Center for Ecology and Conservation Research

Engaged in innovative wildlife science around the globe…expertise in safe capture techniques, sample collection, wildlife tagging, surveys, monitoring… wildlife veterinary services…laboratory analysis… applying innovative analytical methods: tracking technologies, geospatial analytics, advanced data science, ecological modeling…stretching boundaries of scientific inquiry…conduit for knowledge synthesis… translating science to inform decision making process…

bri

Biodiversity Research Institute

innovative wildlife science

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BRI Publications
This icon refers to a BRI publication.
More information can be found on page 36.

MISSION OF BIODIVERSITY RESEARCH INSTITUTE

Biodiversity Research Institute (BRI), headquartered in Portland, Maine, is a nonprofit 501(c)3 ecological research group whose mission is to assess emerging threats to wildlife and ecosystems through collaborative research, and to use scientific findings to advance environmental awareness and inform decision makers.

BRI EXECUTIVE DIRECTOR

David C. Evers, Ph.D., *BRI Founder, Executive Director, and Chief Scientist*
Since 1984, Dr. Evers has specialized in the research and conservation of birds with a particular emphasis on environmental mercury contamination. His current work includes overseeing the first ever loon restoration project. He also serves as a principal science advisor for the Minamata Convention on Mercury and works on projects with governments in more than 40 countries for the United Nations. He has raised more than $70 million for nearly 400 grants, has published more than 115 peer-reviewed papers and six books, and has given more than 240 professional presentations.

CENTER CO-DIRECTORS

Iain J. Stenhouse, Ph.D., *Senior Science Director, Director Marine Bird/Arctic Programs*
Dr. Stenhouse is an avian ecologist with more than 25 years of experience working in marine and Arctic ecosystems. As director of BRI's Marine Bird Program, he has worked to identify data gaps and fill research needs, particularly in the northeastern United States. He has also coordinated elements of BRI's baseline ecological studies in the mid-Atlantic region, including the review of high resolution digital aerial surveys. His recent work in marine ecosystems has largely focused on tracking long-distance migrations and on the identification of important areas of marine biodiversity.

Wing Goodale, Ph.D. Candidate, *Senior Deputy Director*
Wing Goodale earned a B.A. in biology from Colorado College, an M.Phil. in human ecology from College of the Atlantic, and is a Ph.D. candidate in environmental conservation at the University of Massachusetts. He is a National Science Foundation IGERT fellow in the University of Massachusetts Offshore Wind Energy Program. He has worked at BRI since 2000. He has served on municipal committees, environmental nonprofit boards, professional boards, and college boards, including the governor-appointed Maine Board of Environmental Protection.

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www.briloon.org

Contents

innovative wildlife science

Ecological studies aim to understand the interactions between wildlife and their habitats. Conservation research explores how ecological stressors (chemical, biological, and physical) affect different species and ecosystems. Scientists and educators at BRI's Center for Ecology and Conservation Research work across the globe to conduct innovative wildlife studies that help us understand the intricacies of these ecosystems. A vital aspect of our work is to share what we learn with those who determine how best to manage and protect our natural resources.

BRI'S MISSION—In 1989, BRI founder David Evers, then a graduate student, discovered a reliable and replicable way to capture loons. That singular event opened opportunities for wildlife biologists to conduct demographic, behavioral, and contaminant studies on the iconic bird Sigurd Olsen described as a symbol of wildness. Knowledge gained that summer served as the basis for BRI's mission—to conduct scientific investigations to better understand ecological health through the lens of animals. If the air, water, and landscape are healthy, wildlife and humans share in that vitality.

CENTERS OF RESEARCH—Over the years, BRI's research capabilities have grown in response to pressing ecological issues, from the ability to study the natural history of loons to the development of new technologies that enable researchers to predict risks due to climate change and human development. The Institute has evolved into three Centers:

- Center for Mercury Studies
- Center for Loon Conservation
- Center for Ecology and Conservation Research

Our biologists demonstrate a breadth of expertise in researching and monitoring wildlife at a range of geographic scales to address complex research questions. We collect data on all aspects of the ecosystem, from environmental covariates to invertebrates to apex predators. We manage ecological data, conduct geospatial analysis, and develop ecological models.

BRI researcher Iain Stenhouse and collaborators study the migration of birds that breed in Denali National Park, Alaska.

RESEARCH PROGRAMS—Within the Center for Ecology and Conservation Research, BRI manages the following research programs:

Taxonomic

- Mammal Program
- Marine Bird Program
- Raptor Program
- Songbird Program
- Waterfowl Program

Ecosystems

- Arctic Program
- Tropical Program
- Wetlands Program

Environmental Issues

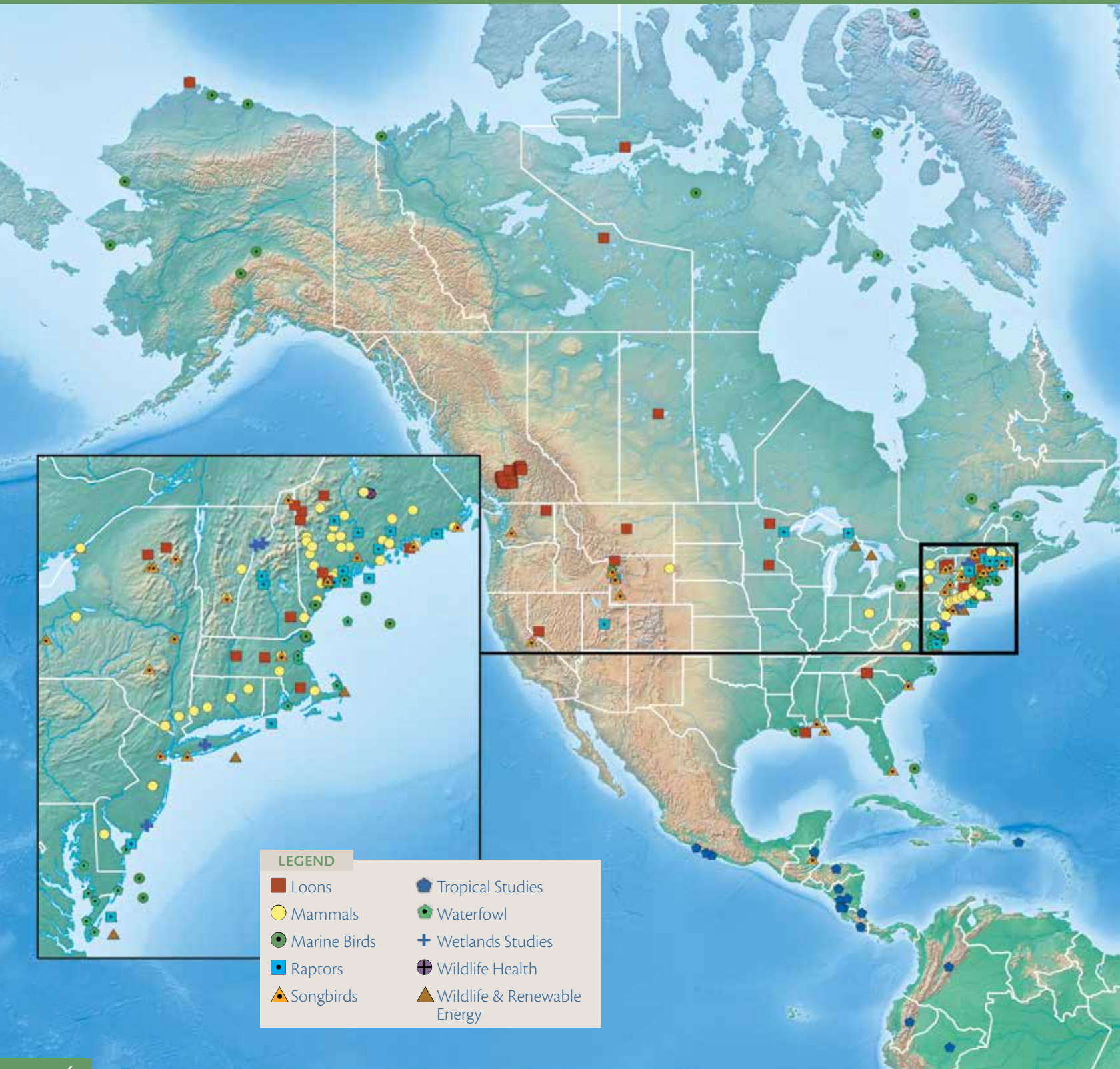
- Wildlife Health Program
- Wildlife and Renewable Energy Program

GSA-CERTIFIED SCIENTIFIC SERVICES

Organized by our research capabilities, this booklet highlights the following expertise, which is covered by BRI's GSA certification for services:

- Capture, sampling and banding of fish, birds, bats, and other mammals
- Natural Resource Damage Assessment (NRDA) studies
- Assessing distribution and potential impacts of contaminants in ecosystems and populations
- Telemetry deployment/monitoring/analysis
- Visual and acoustic bird and bat surveys
- Rare/endangered species inventories
- Wildlife health assessments and laboratory analysis
- Migration and movement pattern analysis
- Natural resource planning
- Habitat modeling and conservation plans
- Ecological modeling
- Population productivity and survival estimates
- Data consolidation and synthesis

For GSA details, see inside back cover.


