainage), which, in turn, serve as estimates of genetic differentiation between groups.

Productivity of Black Oystercatchers in Southwest Alaska

Alaska Cooperative Fish and Wildlife Research Unit

The black oystercatcher is a species of shorebird harmed by the 1989 *Exxon Valdez* oil spill. The population within Kenai Fjords National Park has not recovered, and human disturbance from park visitors may limit population recovery by decreasing productivity. In general, shorebirds are sensitive to human disturbance through direct effects, as with nest abandonment, and indirect effects, as with reduced foraging and chick survival. Examining population dynamics and documenting visitor impacts to nesting oystercatchers can allow researchers to formulate management strategies for the protection of this bird species and of human backcountry use in the park.

Stikine and Taku River Chinook Salmon Distribution and Migration Patterns and Their Relation to Body Condition

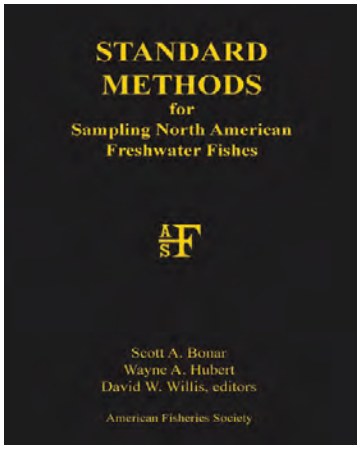
Alaska Cooperative Fish and Wildlife Research Unit

The Stikine and Taku Rivers in southeast Alaska are major producers of Chinook salmon, which are an ecologically, culturally, and economically important species for the region. The salmon from these transboundary rivers, with their headwaters in Canada, are jointly managed and harvested by American and Canadian stakeholders. A radio telemetry study on these rivers can generate information on the behaviors of these fish, including spawning distribution, migration rates, temporal patterns, and dropout rates. A specific focus of this research is the success of fish passing a natural landslide that occurred on the Tahltan River, a tributary of the Stikine River, in which an estimated 50 percent of the Chinook salmon return. Results from this project can validate and inform current mark-recapture studies and escapement estimates, allowing fisheries managers to set more accurate harvest limits for Chinook salmon in both American and Canadian fisheries.

Collaborative Fish and Wildlife Research With Southwestern State and Federal Agencies: Refinement of Standard Fisheries Sampling Techniques in Arizona

Arizona Cooperative Fish and Wildlife Research Unit

Management, monitoring, and research of fish and wildlife populations are increasingly conducted across large landscapes with collaborative efforts involving many agencies. Through the publication of the book "Standard Methods for Sampling North American Freshwater Fishes," the American Fisheries Society (AFS), in partnership with 284 biologists from 107 State, Federal, and local agencies and NGOs, developed standard sampling procedures for freshwater ecosystems. As a part of this project, 4,092 datasets of common indices—for 15 common North American fishes collected using AFS standard techniques—were summarized. To improve the utility of this tool for Arizona fisheries biologists, specific, standardized data for bodies of water in Arizona must be collected and integrated with the datasets. An integrated dataset allows Southwestern fisheries biologists to regionally diagnose problems for fisheries and inform biologists and managers of habitat mitigation needs and management strategies for Arizona lakes.



This important reference book provides standard sampling methods recommended by the American Fisheries Society for assessing and monitoring freshwater fish populations in North America.

Freshwater Predation on Chena River Juvenile Chinook Salmon

Arkansas Cooperative Fish and Wildlife Research Unit

Freshwater predation can limit the survival of juvenile salmon, but little is known about the predators of juvenile Chinook salmon in the Yukon River Basin and their potential role in recent declines. Yukon River Basin salmon long coexisted with many native piscivorous species; however, the relative importance of Chinook salmon predation mortality, and when and where predators inflict the greatest mortality, are poorly understood. This study takes important steps toward understanding the influence of freshwater predation on juvenile Chinook salmon productivity. This study can enable managers to understand how natural or harvest-driven changes in predator abundance affect the numbers of salmon consumed and allow prioritization of predator species for future research.

Migration Ecology of American Woodcock

Arkansas Cooperative Fish and Wildlife Research Unit

A species of conservation concern across eastern North America, the American woodcock has experienced long-term population declines in both the American woodcock Eastern and Central Management Regions, as documented through the Singing-Ground Survey. One poorly understood aspect of American woodcock life history is migration, especially patterns of migration, habitat use during migration, and survival during migration. Satellite transmitters deployed on American woodcock sites, in both their breeding and wintering ground throughout the American woodcock Central Management Region, can provide data on the timing of migration initiation and on migratory routes, which can then be used to fine-tune the determination of hunting season dates.

A Spatially Explicit Population Modeling Framework to Support Conservation Decision Making for Gopher Tortoises in Georgia

Georgia Cooperative Fish and Wildlife Research Unit

Georgia currently lacks a systematic and objective means of targeting specific lands for conservation action that can sustain the statewide population of gopher tortoise. Further, population conservation objectives may not be achievable exclusively on the existing publicly owned land base. Through a combination of analysis and targeted fieldwork, researchers can construct models that combine spatially explicit population processes and landscape elements to predict the responses of gopher tortoise populations to conservation actions. Over time, as conservation actions are performed and the outcomes assessed, accumulated evidence can be made available to better inform modeling efforts.

Growth of Spotted and Largemouth Bass

Georgia Cooperative Fish and Wildlife Research Unit

In the Southeastern United States, black bass are widely targeted by anglers, and two species—spotted and largemouth bass—potentially intermix and compete for resources. The research project can evaluate abundance, age, size, and mortality rates for bass populations in three Georgia reservoirs: Lake Lanier, Lake Chatuge, and Lake Nottely. Estimates of population parameters for these species can provide the Georgia Department of Natural Resources with insight into how these species interact in the wild and assist in developing species-specific management strategies.

Impacts of Rabbit Hunting on Northern Bobwhite Demographics and Behavior

Georgia Cooperative Fish and Wildlife Research Unit

Management of early successional habitat for northern bobwhites often provides habitat for other species with similar habitat preferences, such as rabbits. This positive byproduct creates additional opportunities for small-game hunters; however, the concurrent pursuit of two species with similar habitat requirements may create conflicts among hunters or affect the demography or behavior of one or both species. Rabbit hunting, in particular, can disrupt bobwhite movements and behavior given the traditional presence of large hunting parties and packs of dogs. This study focuses on the effects of hunting at one Georgia Department of Natural Resources Wildlife Management area, in which activities of the two types of hunters are separated in time; specifically, the study investigates whether rabbit-hunting activity disrupts bobwhite behavior sufficiently enough to change the demography and, consequently, bobwhite hunter satisfaction. The data from the project can inform management decisions on northern bobwhite and small game.

Statistical Support for National Park Service Southeast Region Inventory and Monitoring Networks

Georgia Cooperative Fish and Wildlife Research Unit

The NPS introduced a service-wide I&M program to conduct long-term natural resource monitoring for numerous topical areas and scales (for example, water quality, vegetation, amphibians, reptiles, birds, mammals) in the Nation's parks. The objective of this project is to assist in creating sampling designs and guidance for the statistical analysis of data collected under long-term monitoring protocols developed (or in development) by I&M networks within the NPS Southeast Region. Scientists perform statistical analyses on pilot data collected by NPS and conduct power analyses for various sampling designs that are of interest to the I&M program. These analyses can inform NPS networks as they develop standardized operating procedures for on-the-ground monitoring programs.

Validating Gopher Tortoise Habitat and Population Predictions for Georgia

Georgia Cooperative Fish and Wildlife Research Unit

In Georgia, an integral part of gopher tortoise management focuses on validating available habitat and population predictions. This project looks to collect fine-scale habitat data at sites occupied by gopher tortoises and at reference sites where tortoises are not found. This information allows researchers to assess the performance of current habitat prediction models and develop improvements using other spatial data products. The research can define relations between tortoise population size and habitat conditions and assess whether forest management practices can produce conditions favorable to increasing population sizes among tortoises.

Adult gopher tortoise. Photograph by Randy Browning, U.S. Fish and Wildlife Service.

Assessing the Importance of Wetlands on Department of Defense Installations for the Persistence of Wetland-Dependent Birds

Idaho Cooperative Fish and Wildlife Research Unit

This project aims to develop detailed habitat models for rare and endangered wetland birds. Researchers plan to use the models to rank over 600 DoD installations regarding their importance to wetland birds, and they plan to conduct wetland bird surveys on a random subset of DoD installations to verify the models and provide abundance estimates for these rare species. Non-DoD wetlands within the breeding range of the endangered wetland birds on State and Federal listings can be ranked to document the value of DoD wetlands to the preservation of these species. This project enables the production of a first-of-its-kind inventory of the biological value of wetlands on DoD lands, detailed habitat models—which are not currently available—for each species, and baseline survey data on secretive marsh birds at a large subset of DoD installations.

Dispersal Behavior of Yuma Ridgway's Rail

Idaho Cooperative Fish and Wildlife Research Unit

Since 2005, the population of Yuma Ridgway's rail, as detected across its range and measured using standardized surveys, has decreased by 52 percent. Most of this decline occurred at managed wetlands near the Salton Sea in California, but the reasons for the decline are unknown. After attaching transmitters to rails, researchers can determine dispersal distances, dispersal direction, and the conditions under which

young birds move to find new habitat patches. This project can produce valuable information on factors driving the timing, direction, and magnitude of dispersal.

Microhabitat Use of Native and Nonnative Fishes in Kootenai River

Idaho Cooperative Fish and Wildlife Research Unit

The Kootenai River was heavily modified during the construction of dams, powerplants, and diversions, which require habitat restoration and management to preserve important fish populations. This step is the second phase of a multiphase project focused on understanding how habitat restoration activities in a large river system (Kootenai) influence fish assemblage structure and fish population dynamics. Researchers can use specialized techniques to analyze microhabitat use in the field and evaluate the varied ways that native fishes use habitat in the presence of nonnative species.

Movement, Mortality, and Habitat Use of Westslope Cutthroat Trout in the South Fork Clearwater River Watershed

Idaho Cooperative Fish and Wildlife Research Unit

Westslope cutthroat trout are among the most popular sport fishes in Idaho. Although many river systems in northern Idaho support high densities of large individuals, Westslope cutthroat trout populations in the South Fork Clearwater River contain few large fish. The leading hypothesis suggests that high temperatures deleteriously affect the Westslope cutthroat trout. The purpose of this research is to provide insight on the movement and habitat use of Westslope cutthroat trout in the South Fork Clearwater River Basin using a combination of radio telemetry and snorkeling techniques. Results of the study can be used by managers to better manage fish and habitat in the system.

Population Dynamics of Lake Trout in Priest Lake, Idaho

Idaho Cooperative Fish and Wildlife Research Unit

Lake trout are a nonnative species in Priest Lake, Idaho, that create management challenges. The lake trout population provides a popular fishery but may interact negatively with other fish species, most of which provide recreational opportunities in the Priest Lake system. Moreover, high densities of lake trout may contribute to low densities of threatened bull trout in the system. The purpose of this study is to provide managers with information on the population dynamics of lake trout for guiding management decisions at Priest Lake.

Rangewide Habitat Models for Predicting Habitat Suitability for Marsh Birds Throughout the United States

Idaho Cooperative Fish and Wildlife Research Unit

Wetlands are among the most imperiled ecosystems in North America. As a result, many marsh birds suffer population declines and local extinctions. This research uses the National GAP species distribution models for marsh birds to identify important threats and map variation in habitat across species' ranges. Approaches developed by the project can inform resource managers who set conservation priorities for wetlands at the national scale.

Amphibian Occupancy and the Effects of Habitat Use on Chemical Exposure in Northern Leopard Frogs in Iowa Prairie Pothole Wetlands

Iowa Cooperative Fish and Wildlife Research Unit

Loss of habitat from land-use change caused widespread declines in amphibian communities throughout the United States. The glacially formed Des Moines Lobe in Iowa historically contained a high density of small-depression wetlands embedded in a prairie grassland landscape, which typifies the prairie pothole region of North America. However, 95–99 percent of these wetlands were lost after the conversion of Iowa's landscape to intensive row-crop agriculture in the late 19th century. This research assesses the utility of these wetlands for providing habitat and landscape connectivity to amphibians in the Des Moines Lobe by examining water quality, discerning the presence of amphibian disease, and estimating survival, reproduction, and stress levels in native frogs. Understanding the potential utility of restored and constructed wetlands for amphibian conservation is important to land managers and the agricultural community.

Loss of habitat caused by land-use change has resulted in widespread declines in amphibian communities throughout the United States. Northern leopard frog photograph from Pixabay.com, licensed under Creative Commons CC0.

Estimating Breeding Populations of Canada Geese in the Midwest—A Model to Predict Canada Goose Breeding Pair Densities Using National Wetlands Inventory Data

Iowa Cooperative Fish and Wildlife Research Unit

Mississippi Flyway Council States and Provinces have developed and refined methods for estimating giant Canada goose populations in the Flyway region since 1993, but estimates of giant Canada goose populations are imprecise. The goal of this project is to develop a model that predicts Canada goose breeding densities using National Wetlands Inventory data. Results from this study can provide more precise estimates of the breeding populations of these birds in the States and Provinces with resident populations, which is necessary for sound science-based management.

Canada goose.

Grassland Bird and Invertebrate Response to Grassland Diversity in Restored Plantings in Northwestern Iowa

Iowa Cooperative Fish and Wildlife Research Unit

Land managers in the Midwest are interested in connections between diverse plant species, birds, and insects. A critical assumption in grassland management is that the forty-species grassland mix benefits grassland birds greater than the five-species mix or monotypic smooth-brome plantings. This research allows these assumptions to be tested by a design study to monitor grassland birds and insects in the planting treatments. The results can allow managers to understand the trade-offs of using different grassland mixes with birds and insect communities.

Monitoring Protocol for Otter and Bobcat in Iowa

Iowa Cooperative Fish and Wildlife Research Unit

River otters and bobcats recently recolonized Iowa; their populations are sufficient to allow harvest. Successful wildlife management requires that the Iowa Department of Natural Resources monitor the population status of these species. This project uses population models to determine age structure and population trends. The results can improve the understanding of population dynamics for these expanding species and guide harvest regulations.

Researchers collecting a DNA sample from a sedated bobcat.

Early Spawn and Natural Spawn Age-0 Largemouth Bass

Kansas Cooperative Fish and Wildlife Research Unit

Largemouth bass are important predators and popular sport fish. However, adult survival can be poor because of size-structured interactions in the first year of life. For example, poor first-year survival can be linked to size during the first summer, with smaller fish developing slowly because they are too small to consume fish prey instead of invertebrate prey. By sampling largemouth bass in Hillsdale and Perry Lakes in Kansas, researchers can assess the food habits and size structure of young first-year bass. The results of this

project can advance basic ecological knowledge about controls on first-year survival and growth for this important sportfish and provide attainable recruitment objectives for fisheries managers.

Plum Island Ecosystems Long Term Ecological Research

Kansas Cooperative Fish and Wildlife Research Unit

Understanding the role of striped bass in an ecosystem requires that researchers understand the regional-scale dynamics of this highly migratory species. This project focuses on how movements of a top fish predator affect ecosystem structure and function. Researchers used acoustic telemetry to document the seasonal movement patterns of striped bass in and around the Plum Island Ecosystems Long Term Ecological Research Network (LTER) site. The observed seasonal and spatial patterns can be incorporated into LTER models to generate a predictive understanding of the long-term response of coupled land-water ecosystems.

Implanting a transmitter in a striped bass.

Ring-Necked Pheasant Use of Cover Crops in Western Kansas

Kansas Cooperative Fish and Wildlife Research Unit

On the Great Plains, cover crops are grown between regular grain crops as a conservation practice. Cover crops can produce ecological benefits, such as the provision of previously unavailable wildlife habitat, but cover crops incur costs associated with planting and maintenance. As a result, producers need reliable information when considering the costs and benefits of using cover crops. The response by ring-necked pheasants to the establishment of cover crops in the agricultural landscape and a variety of seed mixes is unknown but recognized as a critical research need. This research involves a team testing the selection of cover crops by pheasants relative to the availability of other cover-crop types in the landscape. Given the economic and recreational value of pheasant hunting, evaluating pheasant responses to cover-crop practices can provide management with information that can be made available to agencies and landowners interested in increasing pheasant abundance.

Genomic Variation and Local Adaptation Among Natural Stocks of Eastern Oysters in Coastal Louisiana

Louisiana Cooperative Fish and Wildlife Research Unit

For any fishery, natural genetic variation among stocks is of critical importance, as genetics affect the success of fisheries in a variety of critical areas: aquaculture production, restoration efforts, recovery from overharvesting, and the capacity to respond to environmental change. Nevertheless, there are no comprehensive data on genetic variation among or within Louisiana oyster stocks. This research addresses questions about genomic variation and local adaptation among natural stocks of eastern oysters in coastal Louisiana. These results can improve the ability of managers to choose stocks for aquaculture or to predict how stocks with varying environmental histories might differentially respond to environmental changes.

The Louisiana Cooperative Fish and Wildlife Research Unit is leading research on genomic variation and local adaptation among natural stocks of eastern oysters in coastal Louisiana.

Improving Region-Specific Eastern Oyster Models by Quantifying Physiological Responses to Regional Environmental and Climatic Variability

Louisiana Cooperative Fish and Wildlife Research Unit

Because climate change affects fish and wildlife management, this study proposes to develop a dynamic energy budget (DEB) model for the eastern oyster in the northern Gulf of Mexico. The research team intends to investigate the carrying capacity for proposed regional aquaculture parks, identify areas for restoration, and predict oyster growth and production in response to several scenarios: water diversion, sea level rise, and climate change. This research can help resource managers predict oyster growth and harvests under specific environmental conditions. Ultimately, the generic DEB model could be parameterized for other regions and applied widely.

