BASELINES & BENCHMARKS

The Center for Conservation Biology

Annual Report 2021

CCB's

ONGOING MISSION

The mission of The Center for Conservation Biology, through all of its diverse programs, is to provide the global community with the information needed to drive thoughtful, science-based conservation, to educate and train the next generation of conservation scientists, and to make lasting contributions to the natural world through critical thinking, innovation, and ground-breaking research.

ON THE COVER:

Dawn rises over a mudflat along the Pacific Coast of Panama as the tide recedes. All is anticipation as throngs of shorebirds will come out onto the flats to feed in minutes. The Center has established numerous benchmarks for shorebirds in this area that have been used by the international community to designate preserves. *Photo by Bryan Watts*

WILLIAM & MARY

CHARTERED 1693

A MESSAGE FROM THE DIRECTOR

Friends,

Our perception of the natural world around us is shaped by first-hand experience. But our world is rapidly changing and through generation upon generation our baselines are shifting. Today we think little of traveling two hours for the privilege of hearing a species that was part of everyday experience in the time of our grandparents. As conservation biologists, one of our greatest fears is that one day a generation will wake up with no awareness that the species ever existed — that a choir of 10,000 unique voices will fade into the haze of generational amnesia.

As observers we stand along the shoreline and marvel as the osprey dips down and plucks a fish from the water. As scientists we stand along the same shoreline and wonder how many osprey would have fished these waters a century ago. Our charge is to measure the rise and fall of populations in order to inform societal decisions. Quantitative comparisons back to previous benchmarks are how we assess population change. One of our frustrations is the dearth of credible population benchmarks from the past. Without points of reference, we are lost on a featureless sea without any sense of direction.

Establishing population and ecological benchmarks has become a specialty of The Center for Conservation Biology. We have established hundreds of benchmarks. Beyond considering the integrity of the benchmarks themselves, we have given care to repeatability. These benchmarks are gifts to future researchers and managers who will be charged with safeguarding the natural world. They will be referenced over and over through the generations to come. I have dedicated this short annual report to some of our work establishing benchmarks.

It is our responsibility to assess the condition of populations in our time and pass on this information to future generations. Help us complete this important mission.

Sincerely,

Bryan Watts

Bryan D. Watts
Mitchell A. Byrd Professor of Conservation Biology
Director, The Center for Conservation Biology

Pristine river on the coast of Maine. It will be the prerogative of future generations to decide how much they value the natural world and the populations that depend on it. One of our roles in the present is to establish benchmarks that will inform their decisions.
Photo by Bryan Watts

TABLE OF CONTENTS

High-marsh habitat in Matthews County, Virginia. Surveys conducted by The Center in 1992 established a benchmark for marsh-nesting birds that has been used as a reference for more recent surveys. Compared back to this benchmark, more recent surveys have shown that the nesting community within this habitat has completely collapsed due to sea-level rise. *Photo by Bryan Watts*

POPULATION BENCHMARKS

Populations are the biological units of conservation. Population size measured over time is one of the critical metrics we use to assess trends and the state of recovery or endangerment. Each measurement is a reference, or a benchmark connected to a point in time. Like a surveyor on a mountain establishing elevation benchmarks, we establish a series of reference points over time to measure the rise and fall of populations. Deciding about the approach and cadence of measurement is a craft. Like the cobbler who makes shoes for different uses, we must be purposeful and efficient in our design.

The Center for Conservation Biology specializes in systematic, benchmark population surveys. We have established hundreds of population benchmarks involving more than one hundred bird species. These benchmarks allow us and the broader community to evaluate trends, develop policy and measure the effectiveness of management. The benchmarks are permanent markers that will be referenced over and over again through the generations.