LEGEND
Loons
Mammals
Marine Birds
Raptors
Songbirds
Tropical Studies
Waterfowl
Wetlands Studies
Wildlife Health
Wildlife & Renewable Energy

studies in the americas

BRI conducts research around the world—at any given time, our researchers are involved in about 200 active projects. Many of our projects rely on the collection of environmental data using standard protocols. We then present our findings in technical reports, in peer-reviewed manuscripts, or at professional conferences.

In North America and parts of Latin America, we participate in ongoing research and conservation. Investigations encompass ecosystems from the Arctic tundra to the tropical rainforest, and from oceanic communities to freshwater lakes and rivers. Examples of our diverse studies include:

- Understanding patterns of mercury exposure in shorebirds and loons across the Arctic;
- Determining the use of marine ecosystems by wildlife within potential wind power centers;
- Assisting governments in monitoring and managing mercury in the tropics;
- Identifying habitat use by rare species, such as the northern long-eared and Indiana bats.

In the northeastern United States, the demand for energy at major urban centers necessitates environmentally appropriate responses by governmental regulators. With increasing interest in both existing renewable energy sources (e.g., hydropower and terrestrial wind power) and emerging technologies (e.g., solar power and marine wind power), BRI scientists can help fill critical information gaps (see page 34). Our goal is to gather specific information that regulators, policymakers, and landscape managers need to make informed decisions.

BRI'S GLOBAL STUDIES—These studies emphasize mercury assessment and active monitoring in more than 40 countries.

Learn more in BRI's publication *Center for Mercury Studies.* www.briloon.org/mercury

RESEARCH IN TROPICAL ECOSYSTEMS

BRI biologists have extensive experience in the tropical ecosystems of Central America, the Caribbean Islands, and into parts of South America. Our Tropical Program conducts ecosystem integrity-related field investigations, specializing in addressing mercury issues in Belize, Colombia, Costa Rica, Ecuador, Honduras, Nicaragua, and Puerto Rico.

In cooperation with the United Nations Environment Programme, BRI also assists select countries that are working to meet the obligations of the Minamata Convention on Mercury, including:

- Developing national mercury profiles in Guatemala and the Caribbean Islands;
- Creating training videos with the U.S. State Department to help artisanal small-scale gold miners minimize their exposure to mercury in Colombia, Ecuador, and nearby countries;
- Generating a mercury biomonitoring program for Latin American with an emphasis in Peru;
- Identifying and reducing mercury in a chlor-alkali facility closure in Mexico;
- Forming a network of fish- and bird-sampling sites with local partners to track mercury levels across Central America.

data science

BRI's reputation and integrity are founded on the quality of our work. Throughout every stage of the scientific process—from data collection, to analysis, interpretation, and dissemination—we follow strict protocols and adhere to best practices to provide decision makers with the most accurate information.

Data Collection

In the Field

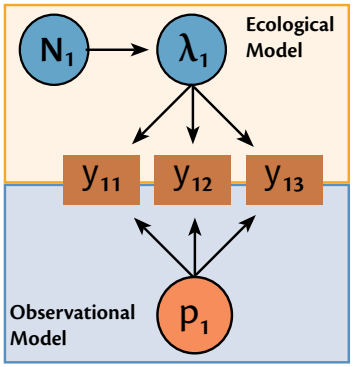
In the Lab

Retrieval from Telemetry

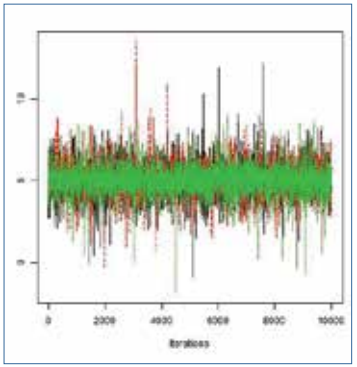
Protocol Development
(see sidebar page 29).

Data Analysis

Develop Models



Test Hypotheses

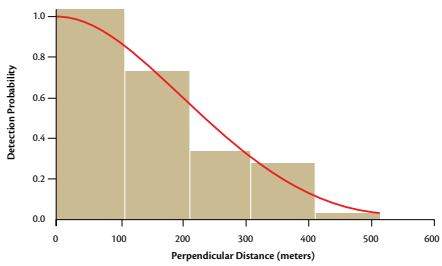


Data Processing and Data Management

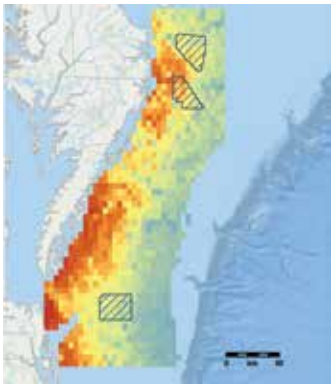
BRI experts achieve the highest quality in data preparation and standardization, ensuring quality control of its data processing and management. We have the expertise to perform the following:

- Automate data management processes using custom Python and R scripts
- Retrieve, automate, filter, and analyze Argos satellite telemetry data
- Manage audio and video data
- Design, develop, and maintain ecological databases, including geospatial databases in PostgreSQL, R, and ArcGIS
- Store and back up very large databases

Model Outputs

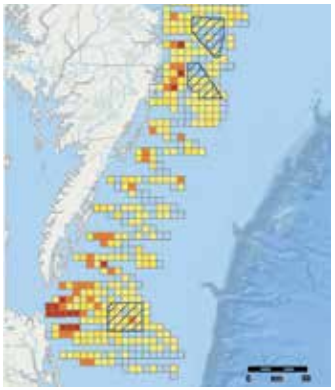


Assess Biases

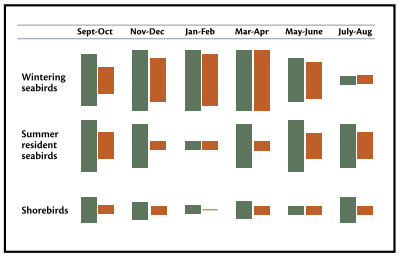


Make Predictions

Data Visualization

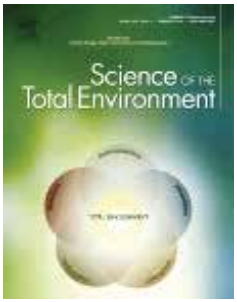


Maps



Graphs

Published Results



Scientific Journals

Science Communications

We present critical information in ways that industry leaders and policymakers can understand and use for successful solutions to environmental issues (see pages 32-33).

capture techniques

Much of BRI's research depends upon working hands-on with wildlife in the field. We capture and handle wildlife for a variety of scientific purposes: to collect blood and tissue samples for toxicology assessment; to apply bands and tracking equipment; and to study behavior, population trends, and movements.

BRI is well versed in the humane capture, handling, and safe release of a broad range of wildlife species including (but not limited to): an extensive array of birds, from warblers to eagles; bats, including species recently listed as threatend or endangered; and furbearing mammals such as otter, mink, muskrat, and beaver.

ABOVE AND BEYOND—BRI biologists maintain strong adherence to protocols that ensure the welfare of the animals we study. Successful captures require ingenuity along with skill. In the field, often in remote locations and under harsh conditions, our biologists rely on a broad range of traditional capture techniques as well as develop new methods specific to the ecosystem or habitat of the study species.

The work of successful capture starts long before our biologists reach the field. The study of wild animals in natural settings, including captures, is controlled in many ways, necessitating a full understanding of the relevant rules and regulations. BRI maintains all state and federal permits necessary for handling wildlife (see page 21).

Photo opposite page: Skilled climbers, BRI biologists scale 70-90 foot trees to reach eagle nests. This page (clockwise from top left): Capturing juvenile Bald Eagles for banding and sampling; Sanderling in hand; Biologists rappel down a cliff ledge for adult Peregrine Falcon capture; Assessing a big brown bat; Capturing White-winged Scoters in floating mist nets.

The capture of an individual bird can provide a wealth of information.

Many types of tissues can be collected safely from birds in a cost-effective way. Different tissues can answer different questions. Blood provides a way to understand the exposure to contaminants in the short-term, while adult feathers indicate more long-term exposure. Analysis of eggs provides information about short- to long-term issues in individual females. In chicks, blood and feathers generally mirror similar outcomes.

sample collection

BRI specializes in the live capture and sampling of a broad range of taxa including invertebrates, fish, birds, and mammals. Sampling collection can vary according to the age and sex of the animal, the season, field conditions, and handling capabilities.