American Marten Population Ecology and Role in Forest Community Dynamics

Maine Cooperative Fish and Wildlife Research Unit

American marten are an important furbearer to trappers in Maine and provide value to hikers, skiers, and wildlife watchers. Also, marten play key ecological roles as efficient predators of small mammals and as prey to larger carnivores. Marten require a component of mature forest and horizontal structure—features that are predicted to be limited on the Maine landscape in the future. This project plans to test various sampling designs and methodologies to derive the best unbiased predictor of population size and trends over time. Results from this research can assist managers in linking population processes to community-level dynamics, which can help link potential management or harvest scenarios to habitat availability.

American marten require a component of mature forest and horizontal structure, features predicted to be limited on the Maine landscape in the future. Photograph by U.S. Fish and Wildlife Service.

Amphibian Use of Wetland-Limited Landscapes

Maine Cooperative Fish and Wildlife Research Unit

Amphibian populations face complex threats, and habitat loss or modification is contributing to amphibian declines globally. This project examines how vernal-pool-breeding amphibian species use wetland-limited landscapes in order to determine what factors might affect the persistence of these species in western and northern Maine. By monitoring the movements of postbreeding wood frogs with radio telemetry, the research team can combine habitat-use information gained from the telemetry studies with data from existing surveys. This information can be used to understand how the wetlands in Maine, and the surrounding high-elevation landscapes, are used throughout the year by pool-breeding species.

Dr. Cynthia Loftin, Maine Cooperative Fish and Wildlife Research Unit, collecting wood frog embryos in a vernal pool.

Biogeography and Conservation of Island Amphibians in Maine

Maine Cooperative Fish and Wildlife Research Unit

Amphibian extinction rates are among the highest for all vertebrates. A significant challenge to amphibian conservation is a lack of distribution data. Much of the scientific knowledge about amphibian distributions is centered on mainland habitats, and information about amphibian distributions on coastal islands is limited. Researchers in this study intend to conduct surveys of amphibians on coastal islands along the entire coast of Maine. The study results can yield valuable information about the role of islands in the natural history and conservation of amphibians in Maine.

Commercial Harvest Influence on White Sucker Demographics

Maine Cooperative Fish and Wildlife Research Unit

Maine issues an unlimited number of commercial permits to harvest white sucker in Maine's inland waters. The fishery provides a source of lobster bait to coastal communities at a time when other bait sources are scarce. The effect of the increasing number of permits and subsequent numbers of anglers on the white sucker population is unknown. The Maine Department of Inland Fisheries and Wildlife (MEDIFW) has closed several areas due to concerns that overfishing or incidental catch of other fish species may occur. The goal of this project is to determine the impacts of commercial fishing on white sucker populations and review the existing management structure to optimize the population size and commercial white sucker harvest in waters that are open. The results can allow the MEDIFW to determine if waters that are currently closed to harvest can be reopened to anglers.

Dam Removals in Sedgeunkedunk Stream and the Penobscot River—Changes in Resident and Migratory Communities

Maine Cooperative Fish and Wildlife Research Unit

Dams alter stream habitats and the distribution and abundance of stream fishes in those habitats by disrupting hydrology, temperature regime, and habitat connectivity. Dam removal is a common restoration tool, and dam removals in the Penobscot River watershed are central to restoring aquatic community systems in this area. Researchers plan to characterize the effects of dam removal over time. Information from this and related projects can inform river restoration decisions and long-term assessment of restoration effectiveness.

Sedgeunkedunk stream restoration efforts.

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Using Otolith Microchemistry to Assess How American Shad and American Eel Use the Penobscot River Estuary

Maine Cooperative Fish and Wildlife Research Unit

The American shad run in the Penobscot River is likely a small fraction of the historical size of the fish run due to extremely poor passage at the former Veazie Dam, where fewer than two dozen fish passed in more than two decades.

American shad in the Penobscot River.

Until recently, Federal managers in the State of Maine assumed that American shad were largely absent from the modern-day Penobscot River fish assemblage; recent work has shown otherwise. Historically, the American eel was the target species of a lucrative fishery, but the fishery collapsed over the course of the last few decades and eels are in decline worldwide. The research team plans to construct an inferred history of the use of freshwater, estuary, and seawater for American shad and American eel in the Penobscot River by using microchemical analysis of the otolith. This research can provide a baseline for the life-history patterns of American shad and American eel prior to the restoration of this fish in the upper reaches of the river.

Ecology of Urban and Rural Black Bears in Massachusetts

Massachusetts Cooperative Fish and Wildlife Research Unit

The black bear population in Massachusetts is growing, and its range is expanding. Many bears now live in and around small to midsized towns and cities. The research team in this study is using GPS to track and monitor bears—in densely populated suburban areas, in urban areas, and in rural locations—in central Massachusetts. The data can inform management decisions about bears in areas across the State.

Black bear cub. Photograph by U.S. Fish and Wildlife Service.

Effects of Dam Removal on Stream Ecosystems

Massachusetts Cooperative Fish and Wildlife Research Unit

In Massachusetts, over the last two decades, dam removal has increased alongside concerns about safety and interests in restoring stream connectivity. This research investigates the effects of dam removal on stream ecosystems. Researchers intend to measure dissolved oxygen and temperature at 12 sites upstream, within, and downstream from impoundments. Eight of the sites were slated for dam removal in 2015 and 2016, and the effects of the removals on dissolved oxygen, temperature, and other aspects of the stream ecosystem are to be quantified. Data can provide information on the extent to which dams impair stream ecosystems and quantify potential improvements in water quality following dam removal. Potential improvements can inform decisions about dam removal and help prioritize dam removals that might maximize ecological benefits.

Effects of Surface-Water-Supply Reservoirs on Streamflow and Biology in Small Massachusetts Watersheds

Massachusetts Cooperative Fish and Wildlife Research Unit

In 2010, the Massachusetts Sustainable Water Management Initiative was created to develop a water allocation program that satisfies human water needs while protecting aquatic ecosystem health. Because information about flow alteration due to surface-water withdrawals from reservoirs is lacking, this research intends to combine data on flows below surface-water withdrawal reservoirs with previous flow alteration data based on groundwater withdrawals. This information can then be used to inform water-supply permitting under the Water Management Act and assess the relation between instream flow and fish assemblages downstream from water-supply reservoirs.

Monitoring water withdrawals.

Evaluating Freshwater Productivity and Sampling Approaches for Juvenile River Herring in Freshwater Lakes and Ponds

Massachusetts Cooperative Fish and Wildlife Research Unit

Anadromous alewife declined in alarming numbers over the last two centuries. Reliable abundance estimates hinge on accurate early life-history data and remain a challenge. This study intends to evaluate the factors that influence freshwater productivity. A survey of 20 coastal lakes sampled in Massachusetts in 2014 is planned for expansion as to include nursery lakes with known alewife runs in Connecticut, Rhode Island, New Hampshire, and Maine. The results can inform future population models and provide direction for habitat restoration and management decisions.

Juvenile alewife caught at night with a pelagic purse seine.

Investigating the Effects of Winter Lake Drawdowns on Fish and Wildlife

Massachusetts Cooperative Fish and Wildlife Research Unit

In Massachusetts, approximately 200 small reservoirs are drawn down in the fall and refilled in the spring as a means of killing aquatic vegetation. The Massachusetts Division of Fisheries and Wildlife is interested in understanding the effects of drawdowns on the fish and wildlife that live in and use the lakes. Researchers are preparing an extensive literature review on the effects of lake drawdowns on fish and wildlife and intend to perform an assessment of the actual scope (location, timing, amount, and rate) of the drawdowns. The information obtained can improve the design of field experiments that assess the effects of drawdowns—like those in Massachusetts—on lake fish and wildlife. The results can also be used to develop drawdown strategies for Massachusetts that benefit fish and wildlife populations.

Regeneration of Forest Vegetation in Response to Browsing by Moose and Deer

Massachusetts Cooperative Fish and Wildlife Research Unit

Over the past 200 years, as southern New England became increasingly populated, human distribution, land cover, and wildlife habitats have diversified. Development, suburban fragmentation, and landscape degradation, concurrent with an increase in the moose population in southern New England in recent decades, led to interest and concern about how forest management affected moose populations. This research focuses on experimental enclosures for monitoring the response of forest vegetation to browsing by moose and deer and can advance the understanding of moose ecology, as they recolonize southern New England, and the potential effects on forest conservation. This information can then be used by regional management agencies to conserve and preserve flora and fauna unique to Massachusetts.

Pictured below: Goose Pond at Tyringham, Massachusetts, undergoing a winter drawdown.

Delineating Sandhill Crane Populations in Minnesota

Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota is home to two breeding populations of sandhill cranes: the Mid-Continent population in northwest Minnesota and the Eastern population in east-central Minnesota. Information about the boundary between these two populations is incomplete. Researchers plan to attach GPS transmitters to the sandhill cranes to better define the population boundary, learn more about movement patterns, gather information on their annual cycle, and gain insight into habitat use. Data derived from the study can inform harvest management strategies.

Sandhill cranes. Photograph by Tom Cooper, U.S. Fish and Wildlife Service.

Resource Use of Arctic Peregrine Falcons Along the Colville River, Alaska

Minnesota Cooperative Fish and Wildlife Research Unit

In 1977, the Colville River Special Area (CRSA) was designed to protect the nesting and foraging habitat of the then-endangered Arctic peregrine falcon. The CRSA is a 2.44-million-acre area that provides nesting habitat for nearly one-fifth of Alaska's Arctic peregrine falcon population, but information on current nesting success and occupancy are limited. Consequently, researchers intend to evaluate existing CRSA peregrine nesting data and implement additional data collection efforts with a focus on assessing nesting-area occupancy. This information can inform management practices involving Arctic peregrine falcons on the CRSA.

Restoration of Elk to Northeastern Minnesota

Minnesota Cooperative Fish and Wildlife Research Unit

The Minnesota Department of Natural Resources is interested in evaluating the feasibility of elk restoration in northeastern Minnesota, but information is needed to inform decision making. The planned research builds upon existing eastern elk restoration research to address two research goals: (1) defining public support for a restored elk population by surveying citizens in and around prospective restoration sites and (2) determining where suitable habitat exists and how many elk it could sustain. The results of this study can provide information critical to the elk management and restoration efforts at the Minnesota Department of Natural Resources.

The Minnesota Department of Natural Resources is interested in evaluating the feasibility of elk restoration in northeastern Minnesota.

Estimation of Angler-Caused Mortality and Development of Live-Well Management Procedures to Improve the Survival of Largemouth Bass

Mississippi Cooperative Fish and Wildlife Research Unit

Black bass are the most popular sport fish in North America and are the target of more than 30,000 fishing tournaments annually, in addition to recreational angling. High-quality bass fishing results from intensive regulation and survival rates from voluntary live catch and release activities. Water temperature affects the survival of tournament bass, but the relation between temperature and bass survival across a range of temperatures is unknown. This research intends to measure the bass mortality that results from catch-and-release angling and tournaments, quantify the temperature and mortality relation for bass, and develop procedures for improving the survival rates for angler-caught bass. The results can advance the development of management procedures that minimize the mortality of angler-caught bass for both recreational and tournament anglers.

Reservoir Fish-Habitat Management

Mississippi Cooperative Fish and Wildlife Research Unit

The average age of reservoirs in the United States now exceeds 60 years, and local fish habitats are showing signs of degradation. This study is an analysis of reservoir fish habitats across the lower 48 States with the purpose of providing information to maintain or rejuvenate reservoir fish habitats. The study blends landscape-level descriptors obtained from

GIS databases with in-lake impairment descriptors obtained by an online survey of field staff representing 48 States. Results from this study can (1) engender a status report for the Nation's reservoirs and associated tailwaters; (2) allow development of a classification system suitable for guiding further research, management, and allocation of restoration funds; and (3) be used to identify major drivers of fish habitat impairment in reservoirs at multiple scales. The project results can also be used to inform decisions on reservoirs across the State of Mississippi.

Review, Revision, and Development of New Monitoring Protocols for Fisheries

Mississippi Cooperative Fish and Wildlife Research Unit

A major problem faced by resource managers is the absence of reliable techniques for obtaining and evaluating data. This research focuses on the development of stock assessment methods. The research team plans to (1) identify approaches for collecting and using data; (2) develop models for evaluating population dynamics; (3) predict the response of anglers to management actions; and (4) develop classification systems for organizing data about fish, fisheries, and the environment. The data and tools from this project can inform management agencies in formulating conservation plans.

A Spatial Assessment of the Status and Risks to Mussel Concentrations in the Meramec River Drainage Basin

Missouri Cooperative Fish and Wildlife Research Unit

A method for identifying risks and threats to mussels in the Meramec River drainage basin is needed and can aid in the development of a monitoring and conservation program. Researchers intend to use landscape models to identify potential core areas of mussel abundance in the Meramec River. The classification scheme used can let researchers develop monitoring plans and protocols for each classification based on their risk status. If successful in the Meramec River, this study can serve as a model for statewide conservation assessments.

A method for identifying risks and threats to mussels in the Meramec River drainage basin is needed and can aid in the development of a monitoring and conservation program.

Bat Occupancy Patterns as a Function of Wildlife and Forest Restoration Activities

Missouri Cooperative Fish and Wildlife Research Unit

Wildfire frequency and severity are increasing in the Western United States, and it is unknown how bats respond to habitats affected by fire. Researchers intend to evaluate the effects of fire severity, distance to fire, fire heterogeneity, habitat availability, and forest characteristics on the occupancy, distribution, and diversity of bat species in Missouri. Additionally, the research team plans to develop a protocol for acoustic monitoring in the Plumas National Forest. The project results can guide USFS restoration efforts in the Plumas National Forest and inform the postfire management of forests for bats across the Sierra Nevada.

Determining Electrofishing Immobilization Thresholds of Smallmouth Bass, Blue Catfish, and Flathead Catfish: A Critical Step to Develop a Standardized Sampling Protocol

Missouri Cooperative Fish and Wildlife Research Unit

Black bass and catfish are popular sport fish in Missouri, with 1.1 million anglers spending about 15 million days on the water each year. Approximately 77 percent of that time is spent pursuing bass or catfish species, making them the two most popular groups of fishes among Missouri anglers. The ability to accurately assess bass and catfish populations is needed to evaluate special regulations and monitor population trends. Assessment is also critical for the ability of the Missouri Department of Conservation to make scientifically sound management decisions. This research offers biologists the tools and knowledge necessary to measure and adjust electrofishing output in the field and affords them the opportunity to sample these species in a standardized, efficient, and safe manner.

Development of Fish and Amphibian Rapid-Assessment Protocols

Missouri Cooperative Fish and Wildlife Research Unit

Missouri wetland taxa—amphibians and fish—can be difficult to detect, meaning that monitoring these organisms must include sampling methods that target specific groups of species and provide a direct link between species response and management actions. The research team plans to evaluate the effectiveness of various sampling methods to determine their

detection probability for amphibians and fish. The planned information outcomes from this project include a standardized assessment protocol, which can be used by State agencies to evaluate and inform amphibian and fish response to wetland management decisions.

Development of Reference Reaches for Missouri Streams

Missouri Cooperative Fish and Wildlife Research Unit

Development and evaluation of cost-effective techniques to help conservation agencies make scientifically defensible decisions for conserving aquatic biota are needed in Missouri. An essential part of this task is identifying priority stream reaches for conservation. Researchers in this study intend to develop reference stream reaches based on physical habitat for the State of Missouri. Results from this study can inform decisions on aquatic resources and help managers prioritize conservation efforts.

Development of Stream Temperature Models for Selected Missouri Streams

Missouri Cooperative Fish and Wildlife Research Unit

Urban and agricultural development grew immensely over the last two centuries, leading to highly degraded stream conditions and losses in aquatic biodiversity. The research team in this study is prepared to identify gaps in stream temperature data for Missouri and develop models that show the relation between streamflow and water temperature throughout the State. Information from this study can be used by the State to assess the effects of water withdrawals on fish habitats.

Life History of the Freckled Crayfish in Two Missouri Streams

Missouri Cooperative Fish and Wildlife Research Unit

The vulnerable freckled crayfish is endemic to the Meramec River Basin of Missouri and has an exceptionally restricted range. Because key parts in the life history of the freckled crayfish are poorly understood, this study intends to document life history traits of freckled crayfish populations in two streams to account for possible variation due to local environmental conditions. The information resulting from this project can provide managers with the knowledge required for more effective conservation planning and management.

Linking Waterfowl Distribution and Abundance

Missouri Cooperative Fish and Wildlife Research Unit

The 2007 NAWMP assessment found that although over $2 billion had been spent to fulfill NAWMP objectives, little research had gone into determining if habitat protection, management, and restoration outcomes were being achieved. To develop better performance metrics, the NAWMP National Science Support Team recommended that joint ventures should develop monitoring programs to track the direct influence of management actions on the quality and quantity of refuge areas and food resources. In this project, researchers plan to address the assessment recommendations and develop a waterfowl monitoring methodology. This research can inform decisions on waterfowl management across Missouri.

Which Geese Are Being Harvested? Body Condition of Lesser Snow and Ross's Geese Harvested by Different Methods During the Light Goose Conservation Order

Missouri Cooperative Fish and Wildlife Research Unit

The increase of midcontinent light goose populations over the past 30 years and the subsequent effects on Arctic and sub-Arctic habitats are well-documented. Uncertainty still exists, however, on whether changes in species composition, sex ratios, or overall condition of light goose populations have occurred as these populations increased. In this study, researchers plan to assess the body conditions of light geese harvested by varying methods and examine species, sex, and age composition. The results can be used to evaluate tradeoffs when considering alternative management scenarios, including potential strategies for reducing light goose populations.