(Opposite) A clapper rail swims across a tide pool within the lower Chesapeake Bay. The Center has established several population benchmarks for this species over the past few decades. Compared to other marsh-nesting species, clapper rails appear to be holding their own. *Photo by Bryan Watts*

(Above) Clutch of piping plover eggs on Cobb Island in Virginia. Piping plovers continue to be a species of high conservation concern. For thirteen years, The Center established a series of annual population benchmarks along the Virginia Barrier Islands. *Photo by Bryan Watts*

(Right) Adult red-cockaded woodpecker at nest cavity entrance in Sussex County, Virginia. Virginia represents the northern range limit for red-cockadeds and the population is highly endangered. The Center has established annual population benchmarks for this population extending back in time for decades. *Photo by Bryan Watts*

ANNUAL

CONTEXT

The cadence, or frequency of establishing population benchmarks through time should reflect the response time for management that is required to correct change and the risk of inaction. For breeding and winter populations, establishing an annual benchmark provides the highest resolution for evaluating population trends. However, establishing annual benchmarks is resource intensive and is reserved for those few species that are critically endangered and when there is a need for a continuous readout of status.

BENCHMARKS

An annual framework for establishing benchmarks is typically employed when close scrutiny is required to correct negative changes either on the population level or within specific sites. The Center for Conservation Biology has conducted several long-term conservation efforts where establishing annual benchmarks is part of the conservation program. Annual programs have included bald eagles, osprey, peregrine falcons, piping plovers and red-cockaded woodpeckers. Some of these programs have changed from annual to other cadences as the status of populations has changed.

Female peregrine falcon turning eggs. The peregrine falcon was extirpated in the eastern United States and a great deal of effort and resources have been expended to re-establish the breeding population. The Center has worked annually to establish population and demographic benchmarks to inform management and facilitate recovery. *Photo by Bryan Watts*

PERIODIC

CONTEXT

Establishment of periodic benchmarks in the range of every five to ten years is appropriate for populations of conservation concern where the consequences of those concerns are expected to play out over longer time horizons compared to species that are critically endangered. Programs that employ periodic benchmarks are intended as surveillance to detect population trends that may require management action in the future. This category includes most species of conservation concern.

BENCHMARKS

As with all benchmark efforts that are structured as time series, care must be taken to ensure consistency of approaches and techniques so that reference points may be compared over time. The Center for Conservation Biology establishes periodic population benchmarks for approximately 50 species including colonial waterbirds, migrant shorebirds, winter marsh birds and grassland birds. These efforts have defined what we know about population trends for these species in several geographic areas.

(Top) Brown pelican just after hatching. The brown pelican expanded its breeding range into the mid-Atlantic during the late 1980s and nests in colonies on bay and barrier islands. The Center has established population benchmarks periodically to track population trends and shifts in breeding distribution. *Photo by Bryan Watts*

(Bottom) Royal tern on post. The royal tern nests on isolated sandy beaches and shell rakes throughout the region. The Center has established periodic population benchmarks for this species to track population trends and shifts in distribution. *Photo by Bart Paxton*

A great egret flies back to the colony carrying a stick for a nest. The great egret is one of two dozen colonial waterbirds that The Center and partners systematically survey every five years to establish a series of bencharks to evaluate population trends. *Photo by Bryan Watts*

TARGETED

CONTEXT

Many species for which we have some basis for concern lack information to assess status or trends. For these species we may establish a population benchmark to allow for comparison sometime in the future or to compare back to some historic benchmark. Targeted benchmarks are often exploratory, with the intent of assessing status for a period of time that will allow for a comparative assessment in the future if necessary.

BENCHMARKS

The establishment of targeted benchmarks is often in response to some emerging issue of interest such as a new stressor to an ecosystem or an ongoing range expansion. The Center for Conservation Biology has established dozens of targeted benchmarks in response to a wide range of questions. These have included marsh birds, grassland birds, shorebirds and species with ongoing breeding or winter range expansions.