Sampling techniques are constantly improving and BRI biologists are at the forefront of developing novel methods for nonlethal capture. For example, to determine contaminant levels in fish, BRI biologists now regularly take muscle biopsies (shown here), and then release individuals back into the water.

The sampling of an individual can provide a wealth of information about contaminant exposure and health over the near-term (blood), mid-term (talon tips or webbing), and long-term (feathers or fur). For mammals such as river otter and mink, we can collect tooth samples to determine an individual's age.

Many ecological questions can also be answered by studying museum specimens. BRI's Wildlife Museum maintains a research and teaching collection of more than 300 specimens representing more than 100 species of birds. Specimens can provide valuable historical information, such as environmental levels of mercury. BRI's archives of more than 5,000 blood, egg, and feather samples, collected since 1995, can also help us understand temporal trends or background levels of contaminants and other stressors.

For more information about BRI's analytical capabilities using animal tissues, see pages 20-21.

BRI assesses the ecological impacts of mercury used at chlor-alkali plants in the U.S. for NRDA, and abroad for the Minamata Convention on Mercury (pictured: a plant in the Czech Republic).

ECONOMIZING NRDA IN THE U.S.

Over the past 16 years, BRI has partnered with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic Atmospheric Administration to quantify environmental damages caused by contaminants (mostly oil and mercury pollution). This process, known as Natural Resource Damage Assessment (NRDA), begins with an injury assessment. Then, a metric of animal-years-lost is quantified and assigned a monetary figure (i.e., economized). Funds procured from the responsible party are used to restore damaged habitats and resources. The NRDA program, which originated with the Oil Pollution Act of 1990, compensates the public for the loss of or damage to natural resources.

BRI NRDA Projects

2000-2010: North Cape Oil Spill, Rhode Island
2002-2004: Sudbury River, Massachusetts (began as a USEPA risk assessment study)
2005-2008: North Fork Holston River, Virginia
2006: B120 Oil Spill, Massachusetts
2007-2010: South River, Virginia
2008-2011: Penobscot River, Maine (a federal court-ordered study using NRDA assessment protocols)
2009-2010: Onondaga Lake, New York
2010-2012: Deepwater Horizon Oil Spill, Louisiana, Mississippi, and Alabama
2011-2012: Androscoggin River, New Hampshire (began as a USEPA risk assessment study)
2011: Piles Creek, New Jersey
2013-current: Pompton Lake, New Jersey

Learn more in BRI's publication *Center for Mercury Studies*

Colored leg bands are commonly used by researchers to identify individual birds from a distance in the field.

wildlife tagging

The successful management of many species relies on a sound understanding of their local and/or annual movements, and the timing of those movements. When do they arrive? How long do they stay? What habitats are most important? Where do they feed? Where do they raise their young? When do they leave? Where do they go? Answering these types of questions can help to define the potential exposure of a species to specific environmental stressors, identify ways to improve their reproductive success and survival, or indicate how best to monitor them.

COLOR MARKING—This method uses colored tags that allow researchers to identify individual animals from a distance in the field, without the need to recapture them. For example, durable plastic color bands can be used in unique combinations, or metal bands can be engraved with numbers or letters to identify specific birds.

Colar marking is ideal for species such as loons, which are large, long-lived birds that use open habitats and return to similar breeding and wintering areas each year.

NANOTAGS TO SAT TAGS—With advances in computer miniaturization, tracking wildlife has become considerably more high tech in recent years. BRI utilizes a variety of methods—radio transmitters, nanotags, geolocators, cellular tracking technologies, GPS tags, and satellite transmitters—that can remotely log locations, behavior, and other environmental information, which is then retrieved by researchers in various ways (see page 22).

Common Loon with unique combination of color bands. Inset: Willet being fitted with a geolocator attached to a plastic leg band. For all birds, standard metal bands, which are uniquely numbered, are used, under federal and state permits.

EXPERTISE WITH BATS

Representing the most diverse group in the animal kingdom, more than 1,300 species of bats worldwide provide vital environmental and economic services including pollination, seed dispersal, and pest control. Conducting bat surveys allows us to monitor populations and examine how species respond to environmental stressors such as habitat loss, contaminants, and disease.

Bat surveys are a critical tool in helping identify and monitor threats to at-risk species such as the Indiana and northern long-eared bats (pictured right). Our Mammal Program includes federally permitted biologists and Qualified Indiana Bat Surveyors.

In the face of rapid declines in bat populations, BRI biologists are working to fill critical gaps in our knowledge about bat ecology. For the past eight years, we have been studying bats in Maine's Acadia National Park using radio telemetry and aerial surveys. Monitoring bats over time gives us a better understanding of their foraging habits, roost behavior, migratory paths, and overall health.

surveys and monitoring

Using a variety of survey and monitoring techniques, BRI researchers assess wildlife health issues, estimate population sizes or trends, describe distributions, and identify responses to climate change. From the Arctic to the Tropics, successful surveys and monitoring projects are founded on a careful selection of field methods to achieve project goals, and require an intimate knowledge of the biology and ecology of the focal species.

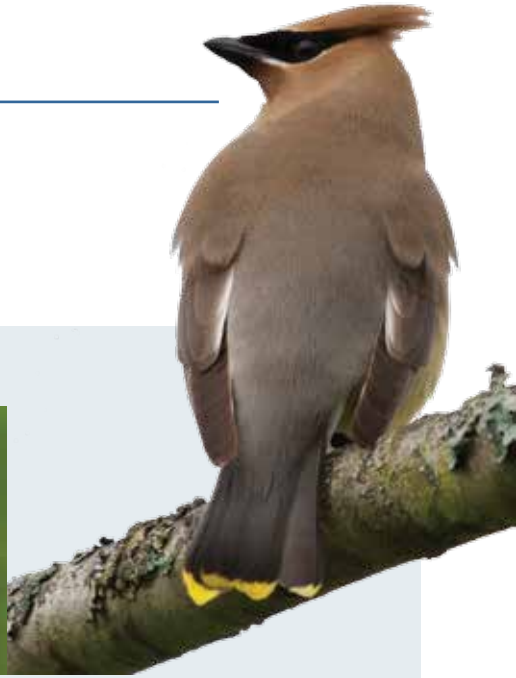
At BRI, we are highly skilled in the use of a broad range of surveillance methods—from traditional population counts to innovative high-tech remote sensing techniques—to survey and monitor wildlife in a variety of ecosystems.

From decades of experience, we also know that the implementation of successful surveys and monitoring projects relies on clear research objectives, based on a thorough understanding of the issues and exactly how data will be used to inform decision making and ecosystem management.

Surveying and monitoring wildlife often requires canvassing large areas from a plane, rappelling down a frozen waterfall to reach a cave where bats hibernate, or carrying a canoe for miles to remote lakes where loons breed. BRI biologists are well trained to handle all field conditions.

CASE STUDY: RIVER POINT BIRD OBSERVATORY



Top: (L to R): Veery, Gray Catbird, Tree Swallow, Cedar Waxwing. Bottom left: BRI biologist removes a Canada Warbler from a mist net. Right: Studying wing molt patterns in a Northern Flicker.

Migratory connectivity—the links between northern breeding sites and southern nonbreeding areas—is a critical component to understanding how environmental threats affect migratory songbird populations.

BRI's River Point Bird Observatory has become a valuable resource for interns, graduate students, educators, collaborating biologists, and visiting scientists in the development of new research studies on migratory birds. In addition to banding, we document bird observations using eBird.

Our research focuses on various aspects of the health, behavior, and life history of bird populations through capture, marking, and monitoring studies.

Ongoing songbird studies include:

- Migratory and breeding monitoring
- Disease monitoring
- Contaminant exposure
- Tracking individuals

For more information, visit:
www.briloon.org/riverpoint

Our bird observatory at River Point is a place where the community at large can observe science in action.

fully equipped in the field

BRI is the agent for the Association of Field Ornithologists' (AFO's) supply company Avian Research Supplies. We are pleased to be able to provide this important service to field researchers. This business is run by ornithologists for ornithologists. We provide the highest quality mist nets and bird banding tools and supplies that we ourselves use in the field.

As partners, AFO and BRI are mutually committed to supporting the next generation of researchers and conservationists through training opportunities and workshops focused on developing field skills and knowledge.

To order supplies from our online catalog, visit:

www.avianresearchsupplies.org

Proceeds support research grants for students, amateurs, and Latin American researchers.

Photos on this page were taken at Un poco del Chocó Reserve in Ecuador by field researchers who use our equipment. Clockwise from top: Researchers extract a Pale-mandibled Arassari from mist net; Banding a female Immaculate Antbird; Color-banded Orange-billed Sparrow; Measuring the wing of a Broad-billed Motmot. Right: Extracting shorebirds from mist nets in New England.


A·R·S
Avian Research Supplies

BRI's veterinary team maintains animal welfare as a top priority, following IACUC-approved protocols. Above: A Common Eider following implantation of a satellite tag.

wildlife health

Assessing and managing the health of wildlife requires a multidisciplinary effort between veterinarians, biologists, ecologists, and other professionals in order to understand the many social and environmental changes that simultaneously affect a population.