Buffalo Bill Reservoir Walleye Suppression

Montana Cooperative Fishery Research Unit

Buffalo Bill Reservoir and the North Fork Shoshone River are two popular fisheries in the Cody Region of Montana that are managed as wild trout fisheries. The illegal introduction of walleye, discovered in 2008, has the potential to negatively affect the existing trout fishery. Consequently, as part of a graduate research study, there is a plan to evaluate the recruitment success of walleye and determine food-web dynamics and per-capita consumption of wild trout by lake trout and walleye. Results from this study can complement an ongoing study to identify management actions, including suppressing the walleye population, that could ensure the long-term persistence of the Buffalo Bill Reservoir wild trout fishery.

Fort Peck Water Chemistry Analysis

Montana Cooperative Fishery Research Unit

The Montana Fish, Wildlife and Parks agency annually stocks millions of walleye fry and fingerlings in Fort Peck Reservoir. However, the contribution of the stocked fish to the fishery remains poorly understood. Given suitable water chemistry variability, otolith microchemistry analysis should provide the information needed to quantify the proportion

of stocked and wild walleye in the fishery and identify the movement and habitat use of walleye in the reservoir and its tributaries. The research team could subsequently provide research recommendations based on the water chemistry and otolith profiles. These data can help managers achieve a strategic stocking strategy.

Reproductive Readiness and Behavioral Ecology of Wild Hatchery-Reared Pallid Sturgeon in the Missouri River Above Fort Peck Reservoir, Montana

Montana Cooperative Fishery Research Unit

To understand the effect of stocking on recovery efforts, fisheries managers document reproduction and behavioral ecology of wild-hatchery-reared pallid sturgeon in the Missouri River above Fort Peck Reservoir, Montana. This project intends to replicate previous research to determine if changes occurred in the home range size or habitat use of pallid sturgeon and assess whether the 1997 year-class became sexually mature. This information can be used by fisheries managers to understand the population ecology of sturgeon and develop successful restoration strategies.

Pallid sturgeon come from a genetic line that has survived for tens of millions of years.

Seasonal Movements of Rainbow Trout, Brown Trout, and Mountain Whitefish in the Smith River, Montana

Montana Cooperative Fishery Research Unit

To achieve multispecies management objectives, fisheries managers need information on the seasonal movements and habitat use of rainbow trout, brown trout, and mountain whitefish in the Smith River, Montana. As part of this study, plans have been made to identify spawning times and locations for these species, assess spawning-site fidelity, identify winter and summer habitat use, identify the degree of interchange of fish between the Smith and Missouri Rivers, and identify factors that limit fish abundance and distribution. The results can be used to understand the interactions of the species within the system and develop species-specific management actions that can optimize multispecies objectives.

Tenderfoot Creek Bair Ranch Foundation Research Project

Montana Cooperative Fishery Research Unit

The Montana Cooperative Fishery Research Unit is investigating the effects of timber harvest on water quality and water yield. The USDA contracted the research team to estimate survival rates, population sizes, and ages for fish populations. A detailed study of Tenderfoot Creek has been ongoing since 2009. The past 4 years of data collection produced an efficient data-collection process, detailed knowledge about the area, connections with local landowners and agencies, and an understanding of the dynamics of the Smith River Basin. With this experience and groundwork, researchers can add to the information already gathered by filling in the gaps where data are lacking and learn more about this system by investigating phenomena discovered over the course of the study.

Tenderfoot Creek brook trout.

Are Long Lives of Southern Temperate Songbirds Explained by Reduced Energy Expenditure of Parents Compared With Northern Temperate Species?

Montana Cooperative Wildlife Research Unit

Songbirds in the tropics and southern hemisphere commonly have long lives and small clutch sizes when compared with the northern temperate species. Regardless, understanding the causes underlying demographic strategies in southern regions remains poor. This research seeks to measure daily energy expenditure and resting metabolism during the nesting period for long-lived songbird species in South Africa. Additionally, the research team plans to measure these traits for short-lived species at a northern temperate site to capitalize on a unique opportunity to address long-standing questions about global patterns. Adult survival and longevity are often the most important influence on demography in songbirds,

such that understanding the determinants of variation in adult survival can offer critical insight into the sensitivity of species to environmental perturbations, thereby acquiring knowledge essential for species management.

Assessing Migratory Avifauna Responses to Managed Land-Use Practices in a Sagebrush/Grassland System

Montana Cooperative Wildlife Research Unit

Grazing management enhances important components of sagebrush and grassland habitat for a wide range of species, but little research has been done to evaluate the effects of prescribed grazing on migratory birds. The scale and magnitude of benefits for avian species remain unclear, especially in the big sagebrush-steppe systems of eastern Montana. This project builds on an existing research infrastructure to evaluate the effects of rest-rotational grazing management—implemented as part of the NRCS Sage-Grouse Initiative—on greater sage-grouse. This research can enable the BLM and USGS to inform sustainable, economically viable land-management practices that sustain habitat for migratory avifauna.

Bitterroot Elk Calf Survival and Population Modeling

Montana Cooperative Wildlife Research Unit

For nearly 70 years, wildlife managers and the hunting public could harvest ungulates with minimal concern for large carnivores, which were largely extirpated or reduced in abundance throughout much of their historic range in the lower 48 States. Over the last two decades, the expansion of grizzly bear, mountain lion, and gray wolf populations throughout portions of western North America have coincided with declines in recruitment and abundance in some elk populations, leading to a polarizing debate between various public sectors over large carnivore management. The focus of this study is estimating calf survival and population modeling of the Bitterroot elk herd. The study includes input from resource managers, stakeholders, researchers, field technicians, and individuals in the local communities. Results from this study can be used to evaluate elk-harvest strategies in the presence of expanding predator populations.

Evaluating the Effects of Nutrition and Hunter Access on Elk Distribution in the Sapphire Mountains

Montana Cooperative Wildlife Research Unit

The Sapphire elk herd in the northern Bitterroot Valley of Montana is important for hunting and wildlife-watching opportunities, but in recent years, elk distribution has become a source of concern for local hunters and landowners. This research is designed to relate the distribution of elk to habitat quality, hunter access points, nutrition, road density, and security cover during hunting seasons. The results of the study can enable managers to predict how habitat treatments affect fall elk distributions and how habitat treatments could be manipulated to produce a more desirable distribution of elk.

Improving Ungulate Sampling Efficiency and Population Estimation in Idaho

Montana Cooperative Wildlife Research Unit

Ungulates play an important role in the economy of Idaho because of hunting-related expenditures. Managing ungulates to maintain desirable population characteristics (such as size and age distribution) requires accurate monitoring data. Researchers plan to analyze current ungulate sampling methods and propose revisions that can improve sampling efficiency and population estimations of ungulates in Idaho. The revised methods, coupled with the implementation of integrated population modeling, can lead to better information for managing this economically important natural resource for the State of Idaho.

Linking Resource Selection to Population Dynamics of Mule Deer in Idaho

Montana Cooperative Wildlife Research Unit

Mule deer occupy variable environments and display volatile population dynamics, making the effective management of this species challenging. The research team plans to investigate the ecological drivers of overwinter juvenile mule deer survival across a wide range of environmental conditions in Idaho. Using Bayesian hierarchical survival models and integrated population models, researchers can test whether density dependence or weather drives mule deer population dynamics. These integrated population models can provide managers with a means to estimate population dynamics with precision and flexibility.

Montana Wolf Monitoring Study

Montana Cooperative Wildlife Research Unit

The gray wolf population in the northern Rocky Mountains has grown to a sufficient size that the USFWS has removed these wolves from the endangered species list. Montana and Idaho were required to monitor wolves intensively for 5 years to demonstrate that their populations remained

Gray wolf.

above relisting levels. This multiple-objective project is designed to (1) improve estimations of wolf recruitment; (2) improve and maintain the calibration of wolf-abundance estimates generated through wolf-patch occupancy modeling; (3) develop a framework for dynamic, adaptive harvest management of wolves; and (4) design a targeted monitoring program for wolves that can provide the information needed to ensure robust estimates and reduce uncertainty in the adaptive harvest management paradigm over time. This applied research can lead to critical information on wolf recovery and management in the northern Rocky Mountains and lead to a novel, successful method of monitoring large carnivores on a broad scale.

Population Dynamics, Modeling, and Data Quality Advancements

Montana Cooperative Wildlife Research Unit

Harvest information is a vital component of mule deer population management. Easy access to harvest statistics provides managers with detailed information on harvest data organized by location and year. The research team in this study plans to develop an extension to the PopR software interface that queries, displays, and tabulates harvest statistics on the basis of user-specified criteria. Managers can use these integrated population models to help inform management decisions about mule deer. Some of these models are implemented in a framework hosted by the University of Montana and are designed to serve as a singular resource for population analysis and data visualization.

Evaluating the Influence of Climate and Predation on the Survival of Rocky Mountain Elk: A Regional Synthesis Across Northwestern States

Montana and Wyoming Cooperative Research Units

Effective management decisions for Rocky Mountain elk are challenging because of changing habitat and the broad diversity of population dynamics that elk exhibit across their distribution. These facts cause confusion in efforts to understand the mechanisms behind the population dynamics of Rocky Mountain elk. The research team plans to evaluate the influence of climate and predation on the survival of elk and conduct a regional synthesis across Northwestern States. Furthermore, the research team intends to assess the influence of landscape-level variation in habitat, climate, predation, and human harvest on the survival and cause-specific mortality of adult female elk across five States in the Northwest. This research can enable managers to inform conservation decisions on habitat, population management, and climate.

Better Soil for Birds in the Niobrara Valley Preserve in Nebraska

Nebraska Cooperative Fish and Wildlife Research Unit

The Nebraska Cooperative Fish and Wildlife Research Unit is investigating how disturbance is used as a tool by managers to improve the quality of grasslands enrolled in the CRP in the Niobrara Valley Preserve in Nebraska. As part of this project, researchers are tracking soil, plant, insect, and bird attributes. The disturbances typically include burning, disking, interseeding, applying herbicide, or some combination thereof. The decision to use one or many of these approaches requires landowners to weigh economic, ecological, and social tradeoffs. By combining the ecological knowledge gained from field investigations with information generated from a statewide landowner survey, this work seeks to provide valuable information to private landowners, agency personnel, and scientists interested in supporting smart land-management decision making.

Habitat Decisions in Altered Landscapes: Behavioral and Physiological Consequences for Long-Distance Migrant Shorebirds

Nebraska Cooperative Fish and Wildlife Research Unit

Concern exists over agricultural intensity and habitat characteristics that influence shorebirds because of reduced food availability. Although shorebirds demonstrate dietary flexibility during migration, overall depression in food resources and limited habitat availability could induce further competition. The goals of this study are to examine (1) patterns of stopover habitat use by migratory shorebirds, (2) the habitat characteristics of stopover sites, and (3) how habitat characteristics might influence the condition and potential fitness for shorebirds during spring migration. This information can be used to develop management strategies that improve habitat quality for selected areas during the spring migration period.

Scientists survey for shorebirds in the Rainwater Basin, Nebraska.

Publication

Gillespie, C.R., 2015, Shorebird migratory stopover responses to local and regional change—Habitat decisions in a vanishing landscape: Lincoln, Nebr., University of Nebraska, Master of Science thesis, 62 p., http://digitalcommons.unl.edu/natresdiss/109/.

Implications of Perceived Predation Risk on Female Pheasant Reproductive Investment

Nebraska Cooperative Fish and Wildlife Research Unit

Ringed-neck pheasant hunters are limited to harvesting male pheasants. Female and male pheasants coexist, and hens likely perceive the presence of hunters and dogs as a threat. Furthermore, pheasant-hunting season in Nebraska is limited to the fall and winter, providing a gap between the perceived risk and the spring breeding season. During this 3-year study, researchers plan to track 60 hen pheasants using radio telemetry in eight study sites to assess clutch size and mass, incubation rhythms, potential physiological and morphological mechanisms driving hen reproductive investment (body condition, stress levels, and immune function), and hen habitat use. This research can provide information on how perceived predation risk affects hen pheasant reproductive strategy and subsequent brood production.

A researcher measuring eggs.

An Assessment of the Genetic Structure of an Urban Cooper's Hawk Population

New Mexico Cooperative Fish and Wildlife Research Unit

For species that are rare or difficult to study, researchers use models based on similar surrogate species to gain insights into the population ecology of the rare species. The research team plans to develop a model based on the demography and population ecology of Cooper's hawk. The study offers a valuable opportunity to compare genetic estimates of population attributes with direct measures obtained through banding and radio telemetry, which can provide useful inference to other raptor populations, including golden eagles. This research can ultimately provide wildlife managers with reliable science for managing raptor populations.

Assessing the Response of Lesser Prairie-Chickens to Mesquite Removal, Prescribed Fire, and Grazing in the Shinnery Oak Prairie Ecoregion of Eastern New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

The lesser prairie-chicken population has declined dramatically over the last century and now occupies a small portion of its former range across Kansas, Oklahoma, Colorado, Texas, and New Mexico. The primary cause of the decline is habitat loss following Western expansion. One top priority for habitat conservation in the shinnery oak ecoregion is the removal of honey mesquite and development of a prescribed fire program. Prescribed fire is believed to benefit the creation of different vegetation types needed by lesser prairie-chickens. Results from this study can contribute to a new prescribed fire program and ultimately lead to improved lesser prairie-chicken populations and habitat.

Assessment of Nutrition and Predation as Limiting Factors for Mule Deer in New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

Nutrition and predation might be limiting factors for mule deer in New Mexico. The research team intends to assess mule deer survival rates, determine mule deer pregnancy rates,

Mule deer.

assess nutrition, estimate prey composition, and determine how habitat selection by mule deer is influenced by habitat conditions and predation risk from mountain lions. The goal of this project is to determine which factors effectively limit mule deer in New Mexico. These data can contribute to the decision-making process of the State wildlife management agency.

Demography and Seasonal Movement Patterns of Band-Tailed Pigeons in New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

Over the last 50 years, populations of band-tailed pigeons declined dramatically across their interior range. The pigeon inhabits mountain terrain, and there is little to no contemporary data on these populations. Band-tailed pigeons are believed to move across the landscape in response to changes in local food abundance. The research team plans to conduct a demographic analysis using band and PIT tag data. As a migratory game-bird species, it is critical for decision makers to have sound scientific data on the current demographic rates and space-use patterns. This project can inform current monitoring strategies and provide the demographic data needed to develop new science-based harvest and management goals that are adaptive to potential declines in this population.

Describing Seasonal Movement Patterns and Development of a Bioenergetics Model to Determine Carrying Capacity of the Middle Rio Grande Valley, New Mexico, for Wintering Sandhill Cranes

New Mexico Cooperative Fish and Wildlife Research Unit

More than 90 percent of the Rocky Mountain population of greater sandhill cranes winter in southern New Mexico and to a lesser degree in southeastern Arizona. Declining annual population estimates and uncertainty about water availability due to long-term drought conditions in the Southwest have raised concerns that population objectives on the wintering grounds are too high for available habitat and food resources. The research team plans to investigate seasonal movement patterns and develop a model for determining the carrying capacity of the Middle Rio Grande Valley, New Mexico, for wintering sandhill cranes. Data from this study can inform larger predictive models using future water-availability scenarios to estimate how changes in land-use patterns ultimately affect crane populations.

Effects of Wildfire and Forest Restoration on Black Bear Habitat Selection

New Mexico Cooperative Fish and Wildlife Research Unit

Catastrophic wildfires in the Western United States have led to an increased need for forest restoration projects. Increased temperatures, drier winters, and earlier springs are likely to further increase wildfire activity. The research team plans to maintain a collared sample of 20 black bears throughout the duration of this project, which is scheduled to take place in the Santa Fe National Forest and on the Valles Caldera National Preserve. This research can assist managers in addressing larger project objectives on black bear responses to landscape-scale forest restoration.

Estimation of Black Bear Densities in New Mexico Using Noninvasive Genetic Analyses

New Mexico Cooperative Fish and Wildlife Research Unit

One of the main challenges for wildlife management agencies is setting harvest levels that ensure the long-term persistence of populations. The primary objective of this project is to estimate the abundance and density of black bear. The researchers plan to use noninvasive sampling and mark-recapture estimation within two bear-management zones currently used by the New Mexico Department of Game and Fish. This information can be used to provide wildlife managers with reliable science for setting harvest levels, establishing harvest objectives, and managing bears in New Mexico.

Estimation of Mountain Lion Density in New Mexico

New Mexico Cooperative Fish and Wildlife Research Unit

Obtaining the population or density estimates of mountain lions is challenging. This information is critical for properly managing harvested species. The goal of this study is to estimate mountain lion abundance and density across New Mexico. The research team plans to compare the habitat model with remote sensing camera data to estimate abundance and density. The results of this study can provide population and density data about mountain lions in New Mexico that can contribute to management plans developed by the New Mexico Department of Game and Fish.

Influence of Stream Temperature, Intermittency, and Nonnative Fishes on the Current and Future Distribution of Fishes of Conservation Need in the Gila and Mimbres Drainage Basins

New Mexico Cooperative Fish and Wildlife Research Unit

Earth's climate is expected to change during the 21st century and affect the distribution of native fish. The high number of native fishes of conservation concern in the Gila and Mimbres River drainage basins highlights the need for a greater understanding of how their distribution might be altered by changing climate and concurrent biotic interactions with nonnative species. The research team plans to investigate these distribution shifts, which are especially important for coldwater fishes. Assessment and characterization of stream temperature and intermittency regimes in the basins are important for the restoration and protection of critical habitat for native species.