Saltmarsh sparrow in the Chesapeake Bay. The saltmarsh sparrow is a candidate for federal listing due to declines driven by sea-level rise. The Center has established population benchmarks for this species during both breeding and winter seasons. *Photo by Bryan Watts*

(Top) A western sandpiper foraging on a mudflat in Panama. Large numbers of this species spend the boreal winter along the Pacific Coast. The Center has established numerous population benchmarks for western sandpipers and several other shorebird species within this region. *Photo by Bryan Watts*

(Bottom) Seaside sparrow standing on eelgrass wrack in the Chesapeake Bay. Seaside sparrows depend entirely on coastal marshes and historically were the most abundant marsh bird in the region. The Center has established population benchmarks over the past thirty years that suggest seasides are experiencing ongoing declines. *Photo by Bryan Watts*

Flock of red knots feed on horseshoe crab eggs as the tide comes in. The rufa population of red knots was recently added to the federal list of threatened species. The Center has conducted targeted surveys of red knots and several other shorebird species throughout the Western Hemisphere to establish population benchmarks. *Photo by Fletcher Smith*

DEMOGRAPHIC BENCHMARKS

Demography is the science of populations or the internal processes that together drive population change. Just as debits and credits determine the viability of a business, births and deaths determine population change. The relationship between birth and death rates determines the age structure and whether a population is increasing, decreasing or stable in the absence of immigration. Demographics provide a baseline for monitoring population health and offer insights into the mechanisms driving population declines. Demographic investigations are often time and resource intensive.

The Center for Conservation Biology has established demographic benchmarks on several species of high conservation concern when having such information may lead to better conservation outcomes. Due to the effort required, the establishment of demographic benchmarks is typically done on an as-needed basis. Some investigations of births or fecundity have spanned decades and have included tens of thousands of breeding attempts. Some investigations of mortality have included marking thousands of individuals.

(Opposite) A Nelson's sparrow in winter. The Center has worked with this species and other marsh sparrows in winter to establish benchmarks of overwinter survival within the Chesapeake Bay region. *Photo by Bryan Watts*

(Top) Attaching satellite transmitter to whimbrel on the Eastern Shore of Virginia. The Center has tracked whimbrel throughout their annual cycle to establish a benchmark for adult survival. *Photo by Barry Truitt*

(Bottom) Female peregrine falcon defends her brood in Yorktown, Virginia. The Center has marked nearly the entire population of peregrines in Virginia to enable the establishment of recruitment and adult survival benchmarks. *Photo by Bryan Watts*

ADULT SURVIVAL

CONTEXT

Mortality rate is the portion of individuals dying within a specific period of time and is the demographic counterweight to reproduction. For most long-lived species, population trends are more sensitive to changes in mortality rate or survival rather than reproductive rates. Adult survival is a particularly important parameter for most populations. Understanding patterns of survival and causes of mortality is often an important step in successful conservation. However, establishing survival benchmarks is time and resource intensive because it requires extensive marking and monitoring programs.

BENCHMARKS

The Center for Conservation Biology has used two approaches to establish benchmarks for adult survival including conventional mark-resight techniques and various tracking technologies. To estimate mortality for local populations, birds are marked and periodic surveys are conducted over time to resight marked individuals. The Center has used this approach with red-cockaded woodpeckers, peregrine falcons, osprey, bald eagles, American oystercatchers and winter sparrows. Depending on the application, benchmarks may be established on an annual basis or over longer time periods. The Center has also deployed tracking devices on several species and followed cohorts through to mortality events. Although expensive, this approach is less time intensive.

Fletcher Smith, Zak Poulton, Chance Hines and Laura Duval (left to right) extract winter marsh sparrows from a mist net in the Chesapeake Bay. The Center has used mark-recapture techniques to establish benchmarks for winter survival. *Photo by Bryan Watts*

RECRUITMENT

CONTEXT

Recruitment is the elevation of an individual from a non-breeding juvenile to a breeding adult. This is a developmental milestone that only a fraction of young achieve. Recruitment depends on survival from birth to adulthood and in some circumstances the ability to compete for mates and a space to breed. Second only to adult survival, populations are often sensitive to fluctuations in recruitment rates. The length of the juvenile stage varies widely across species. For species that require several years to reach maturity, recruitment is often difficult to quantify.

BENCHMARKS

Due to the long generation times for most species that have been the focus of demographic work conducted by The Center for Conservation Biology, we have used a mark-resight approach to establish recruitment benchmarks. This requires an intensive program to individually mark large numbers of young paired with an intense monitoring program to detect which individuals are recruited into the population. We have used this approach with red-cockaded woodpeckers, osprey, peregrine falcons, American oystercatchers and to a lesser extent, bald eagles.

