2013

STATE *Of The* *Birds*

Massachusetts Breeding Birds: *A Closer Look*

Mass Audubon
BIRD CONSERVATION PROGRAMS
State of the Birds

Project Team

Matt Kamm, *Bird Conservation Assistant, Author*

David Larson, *Education Coordinator, Joppa Flats Education Center, Contributor*

Chris Leahy, *Gerard A. Bertrand Chair of Natural History and Field Ornithology, Author*

Michael O'Connor, *Public Relations Manager, Contributor*

Kimberly Peters, *Chief Scientist, Author*

Wayne R. Petersen, *Director Important Bird Areas Program, Editor*

Ann Prince, *Editor*

E. Heidi Ricci, *Senior Policy Analyst, Contributor*

Margo Servison, *Bird Conservation Research Assistant, Author, Photo/Artwork Editor*

Joan Walsh, *Director of Bird Monitoring, Project Manager, Author, Editor*

Cover photo: Eastern Meadowlark

The Massachusetts state bird, Black-capped Chickadee, was found breeding in more than 96% of the state.

To support this work, download this report, and explore Atlas 2 and State of the Birds data and maps visit:
www.massaudubon.org/sotb
www.massaudubon.org/bba2

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Natural Heritage & Endangered Species Program
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Welcome

Everyone likes birds. Their comings and goings are magical, their colors and songs inspire poetry and symphonies, and their migrations inspire awe. A Baltimore Oriole might spend the winter in Panama and return each spring to the very same maple tree in a Massachusetts backyard to amaze us with its display of color and song.

But even though birds seem free and unrestrained by the world of people, they are still profoundly affected by many of the things that we do. Much of the story of changing bird populations is a story of changing habitat, and during the last few hundred years in Massachusetts some of the most drastic habitat changes imaginable have occurred—much of the state has gone from forest to farmland to pasture and back to forest again.

The resurgence of forests in the last 50 years is good news for species like the Pileated Woodpecker, Brown Creeper, and others. Birds such as the Red-tailed Hawk and Wild Turkey have adapted amazingly well to wooded suburban habitat, increasing beyond what anyone would have predicted just two decades ago. However, this newly increased forest cover is fragmented, and species that need larger patches of deep forest, such as the Wood Thrush and Scarlet Tanager, are not doing as well.

The real "losers" in this equation are species of open country including farmland and brushy fields. Species such as the Eastern Meadowlark, Brown Thrasher, and Northern Bobwhite have disappeared from much of Massachusetts over the last 30 years as their favored habitat of hedgerows and overgrown fields has either been left to revert to forest or has been squeezed by roads and house lots.

Increasing forest cover is not necessarily the whole story for these species; it is just one of the factors driving changes in bird populations in Massachusetts. This report delves into the results of the *Massachusetts Breeding Bird Atlas 2* (an exhaustive five-year survey of the entire state) and tells a much more detailed story of which species are doing well, which are not, and what we can do to maintain the highest possible abundance of bird species.

Supporting diverse birdlife may seem trivial to some, but working to maintain the birds that we love will also maintain a landscape of myriad natural habitats. Not everyone will notice a Brown Thrasher or a Chestnut-sided Warbler, but a town that can harbor those species—with small farms, hedges, streams, meadows, forests, and other green space—is a more sustaining and desirable place to live than a town with relatively uniform development.

We should value open space and a healthy environment for many reasons. This *State of the Birds 2013* report provides a detailed summary of how our birds are doing and offers some practical solutions to the challenges they face. It's not just about birds, though; birds simply point the way to a richer and more diverse landscape, which is something we need as much as they do.

David Sibley

July 2013, Concord, Massachusetts

Baltimore Oriole

Scarlet Tanager

The tiny Brown Creeper, a forest-dwelling year-round resident in the state, is a widespread and increasing nesting bird.

Red-tailed Hawk chicks in nest.

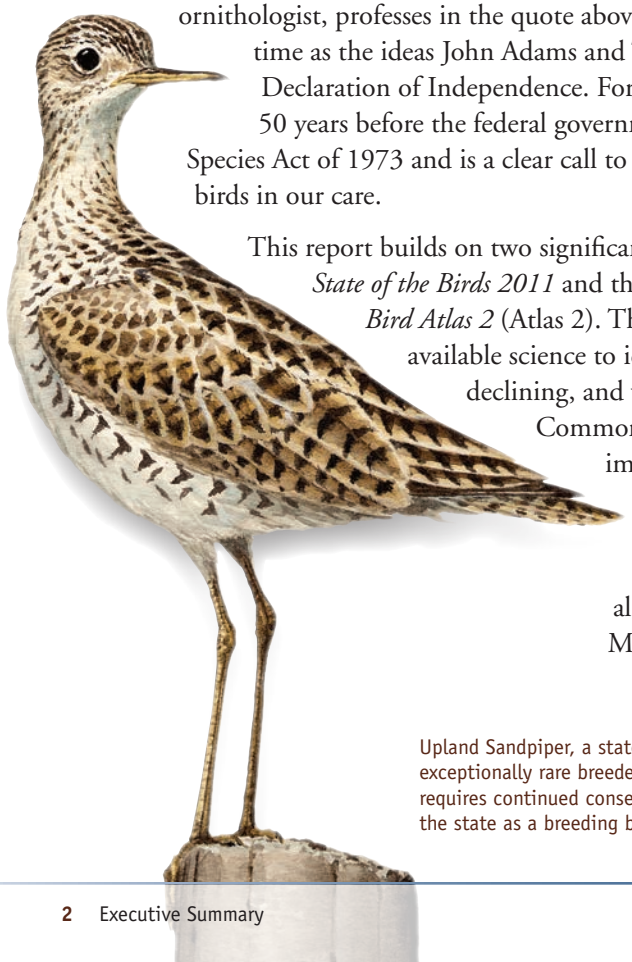
Executive Summary

"Birds may be ranked among the noblest forms of life. Experience has shown that without species protection at the hands of man many species are likely to become extinct."