CRITICAL CONNECTIONS—BRI's wildlife veterinarians operate at the interface of wildlife, human, and ecological health to study the effects of global environmental change on these health interrelationships.

Our Wildlife Health Program provides veterinary support and expertise for the many taxonomic and ecological research programs at BRI. This strong collaboration between veterinarians and biologists provides a unique understanding of the species we study.

Through BRI's many research partners, the Wildlife Health Program also provides veterinary services to governmental and nongovernmental organizations (NGOs), universities, and research facilities throughout the country.

MOBILE VETERINARY SERVICES—We offer mobile surgical and anesthesia services for procedures such as internal transmitter implantation in avian and mammalian species. Our veterinarians specialize in surgical implantation of satellite transmitters in a variety of avian species, including: Common Eiders, Common Loons, Long-tailed Ducks, Northern Gannets, Red-throated Loons, Surf Scoters, and White-winged Scoters.

Fully equipped to offer the highest standard of veterinary care, our mobile surgical capabilities include gas anesthesia, respiratory and cardiac monitoring, sterile technique, and comprehensive pain management. BRI's wildlife

Northern Gannets are powerful birds that require skilled and careful handling.

veterinarians have extensive field experience working in a variety of locations across the United States and abroad.

BRI's wildlife veterinarians can assist researchers on site, and are also available for remote consultation. Our field services include:

- Safe and humane capture and handling of wildlife
- Chemical immobilization of wildlife (Safe-Capture International, Inc., certified)
- Obtaining blood and other tissue samples
- Best practices for sample handling and storage
- Health assessment of captured animals
- Veterinary oversight for translocation and captive rearing projects
- Training for field staff
- Field necropsy

LOON HEALTH STUDIES

In response to ongoing and emerging health threats to loons, BRI initiated a continent-wide Common Loon health assessment study. This large-scale study is the most comprehensive loon health survey ever conducted, focusing on loons from key regions across North America: New England, New York, Minnesota, Wyoming, Montana, Washington, British Columbia, and Saskatchewan.

In collaboration with researchers across the continent, we are examining a wide range of health parameters to provide insight into the health status of individual loons that may be affected by various diseases or environmental conditions. BRI's veterinarians are also working with the University of Miami Avian and Wildlife Laboratory to develop advanced diagnostic techniques to quantify exposure and infection rates of *Aspergillus* in Common Loons.

Studying health and disease in wild avian species is vital to public health because birds can carry many zoonotic diseases (those transmitted between animals and humans). Climate change and growing human–wildlife interaction will continue to increase the occurrence of these pathogens in wildlife, and therefore increase the risk of transmission to humans. In collaboration with infectious disease experts in human and wildlife health, BRI will monitor loon exposure to these zoonotic diseases, and help evaluate emerging risks to public health.

Learn more in BRI's publication *Conserve the Call: Identifying and Managing Environmental Threats to the Common Loon*

laboratory analysis

BRI operates two research laboratories in its Maine headquarters: the Wildlife Health and Pathology Lab and the Wildlife Toxicology Lab.

WILDLIFE HEALTH AND PATHOLOGY LAB—This lab includes our in-house necropsy facility for post-mortem examination of wildlife, and enables in-house processing of samples for routine health evaluation such as hematology and parasite examination.

Necropsies are critical for identifying causes of mortality and collecting tissue samples for further toxicological and disease testing. Vital information gained through necropsy examination can help guide conservation efforts, disease surveillance, and future research.

BRI's Wildlife Health Program also offers necropsy services for other organizations. Our veterinarians can provide on-site necropsy of larger species as well as training for biologists. By partnering with board-certified veterinary pathologists at collaborating institutions, we are able to expand our diagnostic capabilities for high-priority cases.

Necropsies are critical for identifying causes of mortality and collecting tissue samples for further toxicological and disease testing.

BRI veterinarians perform a necropsy on a Common Loon. Our pathology lab cabilities also include wildlife health evaluations and Biosafety Level 2 certification.

RESEARCH LAB COLLABORATORS

In addition to its own laboratory capabilities, BRI has established relationships with distinguished labs around the country for specialty work, including:

- Boston University
- Buffalo State University
- Centers for Disease Control and Prevention
- Dartmouth College
- Harvard University
- Maine Medical Center–Research Institute Vector-borne Disease Laboratory
- Massachusetts Institute of Technology–Runstadler Laboratory
- Smithsonian Conservation Biology Institute
- Texas A&M University
- Tufts University–Cummings School of Veterinary Medicine
- United States Geological Survey
- University of Connecticut–Center for Environmental Sciences & Engineering
- University of Florida
- University of Miami–Avian and Wildlife Laboratory
- University of New Hampshire–
  - Center for Freshwater Biology
  - Foster Laboratory
  - Veterinary Diagnostic Laboratory
- University of Southern Maine
- University of Vermont
- Wright State University

WILDLIFE TOXICOLOGY LAB—BRI's lab staff analyze tissue samples for total mercury and lead. Tissues such as feather, fur, blood, muscle, liver, talon tips, fish, and eggs are analyzed for total mercury using a Direct Mercury Analyzer. Whole blood and post-mortem body fluids are analyzed for lead using our LeadCare® II analyzer.

More than 4,000 samples are annually analyzed for total mercury each year. Samples regularly represent dozens of species of fish, birds, and mammals. Two recent global projects have included human hair samples representing more than 50 countries with approved protocols from an Institutional Review Board (IRB) at the University of Southern Maine.

Our toxicology laboratory capabilities include: total mercury determination (using a Direct Mercury Analyzer); lead ingestion and blood level determination (radiographic and blood analysis); tissue moisture determination (using a freeze dryer); and tissue homogenization (using a cryogrinder).

BRI WILDLIFE PERMITS

BRI holds nearly 100 separate state, federal, and special-use research permits for wildlife in 40 states and territories and seven Canadian provinces. We hold several specialized, difficult-to-obtain permits including those for: endangered bats; adult eagle capture and sampling; and educational, which includes mounts and museum specimens. BRI holds import permits for bird tissues (e.g., blood and feathers) from more than 40 countries. Federal permits include:

- Federal Bird Banding and Marking Permit (U. S. and Canada: #22636)
- U. S. Fish & Wildlife Service Migratory Bird Import and Export Permit (MB083478)
- U. S. Fish & Wildlife Service Native Endangered Species Recovery Permit (bats) (TE63633A)
- U. S. Fish & Wildlife Service Migratory Bird Scientific Collecting (MB830469)
- U. S. Fish & Wildlife Service Migratory Bird Special Purpose Possession for Educational Use (MB093989) — *includes Museum Specimens*
- U. S. Fish & Wildlife Service Eagle Scientific Collecting (MB215131)
- National Park Service Scientific Research and Collecting Permits for Acadia National Park, Grand Teton National Park, Yellowstone National Park
- USDA-APHIS Veterinary Permits for Importation and Transportation of Controlled Materials, Organisms, and Vectors

Member: Institutional Animal Care and Use Committee (IACUC) at the University of Southern Maine.

tracking technologies

The tracking tools available today—from small archival loggers, such as geolocators, to larger battery- or solar-powered transmitters, such as satellite transmitters—offer a broad spectrum of methods for tracking wildlife species with varying degrees of accuracy and on a range of ecological scales. The specific choice of technology depends on the size, habits, and range of the species under study, and the specific research questions of interest.

WHAT WE CAN LEARN—Tracking individuals details the local movements and seasonal migrations of wildlife, and often provides critical insights on animal behaviors that are rarely achievable using other methods. With this kind of information, BRI researchers can describe the phenology of movement, as well as identify migratory routes and connect specific breeding or wintering destinations. This knowledge can be valuable in defining important staging areas, or periods in the annual cycle during which, for example, a species may be most energetically vulnerable or least likely to interact with a specific environmental stressor.

Besides location, tracking technologies can also provide information about an individual's immediate environment, such as temperature or altitude, allowing the identification of ecological attributes of preferred habitats.

Important baseline information gained by tracking individuals includes: identifying important habitats within a species' full geographic range; the extent of home ranges of particular individuals; and hotspots of activity. This data can inform broad spatial planning exercises and permitting processes.

ON THE RADAR—In addition to tracking birds via attached devices, BRI uses radar and passive acoustics to track broad-scale offshore migratory movements and events during the night. As part of the Mid-Atlantic Baseline Studies Project, we used the NEXRAD weather surveillance radar system to document mass migratory activity over broad spatial scales, while strategically deployed acoustic sensors recorded the vocalizations of passing nocturnal migrants, allowing species to be identified.