(Top) Fourth-year bald eagle. This bird is transitioning over to adult plumage. Historically, the transition to adult plumage at age five was the dominant time of recruitment into the breeding population. A more recent benchmark established by The Center indicates that recruitment is being delayed to older ages as the population reaches saturation. *Photo by Libby Mojica*

(Bottom) Young male peregrine falcon fitted with unique alpha-numeric band on Cobb Island along the Eastern Shore of Virginia. The Center has fitted young falcons with coded bands for decades and has used intensive monitoring of breeding adults to set benchmarks for recruitment into the breeding population. *Photo by Bryan Watts*

Bryan Watts uses a loop to examine the crown of nestling red-cockaded woodpecker for emerging red feathers. The Center determines gender for all individuals within the population as part of ongoing dmographic work. Along with annual monitoring this effort allows us to determine gender-specific recruitment rates. *Photo by Bobby Clontz*

REPRODUCTIVE RATES

CONTEXT

Reproductive rate is the number of offspring an individual or population produces in a given period of time. This is the debit side of the population ledger. In birds, we typically express this metric as the number of offspring produced per pair or female per year. Compared to the other demographic parameters, reproductive rate is often easier to measure and may be done along with population monitoring. Exceptions to this pattern are species that have highly cryptic nests within dense habitats.

BENCHMARKS

Bird species exhibit a wide range of reproductive rates. The Center for Conservation Biology has established reproductive benchmarks for many bird species of conservation concern. Depending on the application, reproductive benchmarks may be established on an annual basis or over longer time periods. Some of our programs have established annual benchmarks over decades while others have produced targeted benchmarks to characterize a particular time period and geographic location.

(Top) Green heron brood limbing in Norfolk, Virginia. In recent years, The Center has begun to document reproductive rates of nesting herons in an ongoing effort to establish the first benchmark for the region. *Photo by Bryan Watts*

(Left) Three-egg bald eagle clutch on the Potomac River in Virginia. Establishing demographic benchmarks for imperiled species allows us to compare back to previous periods and monitor recovery. The Center has established annual reproductive benchmarks for bald eagles within the Chesapeake Bay for decades. *Photo by Bryan Watts*

A nestling osprey is examined and measured within the Chesapeake Bay as part of a study of reproductive rates. The Center has established multiple demographic benchmarks with this population since 1970. *Photo by Bryan Watts*

DISTRIBUTION BENCHMARKS

Biogeography is the study of how species are distributed in space. Populations may be confined to small areas or may be distributed over tens of thousands of kilometers. We often think of distribution as a static characteristic, like plumage color or body size. However, distributions shift through time as populations recover or conditions change. Tracking these changes helps us to better understand what a species requires and what problems it may encounter.

The Center for Conservation Biology has had a long interest in distribution and has focused on setting distribution benchmarks for decades. Many of these benchmarks have been set and reset over time by conducting and repeating large-scale surveys to reveal shifts in distribution.

(Opposite) Anhinga with fish. The anhinga along with several other species has been rapidly expanding its range northward. The Center has been establishing distribution benchmarks through time to track the range expansion for several of these species. *Photo by Bryan Watts*

RANGE CHANGES

CONTEXT

Geographic range is the extent of distribution for a species or population. This area includes the core of the range, where a species often reaches its highest density, and the edges of the range where the species reaches its limit. For many species, ranges advance and retreat over time. Within the mid-Atlantic region of North America there is a high rate of turnover where many species reach their northern or southern range limits. This region also supports a high rate of change where species are advancing or retreating like the tide.

BENCHMARKS

The Center for Conservation Biology has had a keen interest in range changes within the mid-Atlantic region. We have established distribution benchmarks for dozens of species over time to document advancing or contracting range limits during both the breeding and winter seasons.