Kirtland Air Force Base Mountain Lion Study

New Mexico Cooperative Fish and Wildlife Research Unit

Kirtland Air Force Base personnel want to better understand how mountain lions are distributed throughout the facility. The goal of this study is to provide information on basic life history and ecological attributes of the mountain lions occupying Kirtland Air Force Base, New Mexico. The research team plans to investigate mountain lion territory locations, home range, and den sites; estimate survival; and determine cause-specific mortality. Additionally, the research team plans to develop a resource-selection model. The results can be used by resource managers when they plan activities on the base.

Population Trajectories and Extinction Probabilities for Populations of Large Ungulates

New Mexico Cooperative Fish and Wildlife Research Unit

Understanding the importance of life history parameters is vital to managing wildlife populations. The goal of this research is to evaluate the minimum population size at which populations are unlikely to go extinct and the population persistence times of various ungulate species across the Southwest in relation to variation in observed demographic rates. The intent is to generate population models using a suite of observed demographic parameters (and their variability), thereby assisting in the management of multiple ungulate species across the Southwestern United States.

Publication

Gedir, J.V., Cain, J.W., III, Harris, Grant, and Turnbull, T.T., 2015, Effects of climate change on long-term population growth of pronghorn in an arid environment: Ecosphere, v. 6, no. 10, p. 1–20, https://doi.org/10.1890/ES15-00266.1.

Population Trends and Predicted Trajectories of American Pronghorn in the American Southwest

New Mexico Cooperative Fish and Wildlife Research Unit

The American pronghorn population appears to be decreasing across much of its range. This research can determine how widespread the decline of the American pronghorn is in the Southwest and identify causal, climatic factors that can best explain these declines. The research team plans to use this information to forecast the trends and the geographic extent of the climatic factors over the next century based on climate-change models for the region.

Publication

Gedir, J.V., Cain, J.W., III, Harris, Grant, and Turnbull, T.T., 2015, Effects of climate change on long-term population growth of pronghorn in an arid environment: Ecosphere, v. 6, no. 10, p. 1–20, https://doi.org/10.1890/ES15-00266.1.

Pictured below: The American pronghorn population appears to be decreasing across much of its range in the Southwest.

Predation Rates and Use of Habitats and Wildlife Drinkers by Mountain Lions

New Mexico Cooperative Fish and Wildlife Research Unit

For decades, State and Federal wildlife management agencies built and supplied manmade water sources within desert landscapes, making surface water a consistent and stable feature of desert landscapes. This situation generates at least three concerns: (1) water could lure ungulates from preferable areas (such as escape terrain) thereby increasing their risk of predation; (2) predators might linger near water sources to increase their chances of killing a visiting ungulate; and (3) water requirements are undetermined for most carnivores, and it is unknown if they obtain sufficient water from the tissue of their prey or if they rely on free water, particularly in arid environments. The research team intends to build baseline information describing mountain lion use of Chihuahuan Desert habitats and quantify how mountain lions use Chihuahuan Desert landscapes. These data are sought by State fish and wildlife agencies.

Mountain lion. Photograph by U.S. Fish and Wildlife Service.

Resource Selection and Movement of Mule Deer and Elk on the Jemez Pueblo

New Mexico Cooperative Fish and Wildlife Research Unit

Wildlife managers are interested in the movement of mule deer and elk on the Jemez Pueblo in New Mexico. This project is part of an ongoing large mammal monitoring project on mortality and migration. The research team plans to describe the seasonal movements of deer and elk, estimate population size and survival rates, and estimate forage availability for mule deer and elk in relation to wildfire and forest restoration treatments. Additionally, the team plans to assess the resource-selection patterns of mule deer and elk in relation to forest restoration and wildfire. Understanding the movements and population demographics for these iconic species can allow wildlife managers to prioritize management actions to meet population management objectives.

Estimating the Distribution and Density of Fishers in an Expanding Population in New York Using Noninvasive Methods

New York Cooperative Fish and Wildlife Research Unit

Fisher populations in New York are expanding, and the New York State Department of Environmental Conservation has received requests to open new areas to fisher trapping. Without knowledge of fisher occupancy or baseline-density estimates, the Department is unable to make adequate management decisions. This study plans to use noninvasive, genetic, spatially explicit capture-recapture techniques to estimate fisher density across the southern tier of New York. Study results can provide the first density estimate of fishers in New York and can be instrumental in helping the State of New York in their decision-making process regarding the potential for opening new areas to fisher trapping.

Publications

Conroy, M.J., and Peterson, J.T., 2013, Decision making in natural resource management—A structured, adaptive approach: Hoboken, N.J., Wiley, 456 p.

Linden, D.W., Fuller, A.K., Royle, J.A., and Hare, M.P., in press, Examining the occupancy-density relationship for a low density carnivore: Journal of Applied Ecology, https://doi.org/10.1111/1365-2664.12883.

New Mexico Cooperative Fish and Wildlife Research Unit scientist with an elk calf captured in the Mexican Wolf Recovery Area in the Gila National Forest, New Mexico.

Great Lakes Cisco Spawning Habitat Assessment

New York Cooperative Fish and Wildlife Research Unit

Coregonids are an important native-forage species in the Great Lakes that have declined because of overfishing, habitat degradation, and invasive species. The research team intends to conduct a habitat assessment to document the quantity and distribution of suitable spawning habitat for Great Lakes cisco. Results from this work can assist in prioritizing population restoration efforts in the lower Great Lakes.

Novel Approaches to Big Problems: Integrating Citizen Science to Monitor and Estimate Black Bear Populations in New York

New York Cooperative Fish and Wildlife Research Unit

Black bears are an important game species in New York, and the bear population is growing. Researchers in this study plan to describe a conceptual framework for joining noninvasive citizen-science efforts with telemetry, spatial capture-recapture, and occupancy methods into a single integrated population model for managing black bears. This integrated approach can be valuable for identifying patterns of black bear distribution, resource selections, and movement across a range of spatial scales.

Population Status of Carnivores

New York Cooperative Fish and Wildlife Research Unit

Carnivores are notoriously difficult to study. In this study, the research team intends to develop models to evaluate the population status of select carnivorous species by using spatial capture-recapture methods and noninvasive genetic sampling. The methods represent a fundamental difference in the way managers previously estimated the abundance of wildlife populations. The research team expects to provide rigorous estimates of population demographics, which are necessary for the effective management of predator species.

Publications

Fuller, A.K., Sutherland, C.S., Royle J.A., and Hare, M.P., 2016, Estimating population density and connectivity of American mink using spatial capture-recapture: Ecological Applications, v. 26, no. 4, p. 1125–1135, https://doi.org/10.1890/15-0315.

Sutherland, Chris, Fuller, A.K., and Royle, J.A., 2014, Modelling non-Euclidean movement and landscape connectivity in highly structured ecological networks: Methods in Ecology and Evolution, v. 6, no. 2, p. 169–177, https://doi.org/10.1111/2041-210X.12316.

Thresholds for Conservation and Management of Terrestrial Vertebrates

New York Cooperative Fish and Wildlife Research Unit

Wildlife research has started to focus on identifying the conservation and management thresholds for terrestrial vertebrates by using camera-trapping data and analyzing trends in the data with the Wildlife Picture Index. The research team plans to use landscape-scale camera trapping for species of conservation or management interest. This approach is suitable for assessing trends in the status of biodiversity or endangered species in areas undergoing rapid declines (for example, Andean bears in Ecuador), as well as for species of localized conservation or management concern in New York, such as fisher, bobcat, marten, and black bear.

Black bear with global positioning system collar.

Advancing the Use and Application of Diverse Data Sources and Species Distribution Models

North Carolina Cooperative Fish and Wildlife Research Unit

Change in land-use patterns and climate are factors influencing avian species status and trends in North America. Stakeholders are increasingly challenged to find a means to respond to changes in species distribution reliably. With this research, the team plans to develop an analytical framework that integrates multiple data sources to efficiently and effectively understand current and future avian distribution patterns and the potential for sustaining populations. Ultimately, the research goal is to provide a framework to inform decisions germane to conservation.

American Eel Age and Growth Assessment in the Roanoke River, North Carolina

North Carolina Cooperative Fish and Wildlife Research Unit

Despite an extensive distribution and the ability to tolerate a broad variety of aquatic habitats, concern about the status of the American eel has risen due to declining trends in commercial harvest and anthropogenic threats to their habitat.

The loss of freshwater-habitat access attributable to dams and other barriers to migration has been estimated to be as high as 44 percent in U.S. watersheds alone and up to 84 percent within watersheds on the U.S. East Coast. The team plans to sample American eels in the Roanoke River in North Carolina. Information from these samples can be synthesized to provide a better understanding of the American eel and inform fishery management decisions.

Factors Influencing Native Aquatic Plant Revegetation Success for Enhanced Sport Fish Habitat in North Carolina Piedmont Reservoirs

North Carolina Cooperative Fish and Wildlife Research Unit

Sport fish managers need to know more about the factors influencing native aquatic plant revegetation success for enhanced sport fish habitat in North Carolina piedmont reservoirs. This research involves field experiments to assess the relative habitat use of native and invasive plants by sport fish at multiple spatial scales. This research can determine the factors contributing most to aquatic vegetation establishment, the costs of vegetation establishment, and the habitat value provided to sport fish on both micro- and macro-habitat scales. The project data can inform decisions on sport fish management plans in the North Carolina piedmont reservoirs.

Pictured below: Weir used to monitor upstream and downstream fish migration.

Stocked Trout Survival, Behavior, and Ecology in North Carolina Streams

North Carolina Cooperative Fish and Wildlife Research Unit

Fisheries managers are faced with the challenge of conserving native species, balancing the management of recreational fisheries, and preserving ecological integrity. The goal of this research is to document the extent of stocked trout migration and mortality among species. The project team intends to document the persistence of stocked trout in designated streams and model persistence with environmental and biological variables. Additionally, the team plans to monitor fish behavior and ecology to gain an understanding of the factors that might affect stocked fish growth, condition, and survival. The results can be used to inform and guide management actions to improve resource-management strategies and educate fishery constituents and the public.

Assessing the Potential for Rainbow Trout Reproduction in Tributaries of the Mountain Fork River Below Broken Bow Dam

Oklahoma Cooperative Fish and Wildlife Research Unit

The tailwater trout fishery in the Mountain Fork River below Broken Bow Dam is one of only two year-round trout streams in Oklahoma. Rainbow trout are stocked in the Mountain Fork River below Broken Bow Reservoir because the water released from the bottom of the dam is cold enough to

support them. The research team plans to investigate whether the small tributaries near the dam support rainbow trout reproduction. Results from this study can be used to inform future stocking decisions.

Researcher with a rainbow trout captured from a Mountain Fork River tributary.

Assessing Wild Juvenile Trout Ecology in the Lower Mountain Fork

Oklahoma Cooperative Fish and Wildlife Research Unit

Tail waters are highly limited resources in the Southern United States and have disproportionate economic value in recreational angling. For example, the tailwater trout fishery in the Mountain Fork River below Broken Bow Dam in Oklahoma generates approximately $25 million in economic benefits annually. Little is known about the dynamics of natural reproduction for trout in these systems because so few instances exist where natural reproduction is sufficient to provide a fishery. The purpose of this study is to determine baseline population-level parameters (hatching times, growth, survival, invertebrate prey use, and availability) of wild juvenile trout in the lower Mountain Fork River. This information can be used by fisheries managers when making management decisions for this important fishery.

The tail water trout fishery in the Mountain Fork River below Broken Bow Dam in Oklahoma generates approximately $25 million in economic benefits annually.

Assessment of Prey Consumption and Body Condition of Missouri River Age-0 *Scaphirhynchus* Sturgeon

Oklahoma Cooperative Fish and Wildlife Research Unit

The USACE Habitat Assessment and Monitoring Program is testing hypotheses regarding responses by juvenile fishes to shallow-water habitat restoration goals in the lower Missouri River. A central assumption is that shallow-water habitat is lacking, negatively affecting recruitment. The purpose of this study is to assess prey use and lipid content of age-0 sturgeon along a linear gradient of the lower Missouri River in relation to previously studied reaches. This research is being used to guide shallow-water habitat restoration efforts.

Developing Standard and Efficient Methods for Sampling Fish in Oklahoma Streams

Oklahoma Cooperative Fish and Wildlife Research Unit

Reliable scientific data are critical for managing water resources. Oklahoma is developing environmental flow criteria for streams statewide that can protect fish and support economic and social uses. The research team plans to establish a stream-sampling protocol that includes the collection of monitoring data to support environmental flow standards. Decision makers can use the long-term results to manage fish assemblages.

Measurements are made across stream transects to support hydraulic models.

Evaluation of Northern Bobwhite in Western Oklahoma

Oklahoma Cooperative Fish and Wildlife Research Unit

Northern bobwhite quail populations experienced a general decline across most of their range over the last 40–50 years, with populations declining by an average rate of 3 percent per year. This project is designed to determine the major factors driving long-term changes in bobwhite populations, particularly for reproduction and survival relative to the interaction of fire and grazing, arthropod availability (particularly during nesting and brood-rearing), aerial and terrestrial predation, and aflatoxins and their effects on reproduction and survival. This information is critical to managers developing conservation strategies for quail.

Bobwhite at Cooper Wildlife Management Area.

Reevaluation of the Status of Black Bears in Southeastern Oklahoma

Oklahoma Cooperative Fish and Wildlife Research Unit

Black bears, once extirpated from the south-central Great Plains, are expanding westward from the forests of western Arkansas into eastern Oklahoma. Previous studies examined the ecology of recolonizing black bears in southeastern Oklahoma. The current effort is designed to reevaluate the population status relative to the initiation of a black bear hunting season. The results can provide wildlife managers with information needed for evaluating the effects of harvesting and assist with the future management of black bears in Oklahoma.

Status and Distribution of Black Bears in East-Central and Northeastern Oklahoma

Oklahoma Cooperative Fish and Wildlife Research Unit

Indications suggest that black bear populations are increasing and expanding in east-central and northeastern Oklahoma. In fact, black bear can currently be hunted in four counties in southeastern Oklahoma. This research is designed to assess the status and distribution of black bears in east-central and northeastern Oklahoma and can provide the basis for development of appropriate management actions for this growing resource, which could include enhanced hunting opportunities in areas where bears are determined to be thriving.

Black bears, once extirpated from the south-central Great Plains, are expanding westward from the forests of western Arkansas into eastern Oklahoma.

Columbia River Fish Monitoring and Evaluation Studies

Oregon Cooperative Fish and Wildlife Research Unit

Downstream passage of juvenile fish through USACE projects in the Upper Willamette River is a high priority because most spawning habitat for anadromous salmonids is upstream from the projects. Therefore, juveniles must be able to navigate reservoirs and pass through dams successfully. The use of PIT and active tags, such as the Juvenile Salmonid Acoustic Telemetry System, are important tools for evaluating juvenile passage and adult return. This research can inform decisions on suitable downstream fish-passage solutions.

The white sturgeon is the largest freshwater species in North America. A juvenile is pictured above.

Intraguild Predator Dynamics: The Effects of Recolonizing Gray Wolf Populations on Cougars in Northeast Oregon

Oregon Cooperative Fish and Wildlife Research Unit

Since the reintroduction of wolves in Idaho, Montana, and Wyoming in 1996, recovering wolf populations have expanded their distributions into Oregon, and other Western States, where they had been largely extirpated. Since the near extirpation of cougars in Oregon in the 1960s, cougar populations have recovered to stable levels throughout the State, and their ecology and population dynamics before the arrival of wolves are well-studied. The recolonization of wolves into Oregon raises important questions about their effect on prey populations (deer and elk), livestock depredation, and interspecific competition with cougars. In this project, researchers plan to study the effects of recolonizing gray wolf populations on cougars in northeast Oregon.

Survival of Suckers in Upper Klamath Lake

Oregon Cooperative Fish and Wildlife Research Unit

The primary causes of early life-history mortality in fishes are advection from nursery grounds, starvation, and predation. Knowledge of pathogen dynamics can provide insight into effective restoration strategies, such as avoiding parasite-associated effects. The research strategy in this project is to identify parasites in Upper Klamath Lake suckers by using molecular techniques. Such knowledge is likely to be important for recently initiated efforts to develop decision models for adaptively managing Upper Klamath Lake suckers.

Deer Abundance and Its Relation to Factors That Affect Forest Vegetation Conditions

Pennsylvania Cooperative Fish and Wildlife Research Unit

Over the last decade, white-tailed deer densities were reduced in many wildlife management units in Pennsylvania. The decisions to reduce deer densities assumed that forest conditions, especially regeneration, would improve with lower deer populations. This research proposes to stabilize deer populations at different densities in the study areas and quantify changes in vegetation with respect to other forest conditions. Study results can provide decision makers with a better understanding of how vegetation responds to changes in deer density in the context of existing monitoring programs and management activities.

White-tailed deer.

Fall Harvest Rates of Female Wild Turkeys in New York

Pennsylvania Cooperative Fish and Wildlife Research Unit

The primary form of population management for wild turkey is a fall either-sex harvest, but current fall harvest rates in New York are unknown. Harvesting more than 10 percent of the fall population is believed to cause a decrease in subsequent turkey population abundance levels. This research can determine the fall survival rate of hen turkeys by using an estimator based on a sample of hens fitted with radio transmitters to estimate the survival rate between tagging and harvest. Knowing the rate at which hen turkeys are harvested in the fall can allow the effective management of wild turkeys without an overharvesting problem.

Modeling Potential Habitat for Pheasant Population Restoration

Pennsylvania Cooperative Fish and Wildlife Research Unit

The Pennsylvania Game Commission established several wild pheasant restoration areas with specific population-density goals (10 hen pheasants per square mile). The research being conducted in these areas is focused on identifying the habitat conditions that resulted in wild pheasant populations meeting or exceeding established pheasant-density goals. These results can generate a predictive model that can be applied to existing landscapes to determine if pheasant restoration is possible or what habitat changes would be required to ensure the success of proposed wild pheasant restoration areas.