Edward Howe Forbush, 1925, *Birds of Massachusetts and Other New England States*

It is a point of pride and legacy that Massachusetts is the birthplace of modern conservation ideals. We were the leaders in stopping the slaughter of herons and egrets during the late 1800s, and we were the birthplace of the first Audubon society. Those actions directly led to the beginning of all federal laws that protect birds. It is no wonder then that the idea Edward Forbush, our first state ornithologist, professes in the quote above was as revolutionary in his time as the ideas John Adams and Thomas Jefferson penned in the Declaration of Independence. Forbush's quote was written about 50 years before the federal government passed the Endangered Species Act of 1973 and is a clear call to action toward preserving the birds in our care.

This report builds on two significant Mass Audubon initiatives—*State of the Birds 2011* and the *Massachusetts Breeding Bird Atlas 2* (Atlas 2). These projects used the best available science to identify which bird species are declining, and which are doing well, in the Commonwealth, and they represent important stepping-stones along the path toward building an evidence-based bird conservation strategy for all the breeding species in Massachusetts.



Upland Sandpiper, a state Endangered Species, is an exceptionally rare breeder in large grasslands. This species requires continued conservation action if it is to persist in the state as a breeding bird.

Massachusetts hosts about 38% of the entire east coast population of breeding piping Plovers.

At high density, White-tailed Deer can remove the understory of a forest, making it unsuitable for some nesting birds.

When allowed outside, domestic cats contribute substantially to bird mortality. This problem is easily remedied by keeping your cat safely indoors.

Once the *State of the Birds 2011* and the *Massachusetts Breeding Bird Atlas 2* were completed, it was clear that, while knowing which species are declining is critical, it is essential that we devise a conservation strategy that is actionable. Creating such a strategy ultimately relies on understanding the reasons for species declines and then being able to create opportunities to truly arrest the declining trajectories for those species. Conservation dollars are rare, and time is of the essence. If we are going to effect change, we need to know why species are declining, be guided by proven recovery plans, and have an understanding of which species are floundering for reasons as yet undetermined.

This document opens the "black box" of our recovery planning process, and chooses a focal declining species to demonstrate the complexity of prioritizing recovery actions. For each focal species, we look at recommended actions for that breeding bird in other states, and the specific conservation challenges in the focal habitat. This approach underscores the sometimes competing management options in different habitats (e.g., create more shrublands but don't fragment forest) and also drives home the fact that for many species the reasons for declines are unknown, and species can continue to decline despite our best efforts to protect their breeding habitat.

Listed below are the habitats and behaviors of breeding species that are declining and the species we have chosen to represent those habitats or behaviors.

- **Grassland birds and birds of agricultural landscapes —** Eastern Meadowlark, Brown Thrasher, Cliff Swallow
- **Coastal-nesting species —** Roseate Tern, Saltmarsh Sparrow
- **Birds of shrublands and young forests —** Brown Thrasher

- **Ground-nesting birds —** Wood Thrush, Brown Thrasher, Killdeer
- **Aerial insectivores (species that eat insects that are in the air) —** Cliff Swallow
- **Freshwater marsh-nesting birds —** American Bittern
- **Long-distance migrants —** Roseate Tern, Cliff Swallow, Wood Thrush

Factors documented to be causing, at least in part, these declines include:

- **Habitat loss in Massachusetts as well as on the wintering grounds**
- **Habitat fragmentation and degradation in Massachusetts as well as on the wintering grounds**
- **Toxic chemicals affecting the birds and their food**
- **Ground predators (including domestic cats) and habitat "engineers" such as deer**
- **Collisions with windows, power lines, cars**
- **Climate change**

There is also good news for many of our breeding birds. Included among these increasing species are:

- **Wooded freshwater swamp-breeding species and species that use rivers, lakes, and ponds**
- **Species that nest on human structures or use nest boxes**
- **Many forest-nesting species**
- **Suburban-adapted breeding species**

Recommendations in this document stress our need to:

- **Support a net gain of land in agriculture in Massachusetts**
- **Encourage everyone to embrace Massachusetts-based agricultural products**
- **Develop tools for both foresters and farmers to encourage bird-friendly management options on their lands**
- **Develop plans to increase shrubland maintenance and creation in sustainable locations**
- **Continue to support initiatives by the state to census rare species and defend the Massachusetts Endangered Species Act**
- **Educate the public and engage in projects to mitigate anticipated climate change stress**
- **Manage our communities sustainably, especially by reducing sprawl, limiting our use of pesticides, and preventing the outdoor roaming of domestic cats**
- **Develop tools to address key land management issues such as the role White-tailed Deer play in altering the structure of the forests in suburban Massachusetts and strategies for weighing management options**

Eastern Towhee, a breeding bird of shrublands and young forests, shows signs of decline in the state.

White-throated Sparrow, a nesting bird in young forests, is one of the species to show the largest decline in its breeding footprint in the state.

Chimney Swift, an aerial insectivore, shows declines throughout much of its breeding range, although the causes of the declines are not yet known.