(Top) Adult white ibis forages on a residential lawn in Virginia. This species has expanded its breeding range northward reaching Virginia in 1979. The Center has tracked the range expansion and population increase by establishing a series of distribution benchmarks over time. *Photo by Bryan Watts*

(Bottom) Colony of double-crested cormorants on the James River. Cormorants have expanded populations both north and south along the Atlantic Coast reaching the Chesapeake Bay in the late 1970s. The Center has established several distribution benchmarks to track the expansion. *Photo by Bryan Watts*

Cliff swallow feeding young. Cliff swallows have been expanding their breeding range eastward from the mountains and piedmont into the coastal plain. We know the rate and distribution of this expansion because The Center has established benchmarks over time. *Photo by Bryan Watts*

LOCAL CHANGES

CONTEXT

Within their geographic range, species often shift their distribution over time. These shifts may reveal changes in underlying resources such as shifts in prey distribution or recovery of primary habitats. Documenting these local changes in distribution helps us to better understand the underlying requirements of a species and how to conduct management.

BENCHMARKS

The Center for Conservation Biology has been a student of local changes in distribution for decades. Establishing serial benchmarks that reveal local shifts in distribution has typically been done while establishing population benchmarks. Local shifts are revealed by looking deeper into the broader data. The Center has investigated local changes in distribution over time for several species where we maintain long-term investigations.

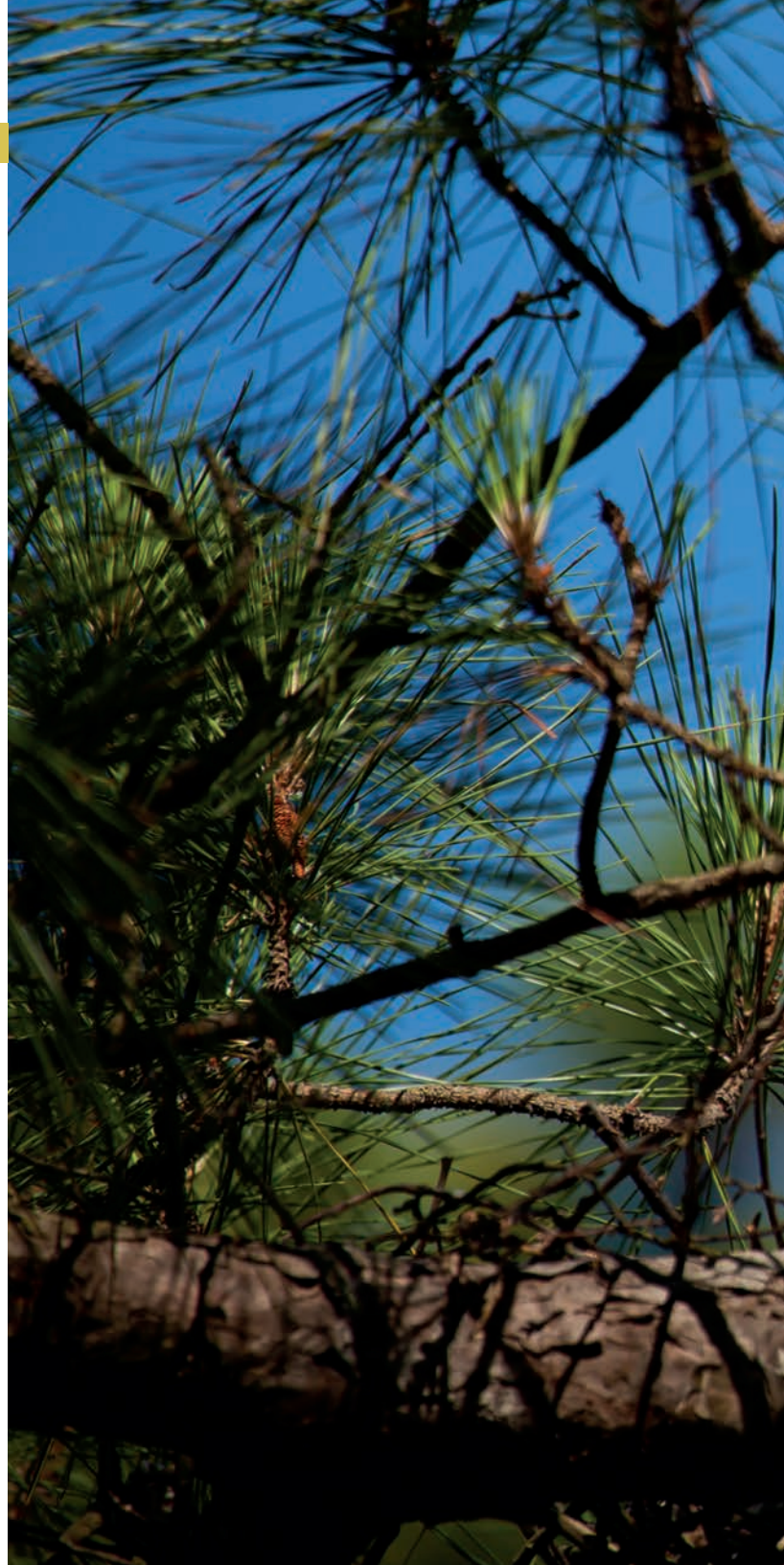
Great Blue Heron foraging in pond. With the recovery of bald eagles within the Chesapeake Bay great blue heron nesting strategy has shifted from few large colonies to many small colonies. Establishment of repeated population and distribution benchmarks by The Center over time has allowed for documentation of changes in local breeding distribution. *Photo by Bryan Watts*