Modeling Bat Habitat Use Across Big South Fork National River and Recreation Area: Potential Effects of Prescribed Fire

South Carolina Cooperative Fish and Wildlife Research Unit

Decision makers are interested in the potential effects of prescribed fire on bats across Big South Fork National River and Recreation Area. Seven prescribed fires have been conducted since 2005, and these sites are to be sampled along with some unburned sites. The project team plans to investigate year-round bat activity on Big South Fork National River and Recreation Area and relate the presence and activity of bats to environmental conditions such as temperature, rainfall, forest type, forest structure, and management history. The study results can guide the area fire-management plan for various bat species.

Use of Horseshoe Crab Eggs by Migratory Shorebirds

South Carolina Cooperative Fish and Wildlife Research Unit

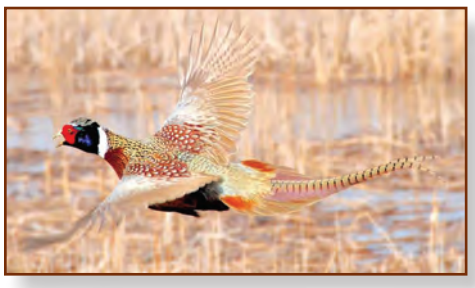
Migratory shorebird populations have declined in recent years, in part due to threats such as human disturbance, predation, loss of beaches and roost sites, and declines in food availability. The goal of this research is to enhance the understanding of the relations between migratory shorebirds, particularly red knots, and spawning horseshoe crab at key locations in South Carolina. These data can provide a sound scientific basis for decisions on horseshoe harvest, red knot endangered species status, and strategic-habitat conservation.

Horseshoe crab and red knots.

Effectiveness of Alfalfa for Nesting Habitat and Seedbed Preparation

South Dakota Cooperative Fish and Wildlife Research Unit

Due to the loss of conservation reserve program lands, many South Dakota grasslands were converted to agricultural production. Consequently, there is a strong emphasis on managing remaining grasslands to ensure the success of upland-nesting game birds. Ring-necked pheasant and waterfowl populations provide recreational opportunities for resident and nonresident sportsmen in South Dakota and provide an important source of revenue for local economies. The economic component provides strong incentives for the maintenance and sustainability of game bird populations. This study is designed to evaluate the use of a new technique that uses alfalfa to prepare seedbeds for grassland restoration. The results can provide land managers with information on the efficacy of the new approach for managing grasslands that can benefit and sustain upland-nesting game bird populations.



Ring-necked pheasant in flight at Sand Lake National Wildlife Refuge, South Dakota. Photograph by U.S. Fish and Wildlife Service.

Growth Potential and Genetic Diversity of Yellow Perch in South Dakota

South Dakota Cooperative Fish and Wildlife Research Unit

Yellow perch are an important sport fish and prey component of fish communities in many South Dakota lakes. Two distinct yellow perch populations exist within eastern South Dakota. The South Dakota Game, Fish and Parks department identified the high natural mortality of yellow perch in some natural lakes as an issue for eastern South Dakota. This research is designed to identify potential causes of observed mortality.

Influence of Fish Density on Growth Rate of Brown Trout in Spearfish Creek, South Dakota

South Dakota Cooperative Fish and Wildlife Research Unit

Drought conditions, angler harvest, habitat modification, fish movements, and a nuisance algal species are possible contributors to the changes observed in the biomass and size of brown trout in streams in the Black Hills, South Dakota. This study is designed to evaluate the temporal patterns in stream discharge and mean summer water temperature over a period of 8 years at two drought-affected streams in the Black Hills. The data can help fisheries managers consider habitat limitations and available water in the streams they manage. Additionally, fisheries managers could collaborate with dam operators and their constituents to develop minimum-discharge thresholds that would satisfy the needs of both fishery managers and dam operators during low-water conditions.

Settling Dynamics of Breeding Ducks in the U.S. Prairie Pothole Region, 1987–2011

South Dakota Cooperative Fish and Wildlife Research Unit

The USFWS conducts surveys to estimate the effects that lands in the NWR system have on waterfowl breeding populations and production. This research plans to use the long-term 4-square-mile duck breeding-pair survey to investigate local and landscape factors influencing the settling of birds in this important ecoregion. The project is anticipated to be one of the first to use this detailed, large-scale dataset to understand associations between setting patterns of breeding waterfowl and local and landscape features. Results from this study have drawn interest from the USFWS, which can use the information in conservation planning.

Survival, Distribution, and Relative Predation of Naturally Produced Rainbow Trout in the Deerfield Reservoir System

South Dakota Cooperative Fish and Wildlife Research Unit

Rainbow trout are an important sport fish species in the Black Hills of South Dakota. Information is lacking on the spawning habitats used by rainbow trout in this region. As part of this study, researchers plan to assess the production, survival, and distribution of naturally produced rainbow trout and evaluate the diet composition of piscivorous fishes to quantify potential predation on rainbow trout in Deerfield Reservoir. The study results can provide managers with a better understanding of the life history of this unique rainbow trout population and help decision makers manage this stock.

Sampling and Managing Catfish Stocks in Tennessee

Tennessee Cooperative Fishery Research Unit

Information is needed to effectively manage catfish stocks in Tennessee. The objectives of this study are to (1) develop unbiased catfish sampling protocols using trotlines, low-frequency electrofishing, tandem hoop nets, or a combination of these three approaches; (2) assemble a statewide database of commercial and recreational harvests of catfish species and examine historical trends in terms of yield; (3) examine the response of catfish populations to different management scenarios; and (4) assess the potential for growth and recruitment overfishing in several Tennessee reservoirs. This research can guide wildlife conservation across Tennessee.

Evaluating the Effects of Drought and Anthropogenic Influences on the Growth of Stream Fishes on the Edwards Plateau

Texas Cooperative Fish and Wildlife Research Unit

Climate change and increasing water demands from population growth are affecting stream fishes on the Edwards Plateau in central Texas. Alterations of stream-channel morphology and flow regime have the potential to affect fish growth. This project intends to evaluate the effects of drought and anthropogenic influences on the growth of stream fishes on the Edwards Plateau in Texas. Results from this study can provide biologists with a better understanding of how drought, coupled with anthropogenic alterations, affects the growth rate of stream fishes, and can also improve decision making in the management and conservation of stream fishes in similar river systems.

Structure and Connectivity of Mid-Continental Snowy Plovers

Texas Cooperative Fish and Wildlife Research Unit

Midcontinental snowy plovers occurring east of the Rocky Mountains and within the Great Plains have attained threatened status under the ESA and are now considered a focal species among the USFWS, the Playa Lakes Joint Venture, and the Great Plains LCC. Rangewide, snowy plovers are experiencing increased pressures from altered precipitation patterns, groundwater removal, exotic invasive species, elevated predation, and anthropogenic disturbances at all spatial scales. The problem is that plovers breeding and wintering in wetland and coastal habitats within the midcontinental United States have received only a fraction of the research, conservation, and management focus of Pacific Coast populations. The goal of this research is to estimate age/sex-specific survival and connectivity of midcontinental snowy plovers via consistent, long-term banding efforts at interior snowy plover nesting locations in Texas, New Mexico, Oklahoma, and Kansas.

Snowy plover. Photograph by U.S. Fish and Wildlife Service.

Cutthroat Population Conditions Within the Logan Watershed

Utah Cooperative Fish and Wildlife Research Unit

Most subspecies of cutthroat trout are imperiled or extinct because of the combined effects of habitat degradation and interactions with exotic species. To quantify abundance and vital rates, researchers selected a large population of Bonneville cutthroat trout from the Logan River of northern Utah, a river characterized by high-quality and connected habitat. Over a 15-year period, scientists conducted a comprehensive population assessment, including depletion-based abundance estimates and a mark-recapture study (2,000 tagged fish) of site fidelity, growth, and survival. These study results provide important conservation and recovery benchmarks for identifying rangewide limiting factors of cutthroat trout.

Phenology and Habitat Use of Larval Darters in the Upper Roanoke River Basin

Virginia Cooperative Fish and Wildlife Research Unit

Little is known about the timing of emergence, habitat use, or distribution of larval Roanoke logperch or other darters inhabiting the upper Roanoke River Basin. The research team is documenting patterns of larval darter abundance and test-capture efficacy for three gear types. The researchers are also able to produce an identification key using photographs of larvae that describe developmental changes and growth rates. This research can advance the scientific understanding of the early life history of Roanoke logperch, and project results can be used by managers to identify areas critical for successful recruitment of logperch and identify the most efficient gear for sampling the species.

Researcher measuring water quality in the Roanoke River Basin.

White-Tailed Deer Influence and Vegetative Response in the Blue Ridge, Ridge and Valley, and Appalachian Plateau of Virginia in Relation to Landscape and Land-Ownership Characteristics

Virginia Cooperative Fish and Wildlife Research Unit

Understanding white-tailed deer relations with biodiversity is a high priority for the Virginia Department of Game and Inland Fisheries for their deer management program. The Virginia Deer Management Plan recognizes that practical and efficient assessments that connect deer population goals to ecosystem impacts need to be developed. Data from this work can be important for maintaining and improving deer habitat quality and quantity, consistent with the goals of the plan.

Understanding white-tailed deer relations to biodiversity is a high priority for the Virginia Department of Game and Inland Fisheries.

Assessments and Evaluations of Three Regional Restoration Sites

Washington Cooperative Fish and Wildlife Research Unit

The University of Washington and the USACE are collaborating on a project to assess and evaluate the success of restoration sites in western Washington. The research team plans to collect data on Chinook salmon. The overall goal of this multiyear research effort is to provide data that can enhance the understanding of the factors that govern the success of different restoration strategies, thus informing future restoration efforts within an AM framework.

Moose Demography in Northeast Washington State

Washington Cooperative Fish and Wildlife Research Unit

Moose are an ecologically and economically important game species in the State of Washington, but the ability to make sound management decisions regarding moose harvests is inhibited by a lack of information on survival rates. The goal of this research is to document the survival rates of adult moose cows and calves for input into statistical-reconstruction models, demographic-projection models, and allowable-harvest models. These models can be used to test whether survival rates of adult cows and calves differ in areas of high versus low wolf density, old versus young forest-age structure, and other habitat characteristics that can be quantified using remote sensing. This information can provide a stronger scientific basis for making management decisions about moose in Washington.

Population Assessment of Wrangel Island, Russia, Snow Geese by Using Satellite Imagery

Washington Cooperative Fish and Wildlife Research Unit

The Pacific Flyway Council and NAWMP use the annual Wrangel Island snow goose spring population estimate to measure the status of the population relative to objectives and harvest management parameters. The Canadian Wildlife Service recently declared the western Arctic population of lesser snow geese overabundant, and several Pacific Flyway States recently increased their harvest, which could affect western Arctic snow geese in key mixing areas. An accurate population estimate is needed to assess the potential effects of increased harvest on this population, which is the only snow goose population in Russia and the only Russian goose population that winters in North America. The team plans to analyze high-resolution satellite photographs for the beginning and

end of nesting season periods on Wrangel Island. This project could provide a replacement for traditional ground-transect surveys by using high-definition satellite imagery sampling techniques, which can provide more accurate results with variance estimates.

Cerulean Warbler and Associated Species Response to Silvicultural Prescriptions in the Central Appalachian Region

West Virginia Cooperative Fish and Wildlife Research Unit

Cerulean warblers benefit from forest management practices that promote a heterogeneous canopy structure. However, questions remain regarding factors such as the minimum effective block size, the timing and proximity of multiple harvested blocks, the longevity of positive bird responses, and the need for intermediate treatments. This research can quantify relative abundance and territory density of cerulean warblers and associated avian species to environmental parameters within the context of applied forest management activities such as thinning and firewood harvests. Results can be used to generate management practices to improve habitat conditions for cerulean warblers and associated species.

Researchers recently completed a 6-year study with the objective of identifying forest-management approaches that are compatible with cerulean warbler conservation.

Creation and Development of Early Successional Habitat and Wildlife Utilization

West Virginia Cooperative Fish and Wildlife Research Unit

Human disturbances—timber harvesting, mining, recreation, development—can affect wildlife populations in many ways. Quantifying the effect of human disturbance on habitats critical to the life-history requirements of a species can help land managers address the collective needs of wildlife populations. This study examines various methods for creating young forest habitat for early successional-dependent species. The results can provide land managers with information to optimize forest management activities that fulfill critical life-history needs for a variety of species.

Golden-Winged Warbler Ecology and Management on High Elevation Grazing Allotments, Monongahela National Forest, West Virginia

West Virginia Cooperative Fish and Wildlife Research Unit

Golden-winged warblers are the fastest-declining early successional songbird and are being reviewed for listing under the ESA. The research team is collaborating with another team on the rangewide study of golden-winged warbler habitat-management strategies that can help guide the management activities of State and Federal agencies. This project also quantifies associated species to broaden the application of management actions to a larger group of game and nongame species. The research results have contributed to the golden-winged warbler status assessment, a conservation plan, Appalachian region management guides, and NRCS management activities.

Golden-winged warblers are the fastest-declining early successional songbird and are being reviewed for listing under the Endangered Species Act.

Publications

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Assessing Neutral and Adaptive Differentiation in Cisco Populations Across Wisconsin Using RAD–Sequencing

Wisconsin Cooperative Fishery Research Unit

Cisco are an important sentinel species that support recreational fisheries and prey for game fish such as muskellunge and walleye. The Wisconsin Department of Natural Resources conducted a large survey of cisco populations to better understand the spatial distribution and dynamics of these populations in Wisconsin. Because cisco vary in a number of morphological characteristics and contain multiple morphotypes (dwarf and normal), the goal of the project is to extend the survey work of the Wisconsin Department of Natural Resources by investigating the spatial genetic structure of cisco populations across Wisconsin. The results can be used to manage cisco across their range in Wisconsin and help managers understand the links between the morphotypes seen at different locations and their underlying genetics.

Assessment of Walleye Population Characteristics in Stevens Point Flowage Using Passive Integrated Transponders

Wisconsin Cooperative Fishery Research Unit

The Wisconsin River supports some of the most prominent walleye fisheries in Wisconsin, but information on these populations is often lacking because of other sampling responsibilities. The central objective of this research is to develop population models that allow estimations of abundance, growth, and mortality metrics for walleye in the Stevens Point Flowage. A larger goal of this research is to determine whether such an approach is useful for other populations where annual sampling does not occur and the sacrifice of fish for otoliths is not desirable.

Brook Trout Movements in the West Branch of the Wolf River, Wisconsin

Wisconsin Cooperative Fishery Research Unit

The West Branch of the Wolf River supports a naturally reproducing population of native brook trout. The sustainability of this population is important because little is known about the movements of brook trout, and these movements could have important implications for brook trout management. The research team plans to determine if brook trout in the West Branch of the Wolf River use multiple river segments during the year. Additionally, the team intends to investigate the percentage of brook trout that enter the Bass Lakes and Neopit Mill Pond and the percentage of brook trout that return to the West Branch of the Wolf River after entering the Bass Lakes and Neopit Mill Pond. The project results can enable managers to develop strategies to account for emigration losses.

Electrofishing Catchability of Juvenile Muskellunge in Northern and Southern Wisconsin Lakes

Wisconsin Cooperative Fishery Research Unit

To assess the effectiveness of muskellunge stocking, biologists conduct electrofishing surveys in the fall to estimate catch per effort (CPE) and the relative contribution of stocked fish. Inherent assumptions of this sampling are that wild and stocked fish have an equal probability of capture and that changes in CPE reflect changes in actual abundance. The initial results suggest that most hatchery fish remained near the release location. On the basis of these results, biologists could improve sampling protocols for evaluating muskellunge stocking success by stratifying sampling efforts so that more time is spent sampling where the fish are located.

Evaluation of Methods Used to Estimate Population Metrics for Adult Muskellunge in Northern Wisconsin Lakes

Wisconsin Cooperative Fishery Research Unit

The muskellunge is an important game fish in Wisconsin, and fisheries managers require information on muskellunge abundance within Wisconsin lakes. The purpose of this project is to evaluate the methods used to estimate population metrics for adult muskellunge in northern Wisconsin. Specifically, researchers want to provide an improved method for predicting muskellunge abundance when recent population estimates are unavailable, evaluate temporal variation in adult populations, and obtain estimates of survival and growth. The study can allow for comparison of gear selectivity and catchability between sexes.

Identifying Recruitment Bottlenecks for Walleye in Northern Wisconsin Lakes

Wisconsin Cooperative Fishery Research Unit

Recruitment failure has been observed in some northern Wisconsin walleye populations that formerly supported moderate to high levels of recruitment. Increased abundance of other species (for example, black crappies and bluegills) concurrent with decreased walleye abundance suggests that predation of walleye by littoral-zone fishes could be limiting recruitment. In collaboration with the Wisconsin Department of Natural Resources, researchers are initiating an intensive study of walleye early life history across a range of walleye populations, including those that recently exhibited recruitment failure and populations that exhibit high levels of recruitment on a relatively consistent basis. Results from this research can elucidate factors limiting walleye recruitment and provide managers with potential actions to increase walleye populations in selected water bodies.

Population Characteristics and Movements of Smallmouth Bass in the Menominee River

Wisconsin Cooperative Fishery Research Unit

The Menominee River supports popular, high-quality fisheries for smallmouth bass in Wisconsin and Michigan, and maintaining these fisheries is an important goal for the Wisconsin and Michigan Departments of Natural Resources. The Menominee River provides an excellent opportunity for researchers to evaluate dietary interactions between smallmouth bass and walleye in a system that supports healthy populations of both species. Examining diets can allow biologists to better understand which prey species are important to smallmouth bass and walleye within the river. More information is needed to determine if current management strategies are appropriate for maintaining the quality of these smallmouth bass fisheries in the future.