Breeding Birds of Massachusetts: *A Closer Look*

In the fall of 2011, we published *State of the Birds: Documenting Changes in Massachusetts' Birdlife*. It was, by design, a "Big Picture" report meant to examine the status of the birds that occur regularly in the Commonwealth, to describe the major threats to those species in significant decline, and to begin to consider conservation actions that might mitigate or reverse those declines.

In this *State of the Birds 2013* report, we focus on that segment of our birdlife for which we arguably bear the greatest responsibility, namely, our breeding birds. These species depend on the land, water, and people of Massachusetts for rearing their young. They are uniquely affected, for good or ill, by the changes we have brought to our state's landscapes and atmosphere.

Of course, many of "our" birds leave Massachusetts after the nesting season, some making prodigious flights to and from wintering grounds as far away as the Southern Hemisphere. In examining possible causes of decline, we have not neglected the kinds of threats that birds increasingly face on migration and in their winter habitats. However, populations expand and contract primarily as a result of two drivers—breeding success and mortality. This document shines a bright light on the losses and gains during breeding using "case studies" for declining species in each habitat.

The focus of this closer look at our nesting birds comes from the 2011 completion of the *Massachusetts Breeding Bird Atlas 2* (Atlas 2). When compared to the results of Atlas 1, which was completed in 1979, this second survey gives us invaluable insights into how the distributions of the birds that nest in Massachusetts have changed in the intervening 32 years. In many cases, they have changed dramatically—often, we are sad to report, showing striking population contractions.

For this report we took a closer look at some of the declining species from Atlas 2. To better understand the breeding ecology of the species in question, we have turned to the scientific literature. From these sources we have outlined known factors that are implicated in population decreases and, when evident, report on management strategies that have been effective in at least slowing rates of decline.

However, a note of caution: for some species the complexity of the problem casts a dark shadow over recovery, and the remedies for some declines are not well understood. But it is a point of pride and legacy that Massachusetts, the birthplace of modern conservation ideals, is well prepared to face the challenges. We were the leaders during the late 1800s when it was time to stop the slaughter of herons and egrets used in the millinery trade, and we were the birthplace of the first Audubon society.

This document helps us to honor that legacy by sharpening our focus toward remedies, and at the same time sharing the "stories" of the troubles our breeding birds face just to stay alive and raise their young.

We are the most complex and effective actors on the landscape, and, as Edward Howe Forbush wrote in the 1925 quote at the beginning of this document, there are things we can do that can help us maintain this precious resource for generations to come. And while each of the profiled species occupies a distinct habitat and faces its own suite of challenges in today's world, we also face those same challenges, and we alone hold the key to solutions that will sustain both our beloved human and breeding bird communities.

Eastern Kingbirds at their nest

One of our most broadly distributed breeding birds, the American Robin, now winters in larger numbers than ever before, but is showing signs of decline.

The delicate Blue-gray Gnatcatcher, a forest-nesting bird, is increasing.

Monitoring Breeding Birds: *Atlas 2 and the Breeding Bird Survey*

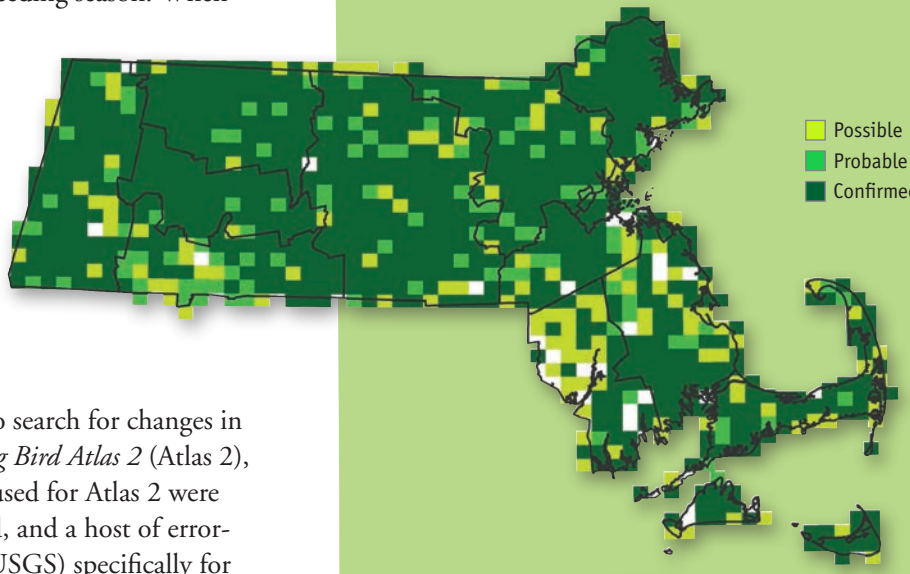
ATLAS 1 AND ATLAS 2

From 1974 to 1979, hundreds of volunteers in Massachusetts undertook the first statewide Breeding Bird Atlas (Atlas 1) in North America. A breeding bird atlas is an internationally adopted system for mapping the *distribution* of the breeding bird species of a given geographical area. While not assessing the *abundance* of a species, an atlas collects evidence of a species' presence or absence during the breeding season. When atlases from different time periods are compared, changes in the status of a species are revealed by expansions or contractions of the *distribution* of the species within the atlas area.