Learn more in BRI's publications: *Mid-Atlantic Wildlife Studies* and *Raptor Research on Block Island*

PEREGRINE FALCON MIGRATION STUDIES

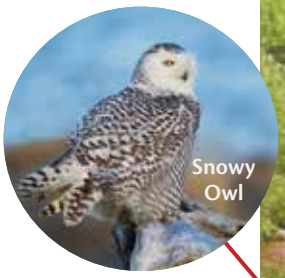
Peregrine Falcons are well known for their flight speeds and multiday, nonstop, over-water crossings. Although much about their ecology remains unknown, tracking technologies provide critical insights. In 2010, BRI began tracking migrant peregrines using satellite telemetry to: chart their migration routes along the Atlantic Flyway; link individuals using breeding, wintering and stopover areas; and evaluate the extent to which peregrines used areas identified for offshore wind energy facilities. These studies also revealed unexpected migration patterns that can help inform important conservation and management decisions.

HARLEQUIN DUCK MIGRATION STUDIES

In North America, the Harlequin Duck uses two distinct habitats for breeding and wintering. Over winter months, harlequins occupy rocky shorelines in northern reaches of the Pacific and Atlantic Oceans. In spring, they migrate to remote northern habitats, seeking pristine, rapidly flowing streams for breeding.

In 2016, BRI collaborated in a western North American Harlequin Duck migration study. We equipped breeding harlequins in Wyoming with satellite transmitters or geolocators. Collaborators also marked harlequins in Montana, Washington, and Alberta. Tracking data will detail movements of these ducks throughout their annual cycle, link important marine wintering areas to their interior breeding streams, and identify critical habitats.

Satellite Transmitters
Tag Size: Small-Large
Resolution: High
Tag Lifespan: 1+ years
Data: Macro scale
Data Access: Satellite network or remotely
Cost: High



Cellular Networks/ GSM Technology
Tag Size: Small-Medium
Resolution: Very High
Tag Lifespan: 1+ years
Data: Meso-Macro scale
Data Access: Cellular network or remotely
Cost: Med-High

Nanotags
Tag Size: Very Small
Resolution: Med-High
Tag Lifespan: Up to 1 year
Data: Meso-Macro scale
Data Access: Receiving towers
Cost: Low

Archival Loggers/ Geolocators
Tag Size: Small-Medium
Resolution: Low-High
Tag Lifespan: 1 year
Data: Meso-Macro scale
Data Access: On recapture
Cost: Medium

Radio Transmitters
Tag Size: Small
Resolution: Med-High
Tag Lifespan: Up to 1 year
Data: Micro-Macro scale
Data Access: Manually in field
Cost: Low

GPS Loggers
Tag Size: Small-Medium
Resolution: Very High
Tag Lifespant: 1 year
Data: Micro-Macro scale
Data Access: On recapture
Cost: High

Depending on the tracking device deployed, different taxa can be tracked across the landscape at a range of scales, from local movements (micro scale) to trans-global migrations (macro scale). Choosing the right tracking device for a specific research project requires careful consideration of a number of factors, including species size, resolution, and the temporal and spatial scale of the data required, as well as overall costs involved.

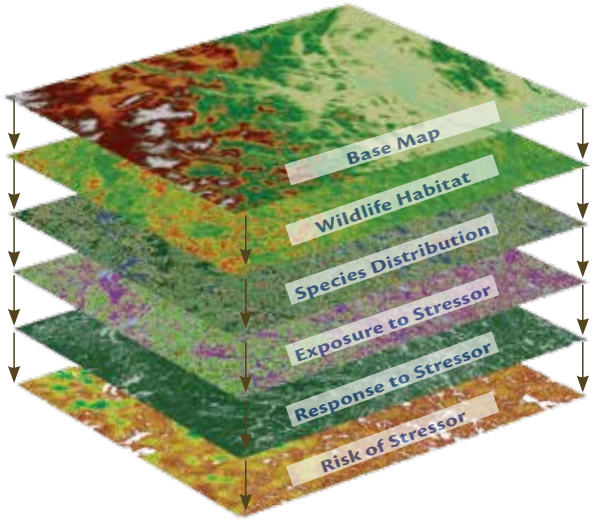
geospatial analytics

Geospatial analytics provides a unique lens through which we can examine complex ecological events, patterns, processes, and anthropogenic stressors. Adding the context of location makes it possible to recognize spatial relationships—distance, direction, proximity, connectivity, and dependence—that would otherwise be missed with traditional analytics.

Analyzing data spatially improves scientific insights by accounting for both time and space, allowing ecologists and decision makers to: 1) see patterns and trends in a recognizable geographic context, so they are clearer to understand and act upon; 2) anticipate and prepare for possible changes due to changing spatial conditions or location-based events; and 3) develop wildlife management solutions that require different responses in different locations.

Ultimately, geospatial analysis makes use of geographic information that links ecological features and phenomena to their locations. BRI scientists use geo-referenced data and spatial analytics to build maps, graphs, and models that make complex ecological relationships more understandable. For example:

- BRI scientists develop models of animal movements and migratory behavior for a variety of waterfowl, seabird, raptor, shorebird, and songbird species using spatially explicit tools such as Brownian bridge movement models, behavioral change point analysis, state-space modeling, and passive RADAR (see page 22).
- BRI scientists use spatial information to examine space use, habitat selection, and home range for a variety of waterfowl, seabird, songbird, and bat species.
- BRI develops spatially explicit models of the distribution, abundance, and movements of terrestrial and marine wildlife to inform decision makers about potential conflicts with rapidly developing renewable energy technologies. For example, our work on the Mid-Atlantic Baseline Studies Project (see page 27).
- BRI scientists model and map risk exposure of wildlife to a variety of potential stressors, including contaminants such as mercury pollution and oil spills. An example of this type of mapping includes our work in the Gulf of Mexico after the *Deepwater Horizon* oil spill (see sidebar and maps at right).



Using an approach that combines spatial information on the distribution of habitats and species with the extent and severity of stressors (as illustrated above), BRI scientists can measure the wildlife response and risk exposure to environmental threats. These data can be mapped to specific locations to better inform natural resource managers, regulators, and other decision makers.

THE POWER OF MAPPING

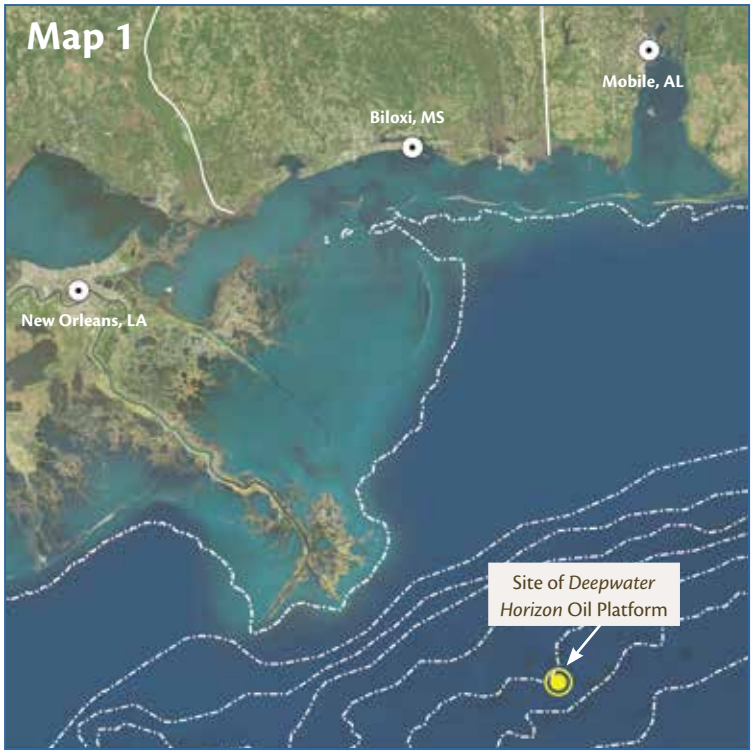
From May 2010 to April 2011, BRI worked with the USFWS and other Natural Resource Damage Assessment and Restoration Trustees on the *Deepwater Horizon* oil spill to assess the external oiling of coastal bird species in the Gulf of Mexico following the spill.