Statewide Evaluation of Calcified Structures Used to Estimate Ages of Largemouth Bass and Northern Pike

Wisconsin Cooperative Fishery Research Unit

Efforts to compare the age and growth of fishes across waterbodies are hampered when different methods are used to collect, prepare, and age structures. The project team is collaborating with the Wisconsin Department of Natural Resources Fish Age Task Group to develop statewide protocols for estimating the age of species of management interest. The results from the project can guide biologists in the selection and preparation of calcified structures from largemouth bass and northern pike.

Wild Age-0 Salmonid Abundance and Outmigration in Wisconsin Tributaries to Lake Michigan

Wisconsin Cooperative Fishery Research Unit

Introduced salmonids (specifically Chinook and coho salmon; rainbow and brown trout) support important recreational fisheries within the Lake Michigan ecosystem. These fisheries are primarily supported by stocking, but natural reproduction is known to occur within some tributary systems. This study plans to compare the mark-recapture methods used to estimate wild age-0 salmonid abundance—to determine if a single sampling event following stocking of marked fish yields similar estimates—with estimates derived from multiple sampling events. These data can help recreational fishery managers across Wisconsin.

Deer-Elk Ecology Project

Wyoming Cooperative Fish and Wildlife Research Unit

Mule deer are an integral part of the outdoor heritage of western North America—a relished species of pursuit among big-game hunters throughout the country—and a key component of the landscape of the West. Nevertheless, mule deer populations have declined across much of their range during the last two decades, with many factors potentially contributing to those declines. Coincident with waning populations of mule deer, populations of elk have burgeoned throughout much of their range through growth in abundance and range expansion. Quantifying the net effects of competition on nutritional condition, survival, productivity, and population growth is a difficult endeavor and one that has been inadequately addressed. This study strives to better understand the factors regulating the growth of struggling mule deer populations and identifying what, if any, effect elk have on mule deer. This information is key to knowing what management and conservation actions can enhance mule deer populations while maintaining robust elk populations.

Pictured below: Mule deer on rangeland. Photograph by Ryan Hagerty, U.S. Fish and Wildlife Service.

Determining Stream of Origin and Spawning-Site Fidelity of Salmonids in the Upper North Platte River Drainage Basin by Using Otolith Microchemistry

Wyoming Cooperative Fish and Wildlife Research Unit

The Upper North Platte River watershed supports a nationally recognized and important wild trout fishery. In Wyoming, there are 76 miles of the North Platte River and 11 miles of the Encampment River, both of which are classified as Blue Ribbon streams. Trout species present, including rainbow, brown brook, and cutthroat trout, have been managed by the Wyoming Game and Fish Department as a wild fishery since the early 1980s. This research intends to identify the tributary streams most important for trout spawning in the watershed and maintain or enhance the productivity of this fishery.

Understanding tributary use of fish in the North Platte River is crucial for successful management of a Blue Ribbon wild trout fishery.

Evaluating the Influence of Beetle Kill on Sierra Madre Elk

Wyoming Cooperative Fish and Wildlife Research Unit

The Wyoming Cooperative Fish and Wildlife Research Unit is evaluating how hunters and elk change their use of the forest as trees die, as dead trees begin to fall, and as beetle-kill management is implemented. Most of the beetle-killed trees in this study area of the Sierra Madre mountains are infected and dying but have not yet fallen over. This study can provide an assessment of elk movement and forest use before, during, and after massive tree falls. The research can also produce documentation on how hunters change their use of the forest and where they choose to hunt elk throughout all stages of the beetle kill and tree fall. This information can be used by managers to predict elk distributions and set harvest regulations in beetle-kill areas in the future.

Harvest Records: Implications for Understanding Factors Affecting Horn and Antler Size in Ungulates

Wyoming Cooperative Fish and Wildlife Research Unit

All harvested bighorn and thinhorn sheep are required by the Wyoming Game and Fish Department to be inspected and have their horns permanently marked with a small identification plug. Consequently, most western natural-resource management agencies maintain harvest records that include the size and age of all sheep harvested. These agency harvest records represent a valuable resource for assessing trends in size and the factors responsible for those patterns on a more regional basis. These records can also provide a more robust test of hypotheses and the effects of specific management practices. The goal of this project is to use two sources of sheep-harvest data to document long-term trends in horn size and the ages of bighorn sheep, Dall's sheep, and Stone's sheep at a regional level. This information can be used to manage sheep populations and potentially increase the number of trophy sheep.

Mule Deer Fawn Survival on the Wyoming Range

Wyoming Cooperative Fish and Wildlife Research Unit

This research is part of the larger Wyoming Range Mule Deer Project investigating the nutritional relations between mule deer population dynamics, energy development and disturbance, habitat conditions, and climate to provide a mechanistic approach to the monitoring and management of mule deer. This specific research component is designed to quantify the effects of predation on fawn survival, a study objective that is often cost prohibitive to achieve or measure properly. Examining survival and cause-specific mortality of a Wyoming ungulate is unprecedented and can be a valuable addition to the larger Wyoming Range Mule Deer Project.

Nutritional Dynamics and Interactions With Disease in Bighorn Sheep

Wyoming Cooperative Fish and Wildlife Research Unit

Pneumonia in bighorn sheep continues to be one of the most poorly understood diseases to threaten wildlife in North America. Bighorn sheep populations often exhibit sporadic fluctuations in abundance with periods of rapid growth, followed by massive declines. Consequently, unraveling the interplay among density, nutrition, and disease are important to understanding population dynamics in bighorn sheep populations. The project team plans to explore the interface between density, nutritional conditions, individual survival and reproduction, and disease susceptibility to better understand how herd density, nutrition, and harvest management interact with pneumonia and seek alternatives for helping manage the disease. This study can yield insight into the ever-complicated relations between disease, density, and population performance in bighorn sheep populations across western North America.

Population Dynamics of Moose in the Snowy Range

Wyoming Cooperative Fish and Wildlife Research Unit

Managers have anecdotally considered the recently introduced Snowy Range moose herd to be performing well. However, a lack of information on the status of the population and the influence of harvesting has created considerable uncertainty in how these moose should be managed (specifically harvest levels) over the long term. Further, questions remain on how to maintain productivity and reduce the probability of a population decline, which has been documented for Shiras moose across much of their range. The overall goal of this project is to characterize the population trajectory of moose in the Snowy Range to determine if the population is increasing or decreasing under current management. Additionally, the research intends to determine the primary factors influencing population performance (with an emphasis on nutrition) and develop cost-effective tools to aid in long-term monitoring and management.

Female, collared moose, that were pregnant early in the year, are visited in July and late August each year to determine the number of calves-at-heel.

Statewide Moose Habitat Project

Wyoming Cooperative Fish and Wildlife Research Unit

For declining Shiras moose herds, habitat deterioration, regional variation in food quality, and other disturbances, such as severe wildfire or bark beetle outbreaks, are common. A newly emergent disease, the carotid artery worm, appears to be prevalent in Wyoming. Unfortunately, researchers do not yet understand the effects of this disease on the nutritional condition and survival of moose. A statewide habitat evaluation can serve as a benchmark for defining the relation between moose habitat and population performance and can provide the Wyoming Game and Fish Department with early-warning metrics to predict where and when declines are likely to occur as well as improve the scientific basis of moose population objectives.

Updating Temperature Criteria for Wyoming Surface Waters

Wyoming Cooperative Fish and Wildlife Research Unit

Tiered aquatic life use is a method of classifying rivers and streams on the basis of what fish and invertebrates are expected to be present in healthy streams. The goal of this project is to provide suggestions to the Wyoming Department of Environmental Quality for new aquatic life use tiers and temperature criteria. The specific objectives are to identify enough aquatic life use tiers to protect the aquatic communities present in the waters in Wyoming, identify thermal tolerances for species within each aquatic life use tier, and evaluate the newly developed aquatic life use tiers against fish distribution data.

Yellowstone Cutthroat Trout Hybridization in the North Fork Shoshone River

Wyoming Cooperative Fish and Wildlife Research Unit

Fisheries managers in Yellowstone National Park are interested in information on Yellowstone cutthroat trout hybridization in the North Fork Shoshone River. The goal of this project is to identify priority tributaries and determine the conservation potential of Yellowstone cutthroat trout in the North Fork Shoshone River drainage basin. The project is designed to examine the extent of population genetic structures among tributaries to assess the degree of spawning, evaluate environmental variables (temperature, discharge, slope), and determine the extent of hybridization. This information can be valuable for identifying stream reaches that might provide genetically pure source stock and warrant efforts to limit the potential immigration of species likely to hybridize with Yellowstone cutthroat trout.

Brown trout are found in some of the coldest waters along the Laramie River.

Wildlife Health and Disease

Populations of bats diminished by white-nose syndrome, a disease of hibernating bats, are unlikely to return to healthy levels in the near future, according to new U.S. Geological Survey research.

Photograph by Nancy Heaslip, New York Department of Environmental Conservation.

Effects and Sources of Strontium in Lesser Scaup

Arkansas Cooperative Fish and Wildlife Research Unit

Scaup populations have declined substantially since the 1980s, reaching a low of 3.25 million birds in 2006, which is 48 percent below the NAWMP goal; the population remains 33 percent below this goal. To date, no single factor fully explains this decline. The research team intends to investigate strontium in scaup eggs at several sites within the boreal forest region of interior Alaska. The data from this research can support efforts to manage diverse waterfowl species.

Scaup populations have declined substantially since the 1980s and reached a low of 3.25 million birds in 2006, 48 percent below the North American Waterfowl Management Plan goal.

Assessment of Endocrine Disrupting Chemicals in the Upper Conasauga River, Georgia

Georgia Cooperative Fish and Wildlife Research Unit

The Upper Conasauga River in northwestern Georgia and southern Tennessee harbors an exceptional diversity of aquatic fauna, including more than 90 fish and 42 mussel species; however, many of these species are imperiled. To preserve this watershed and improve populations of these species, conservation partners proposed the creation of a Conasauga River NWR. Maximizing benefits for an established refuge requires information on potential threats to the aquatic fauna in the river system. The goal of this project is to evaluate the prevalence of endocrine disrupting chemicals (EDCs) in the upper Conasauga River. The project results can inform managers trying to identify reasons for the recent extirpation of some fish species and declines in others within the basin.

Effects of Sylvatic Plague on Northern Idaho Ground Squirrels

Idaho Cooperative Fish and Wildlife Research Unit

Sylvatic plague is a bacterial disease acquired by wild rodents and transmitted by fleas. This study is documenting whether sylvatic plague reduces the survival rates of the federally threatened northern Idaho ground squirrel. This project complements an existing 10-year study to evaluate the effectiveness of habitat-restoration treatments attempting to increase populations of the squirrel. Study results can help managers working to reduce a potential threat—a plague—that might prevent population increases and thereby prevent recovery and delisting.

Factors Affecting Mercury Concentrations in Iowa Fishes

Iowa Cooperative Fish and Wildlife Research Unit

Mercury contamination in aquatic ecosystems is a global concern because mercury bioaccumulates in fish. Mercury can reach levels that are harmful to humans when consumed. Mercury concentrations in fish tissue tend to increase with the age and size of the fish, although concentrations can be highly variable due to other factors. This study is quantifying mercury concentrations in several species of fish consumed by anglers, along with a suite of fish and environmental characteristics to develop a model that can accurately predict mercury concentrations in fish tissue. Results can be used by the Iowa Department of Natural Resources to set consumption advisories and benefit human health.

Conserving Snake Species of Greatest Conservation Need Threatened by an Emerging Fungal Skin Disease

Massachusetts Cooperative Fish and Wildlife Research Unit

A suspected fungal skin disease has emerged as a threat to snakes, including SGCN, such as the massasauga and the timber rattlesnake, in multiple Eastern and Midwestern States. Using data obtained from a regional snake species assessment, scientists and partners plan to use an AM framework for the development of long-term conservation strategies for as many as 40 of the snake species potentially affected by the disease. Other conservation actions include evaluation of treatment options, experimental treatment with antifungal agents, captive rearing, and monitoring.

The eastern massasauga rattlesnake has been listed as a threatened species under the Endangered Species Act. Photograph by Joe Crowley, U.S. Fish and Wildlife Service.

Insecticide Exposure Risk for Grassland Wildlife on Public Lands

Minnesota Cooperative Fish and Wildlife Research Unit

Grassland habitat loss due to agriculture might be one of the primary reasons for the decline of many grassland-dependent wildlife species, but concerns are increasing about the effects of pesticides on birds and other wildlife in agricultural landscapes. Evidence exists that acute toxicity to pesticides might be more relevant than agricultural intensity in explaining grassland bird declines in the United States. This study is assessing the environmentally relevant exposure risk of grassland wildlife to common soybean aphid insecticides, especially chlorpyrifos, in the farmland region of Minnesota. Results from this study can be used to inform the public about BMPs for controlling crop pests and conserving grassland wildlife.

Patterns and Trends in Concentrations of Lead in Bald Eagles in the Upper Midwest

Minnesota Cooperative Fish and Wildlife Research Unit

Bald eagles experienced significant population declines because of exposure to environmental contaminants, particularly DDT. In addition to DDT, chemicals such as polychlorinated biphenyls, mercury, and lead also accumulate in bald eagles, but the extent to which lead affected breeding populations is not well-documented. Working with an existing dataset coordinated by the NPS, scientists are assessing relations between lead concentrations in eagles and reproduction throughout NPS holdings in the western Great Lakes region. The assessment can help managers understand the effects of environmental lead on bald eagles and identify areas of conservation concern.

Determining Concentrations and Persistence of Imidacloprid, Clothianidin, and Thiamethoxam in Terrestrial Agricultural Settings on Missouri Public Areas

Missouri Cooperative Fish and Wildlife Research Unit

The Missouri Cooperative Fish and Wildlife Research Unit is conducting a study to determine the concentrations and persistence of a new class of chemical insecticides known as neonicotinoids. Neonicotinoids are systemic insecticides used as preplanting treatments on crop seeds to control agricultural insect pests. Neonicotinoids are selectively more toxic to invertebrates than vertebrates. The results of this project can inform BMPs on Missouri public lands.

Effects of Endocrine Disrupting Chemicals on the Health of Aquatic Organisms

Missouri Cooperative Fish and Wildlife Research Unit

Endocrine disrupting chemicals are a nationwide issue affecting populations of fish and wildlife. EDCs are chemicals that interfere with biochemical and physiological processes by disrupting the normal homeostasis of endocrine systems and function. The assessment of the biological effects of EDCs on populations of fish and wildlife, and, in particular, those populations that are trust resources of the DOI, has lagged behind the chemical measurements of EDCs in the environment. Researchers plan to evaluate how risk estimates of EDCs to wildlife populations translate from physiological indicators to population level outcomes.

Pictured below: Grassland. Photograph by Georgiana L. Wingard, U.S. Geological Survey.

Prevalence of Neonicotinoid Insecticides on Intensively Managed Wetland Areas and Surrounding Landscapes With a Focus on Effects on Aquatic Invertebrates

Missouri Cooperative Fish and Wildlife Research Unit

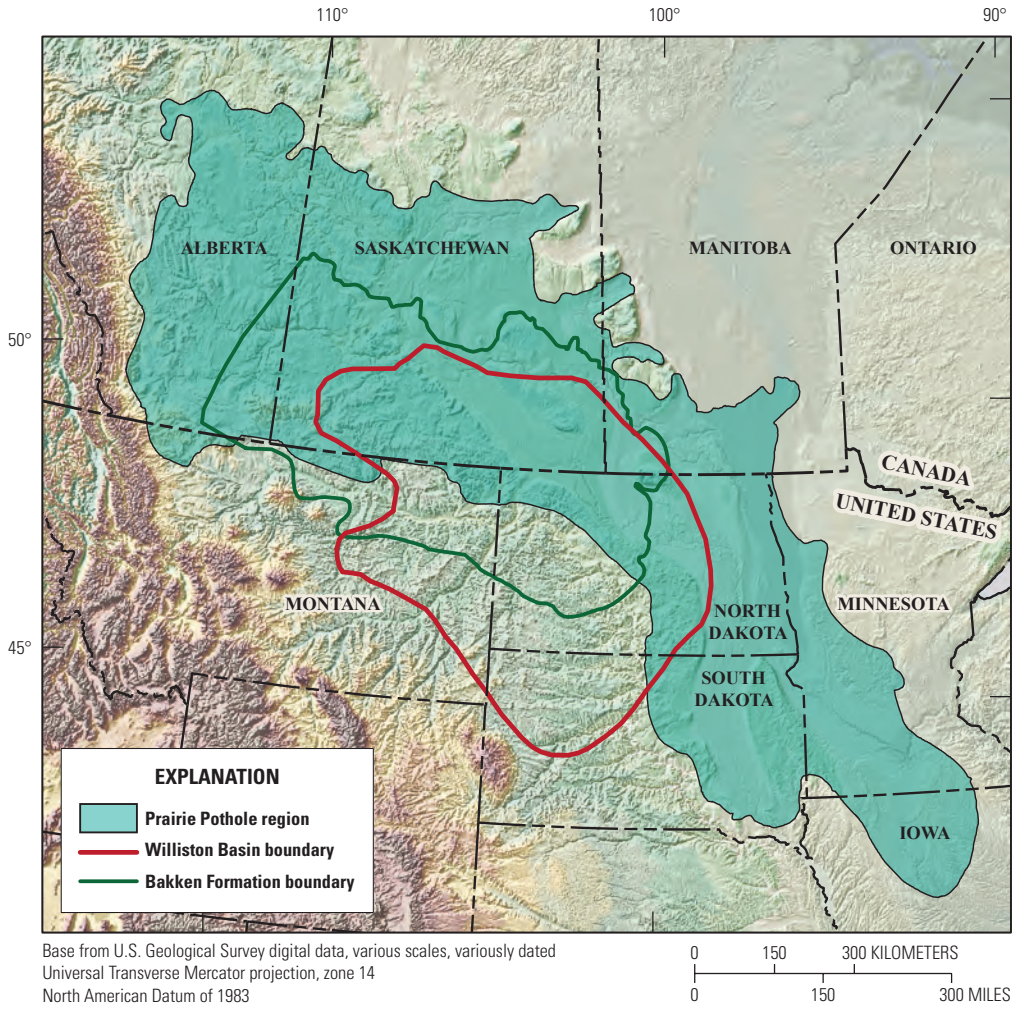
Neonicotinoid insecticides are a new class of chemical insecticide used widely as preplanting treatments on crop seeds to control insect agricultural pests. Given the high use of neonicotinoid insecticides in the Midwest and their inherent characteristics—acute toxicity to insects, relatively long half-lives in soil, and high water solubility—it is imperative to determine if these chemicals are present in Missouri wetlands in concentrations that can cause harm to beneficial, nontarget aquatic invertebrates and other taxa. Data from this study can help managers understand the prevalence of neonicotinoid insecticides on intensively managed wetland areas and the surrounding landscapes with a focus on how it affects aquatic invertebrates.