Atlas 1 followed methods used in the groundbreaking 1979 report *The Atlas of Breeding Birds in Britain and Ireland*, and fieldwork was launched the same time as our neighbors in Vermont began their first atlas project. Soon after that, many other states, counties, and provinces followed suit using similar methods to evaluate the breeding birds. This was notably long-sighted of the designers in the series of Atlas 1 projects—they created a series of massive surveys that were all reasonably comparable, and they did this across the globe.

From 2007 to 2011 more than 700 volunteers again combed the Commonwealth to search for changes in the breeding bird populations. These data, summarized in the *Massachusetts Breeding Bird Atlas 2* (Atlas 2), give us a measure of the sustainability of our breeding bird communities. The data used for Atlas 2 were rigorously evaluated by a team of Regional Coordinators who are experts in the field, and a host of error-checking programs on a website managed by the United States Geological Survey (USGS) specifically for this project.

Map of the distribution of Tree Swallows from the 2007-2011 Atlas 2 surveys.



A Tree Swallow nest and eggs, from a nest box at Mass Audubon's Drumlin Farm.

Tree Swallows nest in fields and sometimes over water, and readily use nest boxes. Atlas 2 shows that they are likely increasing in the state.

ATLAS METHODS

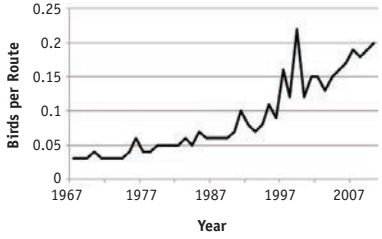
In most breeding bird atlases, a region is divided into *blocks*, and in the case of the Massachusetts Atlas 1 and Atlas 2 those blocks were about 10 square miles in extent. Volunteers surveyed each block during the breeding season, and collected evidence of breeding for as many species as they could find. Evidence was ranked as Possible, Probable, or Confirmed breeding based on careful observation of the species. Once a species is Confirmed breeding in a block, the observer does not need to collect any more evidence for that species. The Atlas is not a count of individual birds: it is an enhanced presence/absence survey.

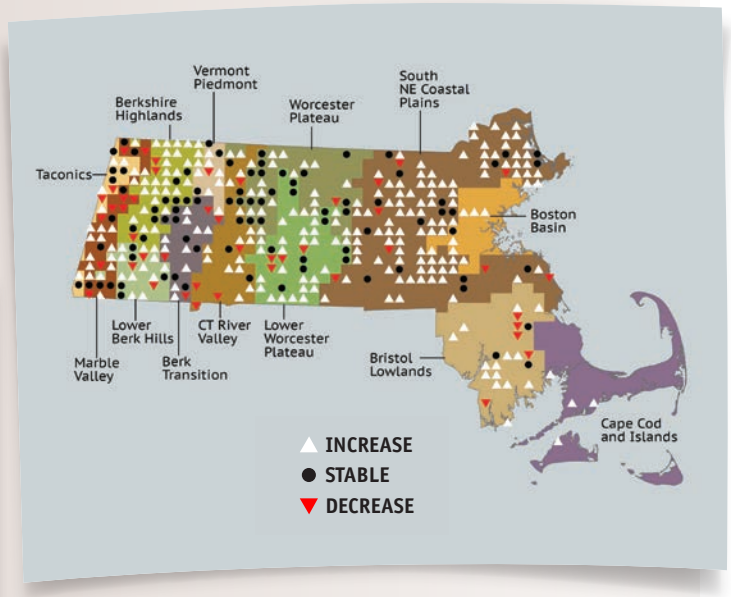
An atlas' greatest strength is that it collects data on all species of birds—from common to rare, from secretive to gregarious, and from inhabitants of localized habitats to those of widespread landscapes—and that the information gathered reveals changes in a species' distribution on a fairly fine scale.

AN EXAMPLE: **BARRED OWL**

The map below clearly shows that the *distribution* in Massachusetts of the Barred Owl expanded greatly during the interval between Atlas 1 and Atlas 2. From this fact it can be inferred that this species' numbers may also have increased. There is documentation that shows that changes in block occupancy rates over time tend to mirror changes in abundance—and tests of the New York State Breeding Bird Atlas 2 data showed a high correlation between the Breeding Bird Survey abundance estimates and Atlas 2 block occupancy rates.

Breeding Bird Survey estimate of the trend for Barred Owls in Massachusetts from 1966-2008.



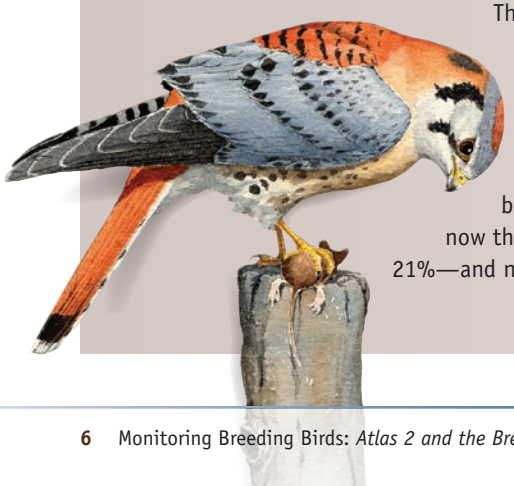


Map of the change in Barred Owl distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