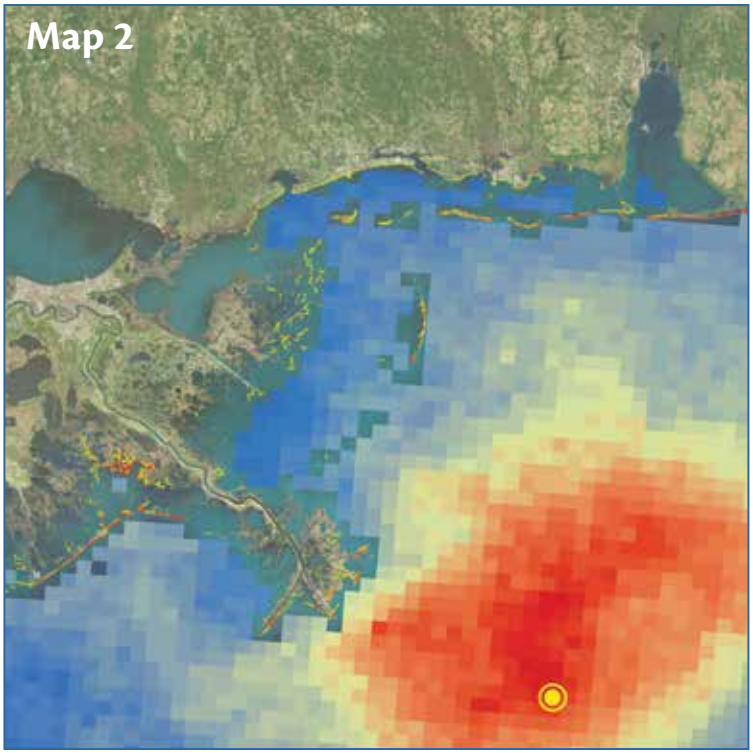
Map 1 depicts the region of concern, bathymetry, and the *Deepwater Horizon* platform where the oil spill originated.

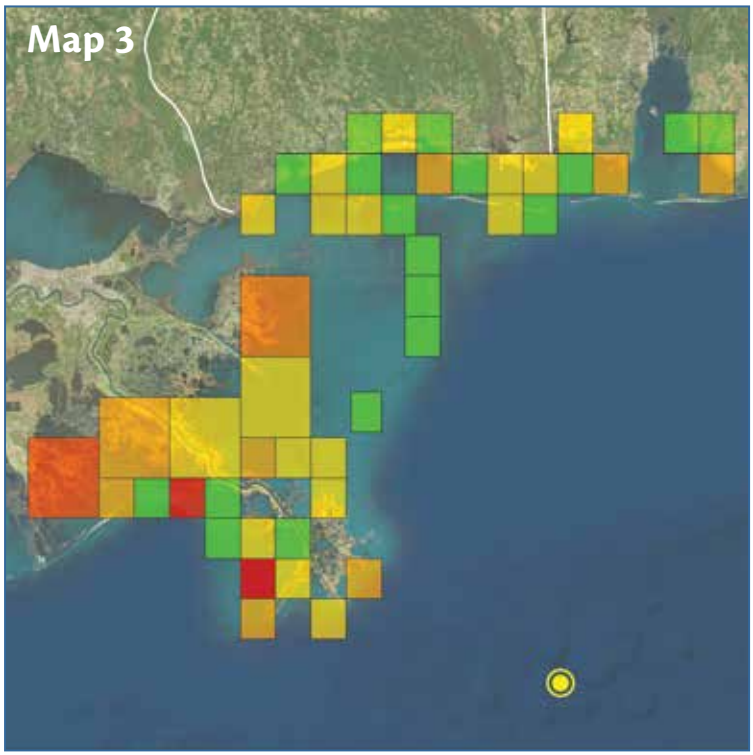
Map 2 shows the magnitude and extent of oiling in the water (red indicates high oiling; yellow indicates lower) and on shore (red indicates high oiling; green indicates lower).

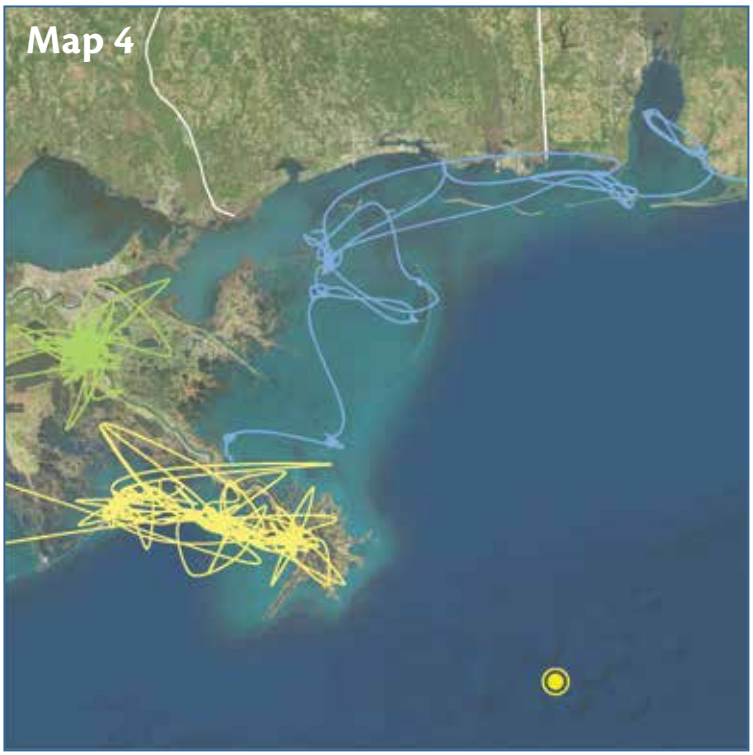
Map 3 demonstrates the oiling rates of all birds, as categorized in survey grids (red indicates high oiling; yellow indicates lower; green indicates no oiling detected).

Map 4 demonstrates results from satellite tracking and monitoring of several target species, with examples of an individual Brown Pelican (blue line), Great Egret (green), and Black Skimmer (yellow) mapped here.


Map 1
Mobile, AL
Biloxi, MS
New Orleans, LA
Site of *Deepwater Horizon* Oil Platform


Map 2


Map 3


Map 4

innovative project design and data analysis

Since 1966, the eastern population of the Painted Bunting has experienced a 3.2 percent decline per year. BRI is working with the Painted Bunting Observer Team to better understand the likely factors behind this decline, such as breeding habitat loss.

Ecology has grown from a descriptive field intent on identifying species and observing behaviors into a quantitative discipline focused on testing hypotheses and measuring effects.

Many of BRI's projects require sophisticated analytical tools and integrated methods to answer complex questions that would be impossible to address with any single method. We have consciously cultivated the expertise and resources needed to develop innovative study designs, achieve more precise analysis, and maintain objective and informative interpretation.

QUANTITATIVE ECOLOGY—Ecology has grown from a descriptive field intent on identifying species and observing behaviors into a quantitative discipline focused on testing hypotheses and measuring effects. BRI researchers apply statistical principles and tools to address pressing ecological issues.

Astute observation retains an important role in contemporary ecology. Advancing technology and its applications, however, have transformed how we perceive the natural world and how we interpret and evaluate our observations. We also know our observations are often incomplete; quantitative ecology fills in the gaps.

MODELING APPLICATIONS—BRI researchers investigate the reasons why species are in decline by sifting through complex and often interlinked causes. Painted Bunting populations, for example, have been decreasing in the eastern United States. By examining a number of variables, we can build ecological models that help us determine where and why adult buntings are disappearing.

For our work on the Mid-Atlantic Baseline Studies Project (see sidebar page 27), we used a variety of analytical methods, which provided a more complete understanding of the ecology of a particular area than any one method could offer. Aerial surveys were more useful to detect animals immediately below the water's surface, while boat surveys proved to be a better method to identify birds to species. We employed both techniques in combination and developed new analytical methods to merge data sets to understand the ecosystem in the most complete way possible.

MID-ATLANTIC BASELINE STUDIES

Beginning in 2012, BRI led a three-year, multi-state collaborative project that fills significant ecological data gaps on bird, marine mammal, and sea turtle distributions and movements from Delaware to Virginia.

The results of this study, one of the largest of its kind ever conducted, help improve our understanding of species composition and use of the mid-Atlantic marine environment, critical information that will help inform sustainable offshore development in the mid-Atlantic United States.

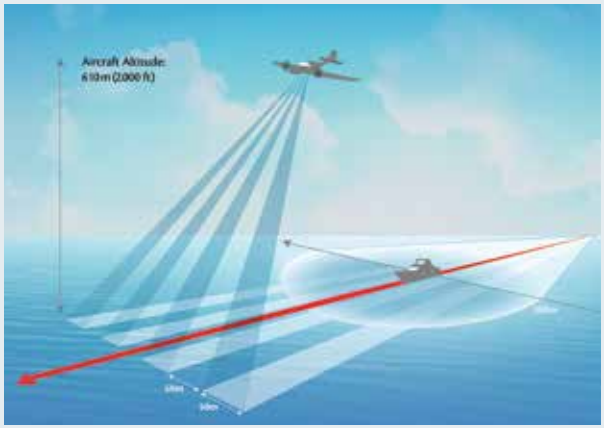
Funded by the U.S. Department of Energy's Wind and Water Power Technologies Office, with additional support from a wide range of partners, the Mid-Atlantic Baseline Studies Project represents an extensive collaborative effort between federal and state agencies, universities, nonprofits, and private industry.

Significance of this Study

We now have baseline data that will become the foundation for well-informed management decisions.

These data are the basis for statistical models developed by the project team to help understand the drivers of wildlife distribution patterns and to predict the environmental conditions likely to support large densities of wildlife.