Ipswich sparrow in the Chesapeake Bay. The Ipswich is a unique population that winters along the middle Atlantic Coast. The Center has established distribution benchmarks over time that show localized shifts across years that appear to reflect spatio-temporal shifts in seed crops. *Photo by Bryan Watts*

ECOLOGICAL BENCHMARKS

Ecology is the study of how species interact with their environment. We typically view species as static robots with a fixed ecological niche. If a list of resources and conditions exist in an area then the species will occur, and if something essential is missing then the species will be absent. But species are much more vibrant and interesting than robots. They are living and breathing entities capable of adapting and changing their relationship to the environment. How a species adapts and changes under varying conditions is one of the most fascinating aspects of ecology. Reaching an understanding of a species' tolerance limits is critical to effective management.

The Center for Conservation Biology has established hundreds of ecological benchmarks that quantify the relationship between a species and aspects of its environment for a specific period in time. Over time, these benchmarks help us to understand how species respond to the myriad changes in their environment and how we may become more effective managers.



(Opposite) Yellow-crowned night heron standing on nest in Norfolk, Virginia. Yellow crowns feed almost exclusively on crabs such that their migration and breeding are scheduled around the availability of crabs. Crabs are becoming active earlier and earlier as climate continues to warm. Benchmarks on the timing of breeding established by The Center when compared to benchmarks established during the 1960s show that arrival on the breeding grounds and nesting have advanced by one month. *Photo by Bryan Watts*

SHIFTING SANDS

CONTEXT

Species have been shaped by vast connections to their environment that splay out through time and space. All of these threads intersecting here and now provide us with a view into a species' niche or "home" space. When conditions change, species either change with them, move or go extinct. Resilience, or capacity for change, is an important attribute for survival. How a species responds to change is one of the most fascinating aspects of ecology and gives insight into how it may be managed.

BENCHMARKS

Establishing benchmarks on the changing relationship between a species and its environment requires information on both environmental conditions and the species itself. Establishing multiple benchmarks through time allows us to see how a species responds to changing conditions. Center biologists have had the opportunity to investigate these changes for many species but have also established norms that may be used by future scientists to understand resiliency.

(Top) Osprey feeding menhaden to young in the Chesapeake Bay. Historically, osprey in the region were thought to be menhaden-dependent. Osprey that have colonized the fresher upper reaches of the Bay hunt blue catfish and gizzard shad. Osprey have shifted diet and to earlier nesting dates in a very short period of time. Ecological benchmarks established by The Center over time have documented rapid shifts in ecology. *Photo by Bryan Watts*

(Bottom) Seaside sparrow perched in black needlerush. Back in 1992 The Center established an ecological benchmark showing that more than 80% of seasides used tall cordgrass during the breeding season. A more recent benchmark shows that 80% are using black needlerush. This shift in substrate reflects a change in vegetation within the tidal marsh due to sea-level rise. Seasides have been resilient to these changes while other species have declined dramatically. *Photo by Bryan Watts*