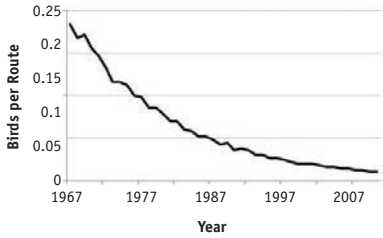
ANOTHER EXAMPLE: **AMERICAN KESTREL**

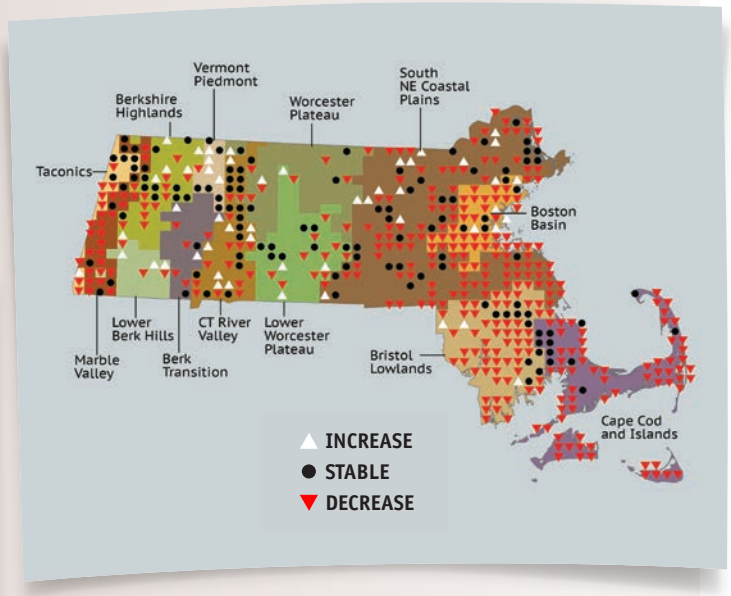
It is critical to note that when a species "winks out" from an Atlas block (meaning it was found in Atlas 1 but not Atlas 2), its numbers have likely decreased to close to zero. This makes an Atlas decline reflective of a serious loss, especially if the bird was formerly numerous. For very rare species, it is plausible that they could be overlooked in a block even though they may be present. Accordingly, for species with very small populations it is important to note that atlas methods are often too blunt a tool for good resolution. But for most species in most blocks, atlas protocols provide a good indicator of distributions and trends.

The map of the decline of the American Kestrel is sobering. This species tells us the opposite story of the Barred Owl. In 1979 American Kestrels were breeding in about 51% of the blocks in the state; now that is reduced to 21%—and no one knows why.



Breeding Bird Survey estimate of the trend for American Kestrel in Massachusetts from 1966-2008.





Map of the change in American Kestrel distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

CITIZEN CONSERVATION

Thousands of dedicated volunteer observers collected the data for the Massachusetts Breeding Bird Atlas 1 and 2, as well as the USGS' Breeding Bird Survey. Indeed, across the US and Canada tens of thousands of participants donate their time and expertise each year to protect birds by participating in projects hosted by many conservation groups.

There are a host of completed and ongoing breeding bird atlas 2 projects across the US and Canada, and both countries are partners in the Breeding Bird Survey. With the completion of the Massachusetts and Maritimes Breeding Bird Atlas 2 projects, there is an impressive swath of fine-scale atlas data from Cape Breton south to Long Island (excepting Maine and New Hampshire), and west through Vermont, New York, Pennsylvania, Ohio, Indiana, Michigan, and through Quebec and north through the far reaches of Ontario.

These data form the baseline of research on bird populations across the continent—and they are, by and large, collected by volunteers. To all of the volunteers, to those who share their data and passion for conservation, and to those who fund these critical projects, we respectfully send our sincere thanks.

If you want to participate in ongoing Citizen Science projects with Mass Audubon please go to www.massaudubon.org/birds and browse the opportunities.

THE BREEDING BIRD SURVEY

The Breeding Bird Survey (BBS)—the largest and most comprehensive source of information on breeding bird population trends across North America—is coordinated by the U.S. Geological Survey's Patuxent Wildlife Research Center and the Canadian Wildlife Service. Started in 1966, by Mr. Chandler Robbins, in response to threats to birdlife resulting from the indiscriminate use of DDT and other pesticides, this continent-wide survey sought to monitor the status of breeding bird populations throughout North America. Today there are more than 4,100 BBS routes in North America including 27 in Massachusetts, many of which have been monitored annually since 1966.

Eastern Bluebird

Peregrine Falcon

Least Tern

The BBS uses a *point count* methodology for estimating the abundance of birds along a series of auto routes. Each summer volunteers stop 50 times along fixed 24.5-mile routes at half-mile intervals; at each stop they count every bird seen or heard within a three-minute period. The BBS records *numbers of individual birds* year after year in precisely the same locations, so it provides an estimate of changes of *abundance over time*. Because it is a continent-wide survey, the BBS not only shows trends in Massachusetts bird populations but also makes possible comparisons with national or regional trends of the same species. No survey method is perfect, and some of the limitations of the BBS are that it underrepresents rare species, those occupying specialized habitats, and nocturnal species because the survey routes and timing typically do not include sufficient samples of these situations.

Although both the BBS and Atlas 2 provide information on breeding birds, each has its strengths and weaknesses, and together they give a robust picture of the trend in both range and abundance of most breeding species. To be sure there are some species such as colonial nesting terns and shorebirds, as well as scarce and broadly distributed marsh-nesting species, that need focused projects. This illustrates that neither the BBS nor Atlas 2 methods are precise enough to capture all the subtlety of some populations. And while Atlas 2 measures the distributions of more species and covers more specialized habitats, the BBS makes it possible to sometimes detect trends *before* they have resulted in noticeable changes in distribution. Together, with more focused research projects in the mix, these large-scale and citizen-based projects create a strong foundation for assessing the status and trends of breeding birds in the Commonwealth.