Neonicotinoid insecticides are a relatively new class of chemical insecticide widely used as a preplanting treatment on crop seeds to control insect agricultural pests.

Linking Exposure to Sublethal Stressors to Individual Vital Rates and Population Abundance

Montana Cooperative Wildlife Research Unit

The Williston Basin of Montana and North Dakota is a leading source of domestic oil and gas production. The primary goal of this project is to develop a tool that links stressors to vital rates—growth and survival, and population—for amphibians in the Williston Basin. The researchers plan to explore the wetlands and use methods such as radio telemetry to estimate the survival of amphibians. The resulting data can demonstrate a novel approach to investigating the potential effects of exposures to contaminants on individuals and how those effects scale up to populations and communities.



The Williston Basin of Montana and North Dakota is a leading source of domestic oil and gas production.

The Ecological Web Contributing to a Sarcoptic Mange Epizootic in Coyotes of the Mojave Desert, Fort Irwin, California

New Mexico Cooperative Fish and Wildlife Research Unit

There is concern over the ecological web contributing to sarcoptic mange in coyotes of the Mojave Desert, Fort Irwin, California. To minimize the human-wildlife conflict at Fort Irwin, the goal of this study is to estimate the coyote population inhabiting the base, explore the potential factors contributing to sarcoptic mange, and check for other parasites and diseases. Through this process, researchers hope to identify and suggest mitigation strategies that can be adopted by the base administration to reduce the size of the resident coyote population and enhance its health, thereby reducing human-wildlife conflict and the potential for the spread of disease to humans and pets.

Environmental Determinants of Sex in Fishes: Endocrine Disruptors and Water Temperature

North Carolina Cooperative Fish and Wildlife Research Unit

The mechanisms of sex determination in fishes are well-understood, but the process can be easily altered by the environment. Compounds within the water, or the quality of the water itself, can directly influence fish physiology and disrupt or alter the normal hormonal cascade that leads to phenotypic sex. This research project intends to document the presence of anthropogenic chemicals, EDCs, and intersex at selected sites and determine whether southern flounder in two brackish water nursery areas have skewed sex ratios based on temperature. This work can provide critical insight into the role of EDCs and natural temperature variations on an important aquatic species.

Density Estimation of Moose in New York State: Investigations Into Apparent Decline

New York Cooperative Fish and Wildlife Research Unit

The apparent decline in the moose population within New York is being investigated by the use of a spatial capture-recapture approach to estimate moose population density. Researchers plan to make suggestions regarding efficient survey designs. The project, in collaboration with the New York State Department of Environmental Conservation and The Wildlife Conservation Society, also intends to focus on developing broader management and population goals for moose in New York, including the characterization of stakeholder concerns for population-level thresholds.

Response of Desert Bighorn Sheep in the Mojave National Preserve to Respiratory Disease

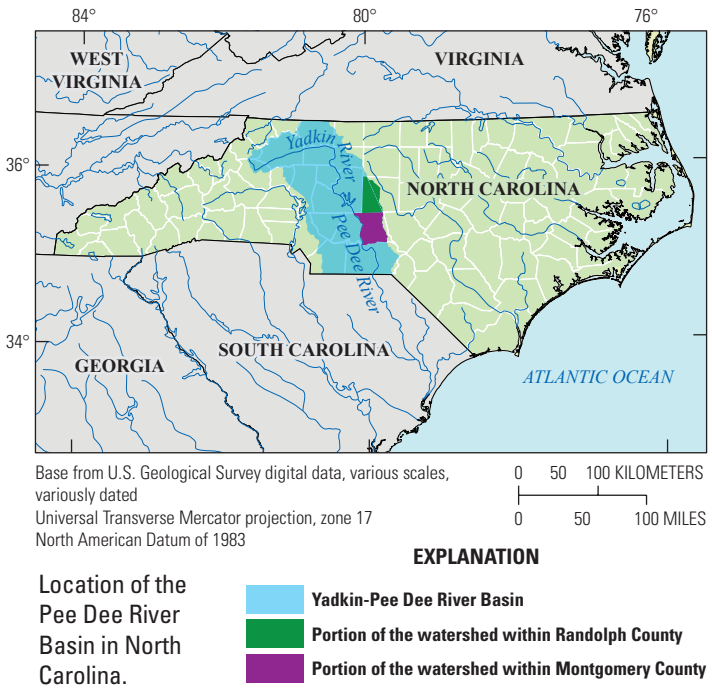
Oregon Cooperative Fish and Wildlife Research Unit

The Mojave National Preserve and adjacent mountain ranges support a large metapopulation of desert bighorn sheep, which is central to the most extensive array of naturally persisting bighorn herds in North America. A recently discovered outbreak of epizootic pneumonia in the deserts of southeastern California caused a substantial die-off of desert bighorn sheep in the largest and most important population in the preserve. This outbreak was likely caused by pathogens transmitted from domestic sheep or goats. This study is using both existing

A Comprehensive Examination of Endocrine Disrupting Chemicals and Intersex Fish in North Carolina Water Bodies

North Carolina Cooperative Fish and Wildlife Research Unit

Endocrine disrupting chemicals can interfere with fish reproduction and negatively affect fisheries. Consequently, fishery managers in North Carolina need to understand the distribution and quantity of EDCs in the water bodies within North Carolina. The goal of this research is to develop a GIS-based map of EDCs, conduct surveys for the presence of EDCs, conduct intensive field research in the Pee Dee River Basin, and conduct laboratory assessments of EDCs in the Pee Dee River. The results can provide a comprehensive understanding of the distribution and potential effect of EDCs on North Carolina fisheries.



Location of the Pee Dee River Basin in North Carolina.

and new data to evaluate adult and juvenile survival over multiple years and across populations where pneumonia is present. This study can establish the demographic consequences of the current disease outbreak.

An Investigation Into the Role of Groundwater as a Point Source of Emerging Contaminants to Smallmouth Bass in the Susquehanna River Basin

Pennsylvania Cooperative Fish and Wildlife Research Unit

There is a current paucity of information on the role of groundwater discharge into surface waters as point sources of contaminants from polluted aquifers. This information is critically needed because groundwater seeps are important for smallmouth bass during the spawning season, and exposure to EDCs during the critical life stage of egg development could have detrimental short- and long-term consequences on immune function and fish health. This research aims to investigate the role of groundwater as a point source of emerging contaminants to smallmouth bass in the Susquehanna River Basin.

Establishing a Strategy for Assessing Risk of Endocrine Disrupting Chemicals to Aquatic and Terrestrial Organisms

Pennsylvania Cooperative Fish and Wildlife Research Unit

Endocrine disrupting chemicals are a national and global concern that affect fish, wildlife, and human populations. Through interactions with neural, endocrine, and immune systems, EDCs can influence growth, development, reproduction, disease, and mortality, with adverse outcomes for populations, communities, and ecosystems. Within the Chesapeake Bay, understanding the effects of EDCs on fish and wildlife populations has been identified as a priority to help inform natural resource management. This research intends to help identify the short- and long-term effects of compounds or classes of chemicals of concern, potential environmental conditions and stressors that might mediate the effects of EDCs, and how land-use management practices can reduce exposure to EDCs.

Landscape Genetics of White-Tailed Deer to Assess Population Structure for Surveillance of Chronic Wasting Disease

Pennsylvania Cooperative Fish and Wildlife Research Unit

Research on surveillance strategies that consider demographic and environmental factors is lacking in most States where chronic wasting disease (CWD) has not been found. Developing surveillance strategies to maximize the efficiency of sampling white-tailed deer was suggested but requires knowledge of deer behavior, movements, and the spatial connectivity of populations. This study uses landscape genetics to provide the necessary framework for understanding landscape features, the dispersal characteristics of deer, and the transmission and spread of CWD through assessment of population structures throughout the region. The results can improve the ability of resource managers to focus surveillance so that it accounts for CWD and predicts spreading or occurrences.

Linking Fish Health, Contaminants, and Population Dynamics of Smallmouth Bass Populations in the Susquehanna River, Pennsylvania

Pennsylvania Cooperative Fish and Wildlife Research Unit

Since 2005, diseased smallmouth bass have been detected throughout the Susquehanna River and its tributaries, raising concerns about the overall health of smallmouth bass and the Susquehanna River Basin in Pennsylvania. This collaborative project aims to investigate a wide range of variables—fish health analysis, contaminants, population modeling, radio telemetry, and others—to better understand the factors that could relate to disease in smallmouth bass. The research is focused on identifying focal points for future research needs with a fish-health emphasis on the young-of-the-year smallmouth bass.

Smallmouth bass. Photograph by U.S. Fish and Wildlife Service.

Evaluating the Effect of White-Nose Syndrome on Bats

South Carolina Cooperative Fish and Wildlife Research Unit

Research has revealed that in addition to the direct effect of WNS-induced mortality on many cave-roosting species, broader bat-community structure was altered following WNS. In New York, the researchers found that the big brown bat was more likely to occur in riparian areas heavily used by the formerly most abundant bat species, the little brown bat, post-WNS, suggesting a relaxation of spatial-niche partitioning between these species. Researchers plan to build on these

recently published findings from New York to evaluate the generality of altered community structures and assemblage post-WNS.

Endocrine Disrupting Chemicals, Global Warming, and Reproductive Health in Fishes

Texas Cooperative Fish and Wildlife Research Unit

Environmental stressors such as EDCs and globally rising temperatures can affect gonadal sex and gamete production in vertebrates. Although data from the laboratories and other sources suggest that the action of these stressors in teleost fishes can be mediated by disrupting the thyroid hormone, stress hormone, and melatonin production pathways, the physiological-molecular mechanisms of these pathways and their interaction with the classical hypothalamus-pituitary-gonad axis are not well-understood. This pilot study intends to gather the available information on the effects of EDCs and thermal stress on thyroid and melatonin signaling in teleosts. Results of this project are relevant to an assessment of the effects of EDCs and global warming on the reproductive health of wild fishes.

Evaluating the Effect of White-Nose Syndrome on Long-Term Bat Community Structure and Remnant Bat-Population Ecology

Virginia Cooperative Fish and Wildlife Research Unit

Research from the Virginia Cooperative Fish and Wildlife Research Unit shows that in addition to the direct effect of WNS-induced mortality on many cave-roosting species, broader bat-community structure was altered post-WNS. This project builds on recently published findings from New York to evaluate the generality of altered community structure and assemblage post-WNS. The team plans to revisit sites that were intensively monitored acoustically for bat activity before the onset of WNS across a wide geographic area in the Eastern United States. By synthesizing historical data and adding additional monitoring data, this project can serve as a leading database for potential long-term monitoring of the effects of WNS and other disturbances on bat communities in the Eastern United States.

Brown bat with white-nose syndrome. Photograph by U.S. Fish and Wildlife Service.

Post-White-Nose-Syndrome Bat Ecology in the Eastern United States

Virginia Cooperative Fish and Wildlife Research Unit

White-nose syndrome is a fungal disease of hibernating bats that spread from the Northeastern to Central United States at an alarming rate. The ecological consequences of large-scale population reductions of hibernating bats are not yet known. This research team plans to radio-tag and track northern long-eared and endangered Indiana bats to investigate the foraging ecology, roosting ecology, and distribution of bats in the mid-Atlantic and Northeast, post-WNS. This project is part of a larger multipartner effort to examine the effects of WNS on bats and assist managers in understanding population responses as the disease spreads.

Northern long-eared bat

Adaptation of Infectious Hematopoietic Necrosis Virus to Pacific Northwest Chinook Salmon and Effects on Other Salmonids

Washington Cooperative Fish and Wildlife Research Unit

Viruses cause many of the most important infectious diseases in both wild and cultured fish. Researchers plan to investigate the cause of the observed adaptation of infectious hematopoietic necrosis virus (IHNV) to Chinook salmon in the Columbia River Basin and the potential effects on other salmonid species of the Pacific Northwest. The team plans to

investigate historical and recent IHNV and landscape patterns and conduct genetic analysis. Collectively, these studies can advance the understanding of how fish viruses function in nature, what determines their host range and geographic distribution, and how they might change over time in response to natural or anthropogenic factors. The goal of this work is to provide scientifically sound data for informed management decisions aimed at the control of fish viruses and the mitigation of fish diseases.

Development and Application of a Juvenile Salmonid Health Index at Selected National Water-Quality Assessment Project Sites

Washington Cooperative Fish and Wildlife Research Unit

There is no clear consensus method for assessing the overall health of individual juvenile salmonids during their freshwater life stage. This research project seeks to begin the development of a standardized method for assessing juvenile salmonid health. The focus of this project is to develop and test a standardized assessment tool that addresses the health of individual, feral salmonids collected at defined locations around Puget Sound. A standardized protocol for individual, juvenile salmonid assessment, combining metrics from various lines of assessment evidence, is to be developed and tested with the broader goal of independent use by various management agencies that could incorporate future modifications or additions into the metric.

Fish-Virus Ecology, Molecular Epidemiology, and Evolution

Washington Cooperative Fish and Wildlife Research Unit

Many of the most important and destructive pathogens among finfish are viruses in the family Rhabdoviridae. The rhabdovirus IHNV is the most significant viral pathogen of salmonid fish in North America. The team plans to focus its research on recent emergence and displacement events observed with IHNV in salmonid fish in the Pacific Northwest. Specifically, the team plans to investigate the basic processes that drive the ecology and evolution of IHNV. The goal of this work is to provide scientifically sound information that can be used to direct management decisions that prevent further spread of the virus.

Chesapeake Bay Priority Ecosystems Fish-Health Studies Molecular Pathology

West Virginia Cooperative Fish and Wildlife Unit

Major fish kills in the Potomac River Basin were first reported in 2003. Research on the health of fish populations and their exposure to toxic contaminants that contribute to reduced health is ongoing. The research team, in collaboration with the USGS Leetown Science Center, plans to identify gene sequences and develop techniques to better understand the underlying mechanisms and (or) pathogens associated with certain identified fish-health issues. This research supports the USGS Chesapeake Bay Science Plan.

Indicators of Endocrine Disruption in the Chesapeake Bay Watershed

West Virginia Cooperative Fish and Wildlife Research Unit

Various chemicals are affecting fish health in the Chesapeake Bay watershed and require further study; therefore, a central goal of this research is to determine sources of EDCs, evaluate the environmental movement of these chemicals, and quantify the potential exposure of wildlife and humans. Researchers plan to synthesize current data, measure hormone activity, and provide land-use and land-cover data. Identifying releases and subsequent exposures to environmental contaminants from different sources is crucial for (1) determining the relative importance of various sources of EDCs in terms of fish health and (2) identifying those sources that can be managed.

Chesapeake Bay watershed, outlined in blue.

Support of Chemical Sampling for Sources, Transport, and Distribution of Endocrine Disrupting Chemicals of the Chesapeake Bay Endocrine Disrupting Chemicals Science Plan

West Virginia Cooperative Fish and Wildlife Unit

2016 is the second year of an ongoing effort to understand the sources, transport, and distribution of chemical contaminants responsible for the adverse biological effects (intersex, diseases) observed within the Chesapeake Bay watershed. This project is part of the overall Chesapeake Bay EDC plan, in which the focus is on agricultural landscapes during the first 3 years and urban/suburban landscapes in the last 2 years. Sites for intensive monitoring are to be subject to stream-water sampling 13–18 times per year. This research supports efforts in the Chesapeake Bay watershed, primarily the Potomac and Susquehanna watersheds, and is expected to lead to a synthesis of chemical and biological data.

Investigating the Relation Between Gill Lice Prevalence and Genetic Diversity in Brook Trout Across Wisconsin

Wisconsin Cooperative Fishery Research Unit

Gill lice are a major threat to brook trout populations throughout Wisconsin. Previous studies suggest a link between genetic diversity and the prevalence of pathogens such as gill lice. Specifically, multiple studies correlate pathogen prevalence with diversity at the genes of the Major Histocompatibility Complex (MHC) or with certain alleles at this gene; the MHC is an important component of the vertebrate immune system that is involved in the recognition of pathogens. The goal of this research is to investigate the possible relation between MHC variation and the prevalence of gill lice in brook trout.