Eastern meadowlark. The eastern meadowlark nests on the ground. This species was previously a common nesting species within the high portion of tidal salt marshes. The Center established population benchmarks for this species during the early 1990s. Recent benchmarks have indicated that eastern meadowlarks have disappeared from nearly all marshes within the lower Chesapeake Bay most likely due to ongoing sea-level rise. *Photo by Bryan Watts*

SPECIES INTERACTIONS

CONTEXT

Other species, including humans, are one of the more interesting components of the environment where a species lives. Pairs of species may have a range of relationships such as predator and prey, competitors for food or space or some form of mutualism. For species pairs with ecological connections, changes in the population of one species may have dramatic effects on the other. Understanding the relationship between coupled species is an exciting area of ecology that provides insight to population management.

BENCHMARKS

Documenting shifts in how species relate to one another requires information on both species and the strength of their connections. On rare occasions, Center biologists have been able to establish benchmarks for coupled populations and their relationships over time that reveal how these relationships are shifting. Such opportunities have presented themselves when we have conducted long-term, intense investigations of populations that happen to be coupled. Documenting how these relationships have changed over time has been very gratifying.

(Top) Red knot preens on the beach after feeding within a spring staging area along the mid-Atlantic Coast. Red knots feed within the intertidal zone of sandy beaches. Red knots are prey for peregrine falcons and the establishment of distribution benchmarks by The Center has shown that red knots shift their foraging locations in response to active peregrine breeding territories in Virginia. The management of peregrines in the area has restricted available foraging habitat for knots. *Photo by Jan van de Kam*

(Bottom) An adult herring gull in breeding condition within the Chesapeake Bay. Herring gulls nest on isolated islands and marshes within the region. Over the past four decades great black-backed gulls have increasingly mixed into herring gull colonies. Herring gulls are declining and now use fewer nesting colonies. The Center has established population and distribution benchmarks for both species that document expansion of great black-backed gulls and the contraction of herring gulls. *Photo by Bryan Watts*

Bald eagle nest in the back yard of a residential house. As recently as the 1980s we had no examples of residential eagle pairs. Year over year during the past two decades the percentage of eagles nesting in residential settings has grown. Co-habitation between eagles and humans that was once thought to be impossible is now ongoing. Ecological benchmarks established by The Center and tracked over time have allowed us to document the changing relationship between eagles and humans. *Photo by Bryan Watts*