Breeding Bird Atlas 2: *A Snapshot*

WHAT SPECIES WERE FOUND IN THE MOST BLOCKS?

- ✓ Song Sparrow
- ✓ Gray Catbird
- ✓ American Robin
- ✓ Common Yellowthroat
- ✓ Red-winged Blackbird
- ✓ Black-capped Chickadee

Song Sparrow

WHAT SPECIES SHOWED THE BIGGEST INCREASE IN BREEDING "FOOTPRINT"?

- ⇧ Wild Turkey
- ⇧ Red-bellied Woodpecker
- ⇧ Carolina Wren
- ⇧ Pine Warbler
- ⇧ Canada Goose
- ⇧ Cooper's Hawks
- ⇧ Eastern Bluebird
- ⇧ Ruby-throated Hummingbird

Wild Turkey chicks

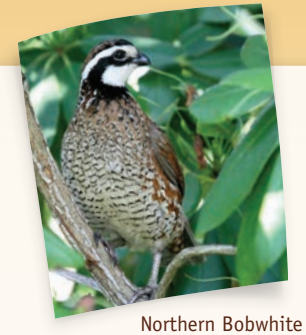
WHAT SPECIES WERE THE RAREST BREEDERS?

- ✓ Leach's Storm-Petrel
- ✓ Tricolored Heron
- ✓ Cattle Egret
- ✓ Sandhill Crane
- ✓ Arctic Tern
- ✓ Protonotary Warbler
- ✓ Short-eared Owl
- ✓ Little Blue Heron

Sandhill Crane

WHAT SPECIES SHOWED THE LARGEST DECREASE IN BREEDING "FOOTPRINT"?

- ⇩ American Black Duck
- ⇩ American Kestrel
- ⇩ Eastern Meadowlark
- ⇩ Ring-necked Pheasant
- ⇩ Brown Thrasher
- ⇩ Purple Finch
- ⇩ Northern Bobwhite
- ⇩ Ruffed Grouse



Northern Bobwhite

Interesting STATS

ABOUT THE DATA COLLECTION

- WHO DID THE WORK? *560+ volunteers*
- HOW MUCH WORK DID THEY DO? *43,360 hours*
- HOW LONG DID IT TAKE? *5 years*
- HOW MANY RECORDS DID THEY COLLECT? *147,836*
- HOW MANY SPECIES DID THEY FIND? *228 species, 191 confirmed breeding*

ABOUT THE BLOCKS

SIZE OF BLOCK = *1/6 of a USGS 7.5 minute topographic map, about 10 square miles*

NUMBER SURVEYED

Atlas 1 – *969*

Atlas 2 – *1,037*

BREEDING BIRDS IN THESE CLASSES HAVE DECREASING BREEDING RANGES

Eastern Whip-poor-will

- Grassland and agriculture birds
- Ground-nesting species
- Shrubland birds
- Long-distance migrants decreasing more than resident birds

BREEDING BIRDS IN THESE CLASSES *LIKELY* HAVE DECREASING BREEDING RANGES

Herring Gull

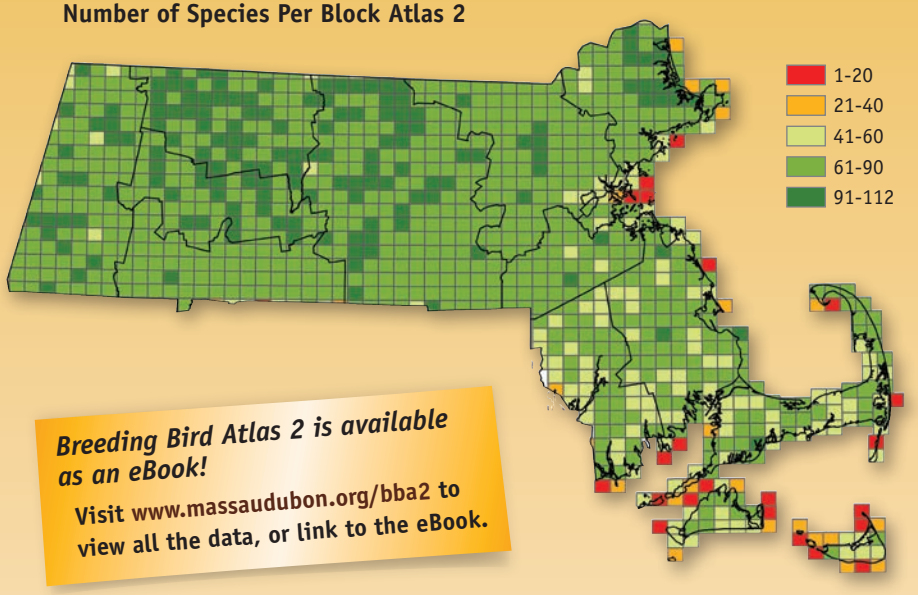
- Listed species, and those listed in the State Wildlife Action Plan (SWAP species) are likely declining
- Coastal breeders
- Aerial insectivores

BREEDING BIRDS IN THESE CLASSES HAVE INCREASING RANGES

Pileated Woodpecker

- Wooded swamp breeders
- River, lake, and pond breeders
- Forest breeders
- Birds at the northern edge of their range are increasing
- Birds nesting on human structures, including nest boxes, are *likely* increasing