Learn more in BRI's publication *Mid-Atlantic Wildlife Studies*



Top: An important aspect of this study compared traditional boat-based survey methods with high resolution video aerial surveying. The diagram shows the fields of view available for each method. Above: BRI analyst reviews video aerial survey footage. In addition to aerial and boat surveys, the study used a mix of technologies including satellite telemetry, echosounding, and radar. Left: The Red-throated Loon, shown here in breeding plumage, is one species tracked and monitored in this study.

continuing to stretch boundaries

The application of advanced technologies is a hallmark of BRI's innovative wildlife science. While BRI's scientists use state-of-the-art technology and field methods, current approaches may not always be sufficient. In response, we continually develop new methods to enhance our fieldwork and improve our data analysis.

INGENUITY IN THE FIELD—Over the course of nearly three decades of loon research, our wildlife biologists perfected nighttime capture techniques. These methods, however, proved inadequate in the Arctic. In response, field crews developed site specific methodology that allowed the capture of loons during the long daylight hours in that region.

Pushing the boundaries of loon research further, BRI biologists have pioneered the development of methods and protocols for successful loon translocation. This 2013 iniatiative, Restore the Call, funded by the Ricketts Conservation Foundation, represents a regional scale collaboration with state and federal agencies.

A juvenile Common Loon translocated to an aquatic enclosure on the rearing lake.

Equipped with microphones, the DeepCLiDAR buoy collects data on birds and bats calling around the structure.

BAT ACOUSTICS: NEW APPLICATIONS—BRI is further developing applications for bat acoustic technologies. One innovative acoustic study at Ely Mine in Vermont, in collaboration with the U.S. Environmental Protection Agency, documents how bats use the mine and surrounding area during fall (migration and fall swarm periods), spring (when bats come out of hibernation), and summer (maternity season). The outcome of this project will help inform best practices for remediation work at the site that will have the least impact on bats.

BRI is also pioneering the use of bat acoustics technology on buouys deployed in deep water. The DeepCLiDAR buoy, developed by the University of Maine, provides an ideal platform to support multiple types of ecological monitoring equipment for offshore sites.

STEREO-OPTIC HIGH RESOLUTION IMAGING: NEW TOOLS FOR NEW CHALLENGES—Monitoring the interactions of birds with wind turbines is a challenge in the offshore environment. The impracticality of frequent monitoring by observers and of surveying for carcasses over the ocean during wind farm operation necessitates development of new technologies to document bird behavior around turbines.

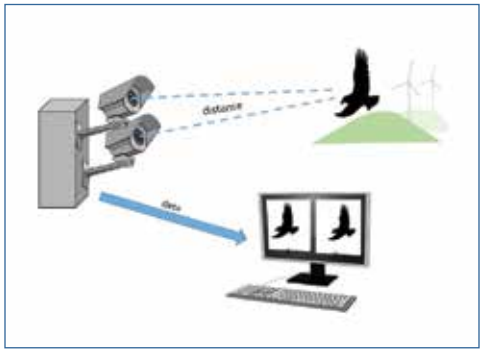
In 2014, BRI, HiDef Aerial Surveying, Ltd., Sun Edison, and the University of Maine began a collaboration to further refine a stereo-optic high definition camera system to detect and track bird movement around wind turbines. Two offset ultra-high definition cameras create a three dimensional view of the area surrounding the turbine, allowing for more accurate tracking of birds and bats flying near the structures.

To test its functionality, researchers deployed the system at an operational wind farm as well as at sites in Maine with high eagle activity. Understanding the movements of eagles (and other species) around wind farms will be important for reducing permitting uncertainty for developers and reducing adverse effects of wind energy development to birds.

NEW MOBILE APP: SEASCRIBE

SeaScribe is a data collection tool for offshore wildlife surveyors, specifically designed to make surveying efficient and to standardize data entry and output. An easy-to-use, intuitive platform for the collection of wildlife survey data, including geo-referenced effort and observation data. This application captures environmental conditions and behavioral information alongside details of each wildlife observation using internal or external GPS function.

The development of SeaScribe was funded by the Bureau of Ocean Energy Management (BOEM). The app was developed in collaboration with Tilson Government Services, and is freely available through the iTunes App Store and Google Play.



Stereo-optic camera system designed to detect wildlife flying near offshore wind turbines.

NEW APPROACHES TO HABITAT RESTORATION—In conjunction with the USFWS, BRI is working to restore stream habitat for anadromous fish such as alewives and blueback herring on numerous rivers throughout Maine.

The successful migration of fish between marine and freshwater systems is not only important in sustaining herring, smelt, and endangered Atlantic salmon populations, but this dramatic seasonal influx of fish and nutrients is a key ecological building block for healthy riparian ecosystems. Anadromous fish runs boost the survival of juvenile and nonbreeding Bald Eagles, the segment of the population critical in continued recovery efforts. Areas where fish and eagles aggregate are thus being identified and prioritized for conservation.

With funding from the National Fish and Wildlife Foundation, BRI and the USFWS will work with landowners, land trusts, and municipalities to provide technical assistance in river connectivity projects for brook trout, Atlantic salmon, and river herring. Outreach efforts will promote links between fish and river restoration efforts, stable wildlife populations, and healthy ecosystems.

knowledge synthesis

In today's complex world, important environmental choices depend on our ability to gather accurate data from different perspectives, synthesize that information, and offer viable solutions. BRI strives to build partnerships across North America and globally to achieve research study goals. In our work, we collaborate with federal agencies, state and provincial governments, colleges and universities, NGOs and foundations, private landowners, and industry.

CRITICAL INTERSECTION: WHERE SCIENCE INFORMS POLICY— BRI scientists frequently work at the interface between science and regulatory requirements, in circumstances where stakeholders are uncertain what data are needed to meet permitting requirements. BRI responds to this challenge by bringing stakeholders together to define goals and develop guidelines, conduct literature syntheses, develop conceptual frameworks, and organize special issues of peer-reviewed journals. We highlight some of those accomplishments on these pages.

BRI is participating in the Gulf of Mexico Avian Monitoring Network. This integrated and coordinated network of scientists and land managers collaborates, shares information, and provides support for the implementation of bird monitoring efforts in the region. The Brown Pelican is one focal species in this effort.

MERCURY CONNECTIONS— In 2001, BRI and Environment Canada led a comprehensive effort with 72 scientists to compile mercury data from across the northeastern United States and eastern Canada. This landmark initiative resulted in 21 scientific papers published in a special issue of Ecotoxicology (2005).

Following on that success, the Great Lakes regional study was initiated in 2008. More than 170 scientists and managers published 35 scientific papers in the journals Ecotoxicology (2011) and Environmental Pollution (2012).

In 2011, in collaboration with the U.S. Geological Survey, BRI assisted in an initiative that included mercury studies in the western regions of the U.S. and Canada. Twenty-six scientists published 10 papers in the journal Science in the Total Environment (2016).

Learn more in BRI's publication *Mercury Connections*
www.briloon.org/mercuryconnections

IDENTIFYING EMERGING ISSUES—Offshore wind power development affects many species in the marine ecosystem including fisth, sea turtles, seabirds, raptors, shorebirds, songbirds, bats, and whales.

In 2011, BRI gathered more than 35 leading researchers in the field of wildlife and offshore wind energy development from North America and Europe to identify areas of scientific consensus on this issue and to provide applied recommendations.

In 2015, BRI worked closely with the State of New York to develop a Research Plan for wildlife and marine wind energy in New York waters, defining the goals of environmental assessment and identifying priority data needs. BRI led a collaborative process involving discussion between federal and state regulators, offshore wind energy developers, environmental NGOs, and environmental consultants.

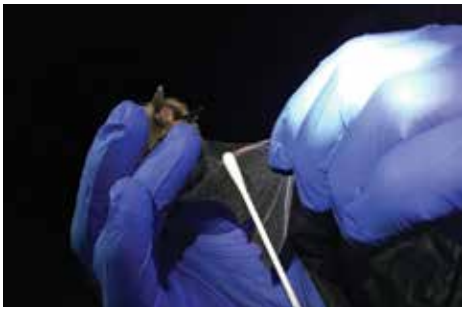
DETERMINING WILDLIFE VULNERABILITY—At BRI, we work to develop creative frameworks and conceptual models designed to address pressing or emerging ecological issues. For example, assessing the vulnerability of species to specific environmental hazards is often difficult, and requires careful consideration of many factors. In developing a heuristic model to determine wildlife vulnerability to offshore wind developments, we included sociological factors, previously ignored in such exercises.

Marine wind turbine under construction off the coast of Denmark. BRI researchers are studying the potential effects of offshore wind turbines on Northern Gannets and sea turtles, among other taxa.

BRI's Arctic Program is working with Oceans North Canada (a project of The Pew Charitable Trusts) to compile an atlas of natural resources for Canada's vulnerable Arctic marine ecosystem. The Arctic Atlas will identify areas of social, ecological, and economic importance, providing focus for future management and conservation efforts in the north.