Chronic Wasting Disease Deposition and Environmental Reservoirs

Wisconsin Cooperative Wildlife Research Unit

Potential management of CWD is hindered by the lack of key information about disease transmission. First, little information exists about when and in what amounts infected animals shed the CWD agent, thereby infecting other animals and depositing the infectious agent into the environment. Second, although the environmental route of transmission is known to be important in captive deer, no information exists on potential environmental deposition by infectious deer or potential environmental reservoirs of CWD infection for susceptible wild deer. The primary reason these issues have not been addressed is the lack of robust and sensitive methods to detect CWD in animal or environmental samples. The goal of this project is to evaluate the presence and level of CWD prions at mineral licks frequented by deer, at deer scrape sites, and in the feces of wild deer. The purpose of these evaluations is to identify and determine the relative importance of alternative environmental sources of CWD that function as potential reservoirs for infection in deer or other domestic animals that contact these reservoirs.

Effects of Climate Change on Plague Exposure Pathways and Resulting Disease Dynamics

Wisconsin Cooperative Wildlife Research Unit

Periodic outbreaks of sylvatic plague caused by the bacterium *Yersinia pestis* has led to near-catastrophic effects on prairie dogs and the endangered black-footed ferret. Although human plague cases in the United States are infrequent, the disease can be fatal, and its occurrence generates considerable public concern and media attention. Sylvatic plague is relevant to the DoD, as prairie dogs, ground squirrels, and other susceptible rodents are present on military installations in several Western States, and the occurrence of plague has curtailed military exercises in the past. Furthermore, plague still occurs in many parts of the world where troops might be deployed, and *Y. pestis* has the potential for development as a biological weapon. Through a combination of field and laboratory work, along with data-driven modeling, this research project plans to evaluate the potential effects of climate change on plague exposure pathways in prairie dogs and other rodents and guide DoD partners regarding the potential for future outbreaks.

Vulnerability of Hawaiian Forest Birds to Climate Change

Wisconsin Cooperative Wildlife Research Unit

The introduction of mosquito vector and avian malaria are considered primary factors in population declines and changes in the distribution of many native Hawaiian forest birds. Avian malaria dynamics are strongly influenced by rainfall and temperature, and successful conservation of Hawaiian

The Hawaiian ‘I‘iwi, a native forest bird species only found in the Hawaiian Islands. Photograph by Robby Kohley. Used with permission.

birds requires strategies that consider future disease risks posed by climate change. This project is prepared to evaluate predicted temporal and spatial changes in avian malaria as a result of anticipated climatic changes, evaluate the potential for additional species extinctions, consider genetic adaptation to malaria, and evaluate the effectiveness and costs of conservation strategies to mitigate anticipated population changes. Study results can provide the first quantitative assessment of the long-term effects of climate change on avian malaria distribution and its effect on endemic Hawaiian forest birds, and it can provide a crucial tool for adaptively managing population recovery and promoting disease resistance.

Investigating Elk Movement and Winter-Range Connectivity to Predict the Spread of Brucellosis

Wyoming Cooperative Fish and Wildlife Research Unit

Brucellosis is an important zoonotic disease of wild and domestic mammals worldwide. In the United States, the disease has been largely eradicated, except for the wild elk and bison populations around the greater Yellowstone ecosystem, where it occasionally spills over from infected elk into livestock. The research team plans to investigate elk movement and connectivity during the transmission period. This investigation is paramount for understanding future cattle risks and the spread of disease among elk. Estimating elk movement and connectivity during the transmission period, and predicting where and how fast brucellosis might spread in elk populations could help managers and biologists achieve management goals. Study results can highlight areas where local efforts might need proactive management and might be useful as a tool for communicating with landowners in this process.

Wildlife-Livestock Disease Transmission in a Changing Climate

Wyoming Cooperative Fish and Wildlife Research Unit

Brucellosis is a chronic bacterial disease that affects livestock, wildlife, and even humans on a worldwide scale. In the United States, the last reservoirs of brucellosis are supported by elk and bison in the greater Yellowstone ecosystem. When domestic cattle become infected with brucellosis, costly testing restrictions can be imposed on producers throughout an entire State. The goal of this project is to develop a framework for understanding the ecology of elk-cattle commingling. Understanding how elk migrate between seasonal ranges can provide crucial information for predicting commingling risk and proactively reducing brucellosis transmission between elk and cattle.

When cattle and elk commingle, there is a risk of disease transmission from elk to cattle.

The outdoor recreation economy generates $887 billion in consumer spending annually. Source: Outdoor Industry Association, 2017, Outdoor recreation economy report, April 25, 2017, accessed May 12, 2017, at https://outdoorindustry.org/resource/2017-outdoor-recreation-economy-report/.

List of Species

Common name	Scientific name
Adélie penguin	*Pygoscelis adeliae*
alewife	*Alosa pseudoharengus*
American alligator	*Alligator mississippiensis*
American black bear	*Ursus americanus*
American eel	*Anguilla rostrata*
American golden-plover	*Pluvialis dominica*
American marten	*Martes americana*
American oystercatcher	*Haematopus palliatus*
American pika	*Ochotona princeps*
American pronghorn	*Antilocapra americana*
American shad	*Alosa sapidissima*
American woodcock	*Scolopax minor*
Andean bear	*Tremarctos ornatus*
Arctic peregrine falcon	*Falco peregrinus tundrius*
Asian carp	*Hypophthalmichthys* spp.
Asian clam	*Corbicula fluminea*
Asian swamp eel	*Monopterus albus*
Asian tapeworm	*Bothriocephalus acheilognathi*
Atlantic salmon	*Salmo salar*
bald eagle	*Haliaeetus leucocephalus*
band-tailed pigeon	*Patagioenas fasciata*
barred owl	*Strix varia*
Bay-breasted warbler	*Setophaga castanea*
big brown bat	*Eptesicus fuscus*
bighead carp	*Hypophthalmichthys nobilis*
bighorn sheep	*Ovis canadensis*
bison	*Bison bison*
black abalone	*Haliotis cracherodii*
black bass	*Micropterus* spp.
black bear	*Ursus americanus*
Blackburnian warbler	*Setophaga fusca*
black crappie	*Pomoxis nigromaculatus*
black-footed albatross	*Phoebastria nigripes*
black-footed ferret	*Mustela nigripes*
black oystercatcher	*Haematopus bachmani*
black rosy-finch	*Leucosticte atrata*
black scoter	*Melanitta americana*
black-tailed prairie dog	*Cynomys ludovicianus*
blueback herring	*Alosa aestivalis*
blue catfish	*Ictalurus furcatus*
bluegill	*Lepomis macrochirus*

Common name	Scientific name
bluehead sucker	*Catostomus discobolus*
blue sucker	*Cycleptus elongatus*
blue-winged teal	*Anas discors*
bobcat	*Lynx rufus*
Bonneville cutthroat trout	*Oncorhyncus clarkii utah*
bonytail chub	*Gila elegans*
boreal toad	*Bufo boreas boreas*
Brandt's cormorant	*Phalacrocorax penicillatus*
Brewer's sparrow	*Spizella breweri*
broad whitefish	*Coregonus nasus*
broad-winged hawk	*Buteo platypterus brunnescens*
brook trout	*Salvelinus fontinalis*
brown pelican	*Pelecanus occidentalis*
brown trout	*Salmo trutta*
bull trout	*Salvelinus confluentus*
burbot	*Lota lota*
burrowing owl	*Athene cunicularia*
Canada goose	*Branta canadensis*
Canada lynx	*Lynx canadensis*
Cape May warbler	*Setophaga tigrina*
caribou	*Rangifer tarandus*
Carolina madtom	*Noturus furiosus*
carotid artery worm	*Elaeophora schneideri*
Caspian tern	*Hydroprogne caspia*
cerulean warbler	*Setophaga cerulea*
Chinese crested tern	*Thalasseus bernsteini*
Chinook salmon	*Oncorhynchus tshawytscha*
Chiricahua leopard frog	*Lithobates chiricahuensis*
chum salmon	*Oncorhynchus keta*
cisco	*Coregonus artedi*
coho salmon	*Oncorhynchus kisutch*
coldwater crayfish	*Orconectes eupunctus*
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*
Columbia spotted frog	*Rana luteiventris*
common eider	*Somateria mollissima*
common reed	*Phragmites australis*
Cooper's hawk	*Accipiter cooperii*
cougar	*Puma concolor*
coyote	*Canis latrans*
cutthroat trout	*Oncorhynchus clarkii*
Dakota skipper	*Hesperia dacotae*

List of Species—Continued

Common name	Scientific name
Dall's or thinhorn sheep	*Ovis dalli*
desert bighorn sheep	*Ovis canadensis nelsoni*
diamond darter	*Crystallaria cincotta*
double-crested cormorant	*Phalacrocorax auritus*
eastern meadowlark	*Sturnella magna*
eastern oyster	*Crassostrea virginica*
eastern wild turkey	*Meleagris gallopavo silvestris*
elk	*Cervus canadensis*
Eurasian watermilfoil	*Myriophyllum spicatum*
feral burro	*Equus asinus*
feral hog	*Sus scrofa*
fisher	*Martes pennanti*
flannelmouth sucker	*Catostomus latipinnis*
flathead catfish	*Pylodictis olivaris*
Florida pine snake	*Pituophis melanoleucus*
freckled crayfish	*Cambarus maculatus*
geoduck	*Panopea generosa*
giant Canada goose	*Branta canadensis maxima*
giant kangaroo rat	*Dipodomys ingens*
gill lice	*Salmincola* spp.
golden alga	*Prymnesium parvum*
golden eagle	*Aquila chrysaetos*
golden-winged warbler	*Vermivora chrysoptera*
gopher frog	*Rana capito*
gopher tortoise	*Gopherus polyphemus*
gray wolf	*Canis lupus*
greater prairie-chicken	*Tympanuchus cupido*
greater sage-grouse	*Centrocercus urophasianus*
greater sandhill crane	*Grus canadensis tabida*
green sturgeon	*Acipenser medirostris*
grizzly bear	*Ursus arctos*
Guadalupe bass	*Micropterus treculii*
harbor seal	*Phoca vitulina*
headwater chub	*Gila nigra*
honey bee	*Apis mellifera*
hornyhead chub	*Nocomis biguttatus*
horseshoe crab	*Limulus polyphemus*
Hubbs' crayfish	*Cambarus hubbsi*
Humboldt marten	*Martes caurina humboldtensis*
humpback chub	*Gila cypha*
humpback whale	*Megaptera novaeangliae*

Common name	Scientific name
ʻIʻiwi	*Vestiaria coccinea*
Indiana bat	*Myotis sodalis*
Key Largo woodrat	*Neotoma floridana smalli*
king eider	*Somateria spectabilis*
Kirtland's warbler	*Setophaga kirtlandii*
lake sturgeon	*Acipenser fulvescens*
lake trout	*Salvelinus namaycush*
largemouth bass	*Micropterus salmoides*
Laysan albatross	*Phoebastria immutabilis*
Leach's storm-petrel	*Oceanodroma leucorhoa*
lesser prairie-chicken	*Tympanuchus pallidicinctus*
lesser scaup	*Aythya affinis*
light goose	*Chen* spp.
little brown bat	*Myotis lucifugus*
loggerhead sea turtle	*Caretta caretta*
longnose darter	*Percina nasuta*
Louisiana waterthrush	*Parkesia motacilla*
lowbush blueberry	*Vaccinium angustifolium*
Lower Keys marsh rabbit	*Sylvilagus palustris hefneri*
Mammoth Spring crayfish	*Orconectes marchandi*
marten	*Martes americana*
massasauga	*Sistrurus catenatus*
mink	*Neovison vison*
monarch butterfly	*Danaus plexippus*
moose	*Alces alces*
mottled sculpin	*Cottus bairdii*
mountain lion	*Puma concolor*
mountain sucker	*Catostomus platyrhynchus*
mountain whitefish	*Prosopium williamsoni*
mountain yellow-legged frog	*Rana muscosa*
mule deer	*Odocoileus hemionus*
muskellunge	*Esox masquinongy*
Neosho madtom	*Noturus placidus*
New Zealand mudsnail	*Potamopyrgus antipodarum*
Niangua darter	*Etheostoma nianguae*
northern bobwhite	*Colinus virginianus*
northern Idaho ground squirrel	*Urocitellus brunneus*
northern leopard frog	*Lithobates pipiens*
northern long-eared bat	*Myotis septentrionalis*
northern pike	*Esox lucius*
northern red-bellied cooter	*Pseudemys rubriventris*

List of Species—Continued

Common name	Scientific name
northern redbelly dace	*Chrosomus eos*
northern spotted owl	*Strix occidentalis caurina*
Pacific golden-plover	*Pluvialis fulva*
pallid sturgeon	*Scaphirhynchus albus*
pearl dace	*Margariscus margarita*
pigeon guillemot	*Cepphus columba*
pink mucket	*Lampsilis abrupta*
pink salmon	*Oncorhynchus gorbuscha*
plains topminnow	*Fundulus sciadicus*
Poweshiek skipperling	*Oarisma poweshiek*
prairie dog	*Cynomys* spp.
Puerto Rican crested toad	*Peltophryne lemur*
purple cat's paw pearlymussel	*Epioblasma obliquata obliquata*
quagga mussel	*Dreissena bugensis*
rainbow or steelhead trout	*Oncorhynchus mykiss*
razorback sucker	*Xyrauchen texanus*
red knot	*Calidris canutus*
red-spotted newt	*Notophthalmus viridescens viridescens*
red squirrel	*Tamiasciurus hudsonicus*
Redwood Creek coho salmon	*Oncorhynchus kisutch*
regal fritillary	*Speyeria idalia*
ringed crayfish	*Orconectes neglectus*
ring-necked pheasant	*Phasianus colchicus*
Rio Grande blue sucker	*Cycleptus elongatus*
Rio Grande cutthroat trout	*Oncorhynchus clarki virginalis*
river herring	*Alosa* spp.
river otter	*Lontra canadensis*
Roanoke logperch	*Percina rex*
robust redhorse	*Moxostoma robustum*
Rocky Mountain elk	*Cervus canadensis nelsoni*
roundtail chub	*Gila robusta*
sagebrush sparrow	*Artemisiospiza nevadensis*
sage thrasher	*Oreoscoptes montanus*
sandhill crane	*Grus canadensis*
sand shinnery oak	*Quercus havardii*
San Joaquin antelope squirrel	*Ammospermophilus nelsoni*
San Joaquin kit fox	*Vulpes macrotis*
sarcoptic mange	*Sarcoptes scabiei*
scaled quail	*Callipepla squamata*
sea lamprey	*Petromyzon marinus*

Common name	Scientific name
semipalmated sandpiper	*Calidris pusilla*
sharp-shinned hawk	*Accipiter striatus venator*
Shiras moose	*Alces alces shirasi*
shoal bass	*Micropterus cataractae*
shorthead redhorse	*Moxostoma macrolepidotum*
shovelnose sturgeon	*Scaphirhynchus platorynchus*
sicklefin redhorse	*Moxostoma* sp.
silver carp	*Hypophthalmichthys molitrix*
smallmouth bass	*Micropterus dolomieu*
Smith's longspur	*Calcarius pictus*
Snake River cutthroat trout	*Oncorhynchus clarkii behnkei*
snow goose	*Chen caerulescens*
snowshoe hare	*Lepus americanus*
snowy plover	*Charadrius nivosus*
snuffbox	*Epioblasma triquetra*
sockeye or kokanee salmon	*Oncorhynchus nerka*
Sonoran desert tortoise	*Gopherus morafkai*
sora	*Porzana carolina*
southern flounder	*Paralichthys lethostigma*
southern hognose snake	*Heterodon simus*
speckled dace	*Rhinichthys osculus*
spectacled bear	*Tremarctos ornatus*
spectacled eider	*Somateria fischeri*
spotted bass	*Micropterus punctulatus*
spruce-fir moss spider	*Microhexura montivaga*
Steller sea lion	*Eumetopias jubatus*
Steller's eider	*Polysticta stelleri*
stonecat	*Noturus flavus*
Stone's sheep	*Ovis dalli stonei*
striped bass	*Morone saxatilis*
striped newt	*Notophthalmus perstriatus*
Swainson's hawk	*Buteo swainsoni*
swift fox	*Vulpes velox*
sylvatic plague (bacterium)	*Yersinia pestis*
tidewater goby	*Eucyclogobius newberryi*
timber rattlesnake	*Crotalus horridus*
Topeka shiner	*Notropis topeka*
Townsend's big-eared bat	*Corynorhinus townsendii*
tree frog	*Eleutherodactylus coqui*
tri-colored bat	*Perimyotis subflavus*
Virginia rail	*Rallus limicola*

List of Species—Continued

Common name	Scientific name
walleye	*Sander vitreus*
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*
white sturgeon	*Acipenser transmontanus*
white sucker	*Catostomus commersonii*
white-tailed deer	*Odocoileus virginianus*
whooping crane	*Grus americana*
wild turkey	*Meleagris gallopavo*
wolf or gray wolf	*Canis lupus*
wolverine	*Gulo gulo*
wood frog	*Lithobates sylvaticus*
wood turtle	*Glyptemys insculpta*
yellow-billed loon	*Gavia adamsii*
yellow perch	*Perca flavescens*
Yellowstone cutthroat trout	*Oncorhynchus clarkii bouvieri*
yellow tang	*Zebrasoma flavescens*
Yuma Ridgway's rail	*Rallus obsoletus yumanensis*
zebra mussel	*Dreissena polymorpha*

Pictured above: Desert bighorn sheep.

Contact Information for Cooperative Fish and Wildlife Research Units

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Arkansas Cooperative Fish and Wildlife Research Unit	GS-B-CoopunitAR@usgs.gov	(479) 575–6709
California Cooperative Fish and Wildlife Research Unit	GS-B-CoopunitCA@usgs.gov	(707) 826–3268
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Pictured below:
American bison.

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