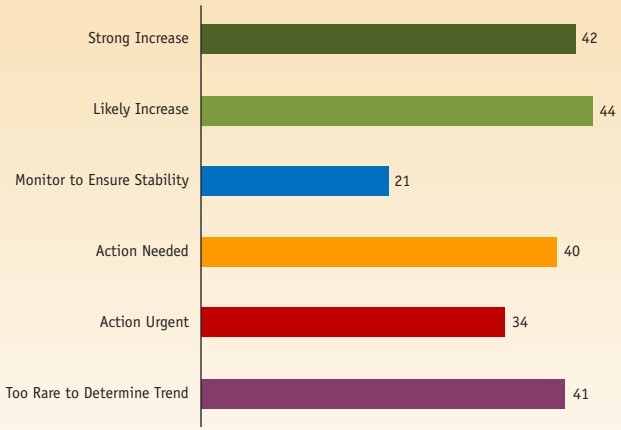
Number of Species Per Block Atlas 2



Breeding Bird Atlas 2 is available as an eBook!

Visit www.massaudubon.org/bba2 to view all the data, or link to the eBook.

Conservation Status of Massachusetts Breeding Birds from Atlas 2 and BBS Trends; number of species in category at end of bar. Species occurring in fewer than 10 blocks are classed as too rare to determine trend.



Drivers of Decline

CAUSES OF DECLINE

The conservation community has come a long way since the founding of Mass Audubon in 1896, when the organization was established to stop the killing of birds for the millinery trade—a devastating worldwide practice that was unchecked and nearly brought to an end the vast breeding colonies of herons and egrets in the US. Fortunately, times have changed and that historic driver of decline is no longer a factor for birds within the US, although for some species that winter in the tropics unrestricted and illegal hunting still plays a role in the species' declines (*see Roseate Tern in this document*).

Today the drivers of decline are more pernicious and more widespread (habitat fragmentation), and the effects are sometimes insidious (toxic accumulation), incremental (tiny decreases in the reproductive rate leading to certain areas becoming breeding "sinks"), or stunningly complex (climate change). Regrettably, these drivers are accelerating worldwide and are accumulative over time.

To halt the declines of our breeding birds identified in Atlas 2 and to sustain stable breeding populations in Massachusetts, it is imperative that we identify the pressures, or *limiting factors*, facing breeding birds in the Commonwealth. Often it is a devastating mix of factors that collectively cause declines. For some, like aerial insectivores, the birds that feed on insects while on the wing, the causes are elusive and as yet unknown. Fortunately, there is a growing body of scientific evidence that is helping to identify, clarify, and address some of Massachusetts' breeding birds' key limiting factors, which include the following:

Snowy Egret

- Habitat loss and fragmentation in Massachusetts as well as on the wintering grounds
- Habitat degradation here and on the wintering grounds
- Toxic chemicals affecting the birds and their food
- Ground predators (including domestic cats)
- Collisions with human-made structures
- Habitat despoilers such as deer
- Climate change

HABITAT LOSS

When the habitats that breeding birds rely on vanish, bird population declines inevitably follow. Some species are generalists that are able to make use of several habitats for breeding, and our analyses show that many of these species are doing well. Other species are specialists—obligate users of just one specific habitat—and for these species the story is less optimistic. When specialists are unable to find a place to nest they can't just find the "next-best thing"—they have evolved to occupy a specific niche. This mortal game of "musical chairs" is playing out in Massachusetts as an iconic landscape of New England decreases. The loss of farmland, fallow fields, old fields, and shrubby fields is driving the decline of the species that specialize in those landscapes.

LOSS OF AGRICULTURAL LANDS, GRASSLANDS, AND SHRUBLANDS

Massachusetts, like much of the Northeastern US, changed dramatically after European settlement in the early 1600s. What was once a primarily forested region was gradually cleared for agriculture so that by the middle 1800s less than 40% of Massachusetts was forested. Along with this landscape change came an influx of breeding species from the long and tallgrass prairies of the Midwest.

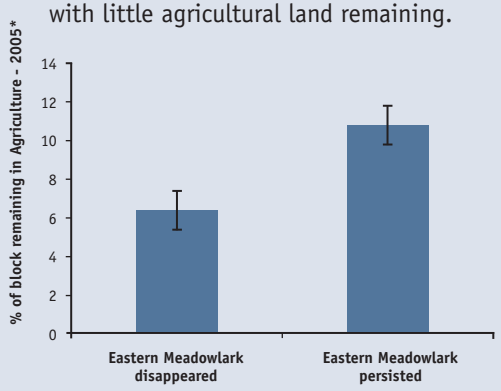
OUR ACTIONS MATTER

Some argue that because many breeding species that rely on fallow agricultural land, grasslands, and shrublands were historically rare in Massachusetts, we should not be concerned with their declines. However, many of these species are also in trouble across their entire range. Grassland species are suffering from documented habitat loss in the historic core of their breeding range. **Specifically, more than 97% of the native grasslands of the US have been lost, mostly because of conversion to high-intensity agriculture in the West. Consequently, grassland birds as a group have declined more than any other group**.

Accordingly, the Commonwealth's regional responsibility for helping to maintain North American populations of breeding grassland birds at a healthy level may be greater than ever before. Mass Audubon is working in concert with the conservation community to ensure that the state's remaining grasslands and shrublands are managed with birds in mind. These include agricultural lands, municipal lands, airports, and actively managed forests.

Vesper Sparrow

Eastern Meadowlark:
More likely to disappear from Atlas blocks with little agricultural land remaining.