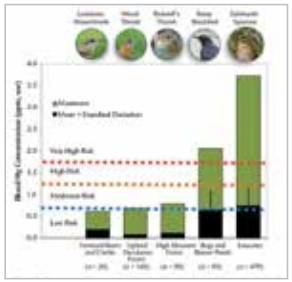
SCIENTIFIC EXPERTISE

BRI's distinguished team of research and conservation biologists conducts innovative wildlife science around the world.



DATA SCIENCE

We have developed an integrated approach to organize disparate databases, and analyze and share those data.



WORKSHOPS/MEETINGS

International collaborations with other leading scientists, government agencies, and nonprofits help us understand environmental effects on a global scale.

Translating Science

Publishing Scientific Findings

sharing knowledge

Most, if not all, of the environmental challenges we face today require more and better science to identify and assess emerging threats, and innovative technology to identify and recommend solutions. At BRI, we also recognize the need to provide results of our scientific research to a wide audience. BRI is dedicated to providing unbiased scientific information to policymakers and resource managers that helps to inform critical decisions regarding environmental health and integrity.

PEER-REVIEWED JOURNAL ARTICLES

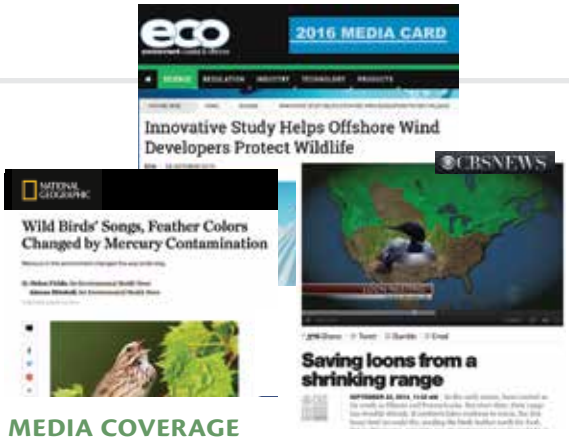
BRI consistently publishes the results of our applied wildlife studies in professional journals. The integrity of our scientific research is critical to our mission.

BRI'S SCIENCE COMMUNICATIONS AND PUBLIC OUTREACH

We translate our published findings into succinct, clear language, engaging readers through the use of wildlife photography and infographics that convey complex scientific concepts. Our outreach materials serve as a foundation for:

- press conferences
- policy development workshops
- legislative hearings
- public events

Raising Public Awareness



MEDIA COVERAGE

Our media campaigns have generated coverage in major news outlets worldwide such as *The New York Times, Audubon Magazine, National Geographic Online, National Public Radio, BBC, CBS Evening News, Huffington Post*, and many others. This exposure both informs the public and promotes positive action.

Providing a Platform for Public Discussion

Informing the Policy and Management Process

POLICY AND REGULATIONS

BRI scientific information is used by industry and regulators for successful solutions to environmental issues.

Translating Science

translating science to inform decision making

BRI's commitment to provide clear and accurate scientific information that helps inform decision makers is demonstrated by our work related to the renewable energy industry. In 2011, we created the Wildlife and Renewable Energy Program in response to rapid advances in renewable energy development, which has become an important economic activity for the United States and the world.

Ecological assessments are critical for identifying sensitive habitats, the presence of and use by rare, threatened, and endangered species, and migratory concentrations. BRI's Wildlife and Renewable Energy Program is currently working with three major energy sectors—hydropower, wind power, and solar energy. Our research results and abundance and distribution models provide valuable information to help guide development decisions being made by federal and state governmental agencies, industry, consulting companies, and other nonprofit organizations.

WIND POWER—Our mid-Atlantic wildlife study positioned BRI as a leader in assessing the use of offshore areas by wildlife (see page 27). The results of our study will inform the siting and permitting of offshore wind power facilities, both in the Atlantic Ocean and in the Great Lakes.

Efforts continue with partners in the mid-Atlantic region (USFWS, Bureau of Ocean Energy Management, State of Maryland), New York (New York Energy Research Develop Authority), Great Lakes region (Great Lakes Commission), and in Maine (University of Maine and State of Maine).

HYDROPOWER—Since 1994, BRI biologists have conducted studies to help power companies meet the environmental interests of the USFWS and state agencies in Maine, New Hampshire, New York, and Vermont as overseen by the Federal Energy Regulatory Commission (FERC). BRI has helped manage breeding Common Loon populations on reservoirs within Maine's Androscoggin and Kennebec River

Offshore wind turbines, like these off the coast of Denmark, are currently under construction on the Eastern Seaboard of the United States.

BRI develops infographics to convey complex scientific concepts to a general audience. For example, the illustration here shows how artificial nesting platforms, or rafts, help compensate for potential impacts of water level fluctuations that can flood or strand natural nest sites.

Learn more in *Conserve the Call*

Learn more in *Mid-Atlantic Wildlife Studies*

watersheds using rafts, color-marked and transmitted individuals, and weekly monitoring of reproductive success. Breeding loons are also monitored in New York's Adirondacks for FERC relicensing purposes.

BRI's assessments regularly include biotic mercury monitoring because water level fluctuations can enhance methylation rates and generate higher-than-normal mercury concentrations in fish, birds, and mammals. Long-term mercury monitoring using fish, loons, and other bioindicators is taking place in Maine watersheds and on reservoirs of the upper Connecticut River.

SOLAR ENERGY—Over the past decade, improvements in the efficiency and cost-effectiveness of solar energy have placed a greater emphasis on the need for environmental assessments to account for the potential effects of a growing number of solar fields in the Northeast.

BRI researchers are undertaking projects to determine potential impacts of new solar fields on grassland birds (generally a declining group of birds in the Northeast), wetlands, and rare species (e.g., the federally threatened northern long-eared bat).

Solar energy, a growing field in the northeastern United States, may have potential impacts on wildlife habitat.

BRI publications

Mid-Atlantic Wildlife Studies: Distribution and Abundance along the Eastern Seaboard 2012-2014

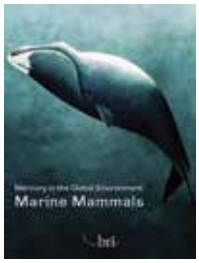
This report highlights the study goals of this project: to provide comprehensive baseline ecological data and associated predictive models and maps to regulators, developers, and other stakeholders for offshore wind energy. Our results will help inform the siting and permitting of offshore wind facilities on the mid-Atlantic Outer Continental Shelf. (2015)

Wildlife Studies Offshore of Maryland

This publication features survey results and case studies on marine mammals, sea turtles, and wintering seabirds, and represents an overview of results from the final technical report for the Maryland-focused study. This project was undertaken as part of a larger regional effort in the mid-Atlantic United States, from Delaware to Virginia. (2015)

Mercury in the Global Environment: Understanding Spatial Patterns for Biomonitoring Needs of the Minamata Convention on Mercury

The report highlights marine organisms with the greatest concentrations of mercury. These data are related to the global seafood capture dataset and provide insight into the potential risks associated with consumption of seafood with high mercury concentrations. (2016)



Mercury in the Global Environment: Marine Mammals

This report highlights BRI's scientific findings on the levels of mercury contamination in marine mammals. The publication identifies five mammal groups that are particularly affected including: toothed whales; baleen whales; pinnipeds (seals and walruses); people (in particular, aboriginal subsistence commmunities); and the polar bear. (2016)

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BRI Program Brochures

BRI supports 10 programs within its Center for Ecology and Conservation Research. These brochures highlight the research capabilities in each program. To download these pieces, visit www.briloon.org and search by program: Arctic, mammal, marine bird, raptor, songbird, tropical, waterfowl, wetlands, wildlife and renewable energy, and wildlife health. (2016)

BRI's Center for Mercury Studies

This publication highlights BRI's mercury projects and initiatives that range from the global-scale monitoring of mercury in aquatic ecosystems to detailed monitoring of mercury exposure in single species and at-risk populations. (2015)

Conserve the Call: Identifying and Managing Environmental Threats to the Common Loon

As part of BRI's loon restoration project, *Restore the Call*, this booklet highlights scientific findings related to how environmental stressors affect loon populations. A series of State Loon Status Reports are updated annually and available online. (2014)

Raptor Research on Block Island

This publication highlights our studies of migrant raptors at our Block Island Raptor Research Station, which was established on this island off the coast of Rhode Island in 2012. The raptor station is the northernmost and furthest offshore on the Atlantic coast. These characteristics, coupled with the unique migration patterns of raptors there, make this island valuable for its research and monitoring potential. (2014)

Great Lakes Mercury Connections: The Extent and Effects of Mercury Pollution in the Great Lakes Region

This report distills key results from the work of more than 170 scientists, researchers, and resource managers who used more than 300,000 mercury measurements to document the impact of mercury pollution on the region. As a result, 35 scientific papers were published in the journals of *Ecotoxicology* and *Environmental Pollution*. (2011)

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