INSTITUTIONAL PARTNERS 2021

Acadia University
Advanced Conservation Strategies
Aluminum Company of America
American Bird Conservancy
American Eagle Foundation
American Wind Wildlife Institute
Arborscapes, LLC
Arizona Bird Conservation Initiative
Atlantic Coast Joint Venture
Audubon North Carolina
Audubon South Carolina
Audubon Louisiana
Avian Research and Conservation Institute
Bird Studies Canada
BirdsCaribbean
Boreal Songbird Initiative
Brooks Bird Club
Buck Island Ranch
Canadian Wildlife Service
Center for Coastal Resources Management
Chesapeake Bay Bridge Tunnel Authority
Chesapeake Bay Foundation
Chesapeake Conservancy
Coastal Virginia Wildlife Observatory
Colorado State University
Conserve Wildlife New Jersey
Cornell Laboratory of Ornithology
Cube Hydro Carolinas
Dalhousie University
Delaware Division of Fish and Wildlife
Delaware Natural History Museum
Discover the James
Dominion Energy
EA Engineering
EDM International
Environment Canada
Exelon Corporation
Florida Audubon
Florida Fish and Wildlife Conservation Commission
Friends of Dragon Run
Friends of Rappahannock River
George Mason University
Georgia Dept of Natural Resources
Georgia Ornithological Society
Georgian Bay Osprey Society
Gomez and Sullivan Engineers
Good Shepherd Fund
Gulf Coast Bird Observatory
Hampton Roads Bird Club
Hanover Aviation
Idaho Bird Observatory
Illinois Natural History Survey
Institute for Integrative Bird Behavior Studies
James River Association
Jim Reed Enterprises, Inc
Kentucky Dept of Fish and Wildlife Resources
Kissimee Prairie Preserve
Kleinschmidt Associates
Laramie Audubon
Louisiana Fish and Wildlife
Low Country Institute
Luck Stone Corporation
Maine Dept of Inland Fisheries and Wildlife
Maine Natural History Observatory
Manomet, Inc
Martha's Vineyard Raptor Research
Maryland Dept of Natural Resources
Maryland Ornithological Society
MathScience Innovation Center
Michigan Audubon
Michigan Dept of Natural Resources
Michigan Natural Features Inventory
Microwave Telemetry, Inc
Midstream Technology, LLC
Midwest Coordinated Bird Monitoring Partnership
Mississippi Museum of Natural Science
Mississippi State University
Mount Allison University
Movebank
National Aeronautics and Space Administration
National Audubon Society
National Fish and Wildlife Foundation
National Park Service
New Hampshire Audubon
New Jersey Audubon
New Jersey Conservation Foundation
New Jersey Division of Fish and Wildlife
Norfolk Southern Corporation
North Carolina Wildlife Resources Commission
Northern Neck Audubon Society
Northern Virginia Conservation Trust
Ohio Dept of Natural Resources
Oklahoma State University
Panama Audubon
Parks Canada
Partners in Flight
Pennsylvania Game and Fish Commission
Progress Energy
Richmond Audubon
Richmond Times-Dispatch
Richter Museum of Natural History
Santa Rosa Ranch
Smithsonian Institution
Smithsonian Tropical Research Institute
Solertium Corporation
South Carolina Dept of Natural Resources
Southern Company
Southern Illinois University
State University of New York
Tennessee Ornithological Society
Tetra Tech, Inc
Texas Parks and Wildlife
The Carolina Bird Club
The Nature Conservancy
The Peregrine Fund
The Wildlife Center of Virginia

Toronto Ornithological Club
Three Lakes WMA
United States Army Corps of Engineers
United States Coast Guard
United States Dept of Agriculture
United States Dept of Defense
United States Fish and Wildlife Service
United States Forest Service
United States Geological Survey
Universidad de La Pampa, Argentina
University of Connecticut
University of Delaware
University of Georgia
University of Maine
University of Maryland
University of Moncton
University of Queensland
University of Rhode Island
University of Virginia
Virginia Academy of Science
Virginia Aquarium
Virginia Coastal Zone Management Program
Virginia Dept of Conservation and Recreation
Virginia Dept of Environmental Quality
Virginia Dept of Mines, Minerals, and Energy
Virginia Dept of Transportation
Virginia Dept of Wildlife Resources
Virginia Institute of Marine Science
Virginia Marine Resources Commission
Virginia Master Naturalists
Virginia National Estuarine Research Reserve
Virginia Outdoors Foundation
Virginia Society of Ornithology
West Virginia Dept of Natural Resources
West Virginia University
Whitaker Center
William & Mary
Williamsburg Bird Club
Williamson Ranch
Wisconsin Bird Conservation Initiative
Woods Hole Group, Inc
XL Ranch
Xponent 21, Inc

ON THE BACK COVER:

Michael Academia changes a memory card on a nest camera set up on an osprey nest in the Chesapeake Bay. The Center has used nest cameras to set diet benchmarks for comparison through time and across geographic areas. *Photo by Bryan Watts*

CCB

THE CENTER FOR CONSERVATION BIOLOGY

William & Mary
P.O. Box 8795
Williamsburg, VA 23187-8795
Phone: (757) 221-1645
Email: info@ccbbirds.org

STAY CONNECTED

Follow the latest news from The Center for Conservation Biology

Visit us online: www.ccbbirds.org

Like us on Facebook: www.facebook.com/ConservationBiology

Follow us on Twitter: @CtrConsBiology

Report content by Bryan Watts

Report design by Professional Printing Center

WILLIAM & MARY
CHARTERED 1693