*With standard error

When preliminary analyses were conducted on the Atlas 2 data, species like the Eastern Meadowlark were clearly showing declines in response to the loss of agricultural land. *(Read more about this topic in the Eastern Meadowlark and Brown Thrasher case studies.)*

Since the early 1900s, however, the amount of land in agriculture has dwindled. A coinciding decline in breeding grassland and shrubland birds has become particularly apparent, with species including the Eastern Meadowlark, American Kestrel, and Savannah Sparrow essentially "blinking out" across the state. So, what has happened to agricultural land?

Initially, the landscape began to revert back to its earlier, forested state, a process known as succession, but in recent decades this trend toward increased forest has stopped, even as open agricultural lands, grasslands, and shrublands continue to disappear. Today, the loss of our fields and shrublands appears to be driven more by human development than by succession—a factor that has taken its toll on our forests as well.

LOST WITH THE LAND: AGRICULTURAL LANDS

The loss of agricultural lands, including the iconic barns that used to dot the New England landscape, is contributing to the decline of many species, including:

- Short-eared Owl
- Eastern Meadowlark
- Northern Bobwhite
- Vesper Sparrow
- Barn Owl
- American Kestrel
- Cliff Swallow
- Upland Sandpiper
- Horned Lark
- Bank Swallow
- Grasshopper Sparrow
- Song Sparrow
- Barn Swallow
- Red-winged Blackbird
- Eastern Kingbird
- Savannah Sparrow

Nashville Warbler, a shrubland-nesting bird, declined from 164 blocks in Atlas 1 to only 102 blocks in Atlas 2.

LOST WITH THE LAND: **SHRUBLANDS**

Shrubland-nesting species are declining in general, but those that nest only in shrublands are showing some of the steepest declines of any group in the Commonwealth.

- Golden-winged Warbler
- White-eyed Vireo
- Nashville Warbler
- White-throated Sparrow
- Black-billed Cuckoo
- Brown Thrasher
- Prairie Warbler
- Field Sparrow
- Chestnut-sided Warbler
- Eastern Towhee

American Kestrel continues to decline in the state, and is in need of urgent conservation action.

HABITAT FRAGMENTATION

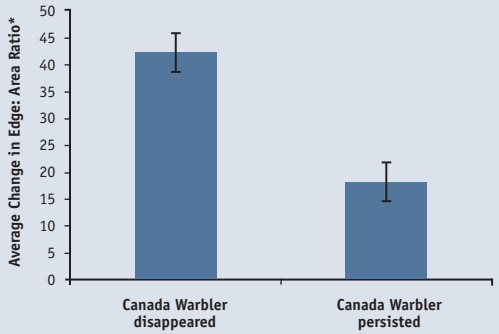
Rather than being lost outright, sometimes large areas of habitat become subdivided by human-created features like roads and housing developments, leading to what is known as *habitat fragmentation*. A fragmented habitat can obstruct movement and make it easier for invasive species and predators to spread. This splintering effect can have dire consequences for breeding birds and can occur across many habitat types, including salt marshes, freshwater swamps and marshes, forests, and grasslands.

Two views near Plymouth, March 1995 and November 2012, showing fragmentation of the forest during that time period. Habitat degradation and fragmentation associated with development is larger than the actual footprint of the development. Mass Audubon estimated the negative effects of development actually impact an area three to four times greater than the developed footprint, see Mass Audubon's *Losing Ground* at www.massaudubon.org/losingground/. Image courtesy of US Geological Survey, Mass GIS, and Google Earth.

EDGE EFFECTS OF HABITAT FRAGMENTATION

Many bird species are area sensitive. Some will not occupy small patches of breeding habitat below a certain threshold, even when that habitat might appear suitable to human eyes. Others, including those inhabiting wooded suburban landscapes, may continue to use the small patches but are susceptible to what are known as edge effects. For example, roads, suburban yards, and power lines along wooded edges often serve as corridors for nest predators so that birds nesting near these features are more likely to sustain predation. Brown-headed Cowbirds also tend to be very common along habitat edges. This nest parasite will lay its own eggs in the nests of other species so that the host species ends up using its resources to raise the young cowbird at the expense of its own young. Atlas 2 analyses indicate that for several forest species (e.g., Canada Warbler), edge effects likely play a role in Massachusetts declines.

Canada Warbler



Brown-headed Cowbirds don't build their own nests; they lay their eggs in the nests of other birds. They increase in forests as the forests are fragmented.

Raccoons and other nest predators can increase when human development increases.

LOST WITH THE LAND: AREA SENSITIVITY

Some breeding species need particularly large patches of habitat. These species are area sensitive and managing for those species requires preserving large parcels of land. Examples of declining species in Massachusetts that are highly or moderately area sensitive:

- Black-and-white Warbler
- Scarlet Tanager
- Wood Thrush
- Eastern Meadowlark
- Grasshopper Sparrow
- Savannah Sparrow

Black-and-white Warbler

Other Drivers of Decline

HABITAT DEGRADATION: THE SINK

The collective effects of suburbanization, sprawl, fragmentation, and loss can create habitats that become "sinks"—places where breeding birds may exist but have low reproductive rates resulting from predation, lack of food, or increased disturbance, making them unable to "replace themselves." Habitats may also suffer degradation from the accumulation of toxic chemicals or the introduction of invasive species. The greatest danger of degraded habitats is that they often still appear to be suitable, both to humans and to birds. Unfortunately, because birds have so much difficulty successfully raising chicks in degraded habitats, the parents receive little to no "return" on their reproductive "investment," which over time leads to decreases in population.

Freshwater wetland invaded by Purple Loosestrife.

PESTICIDES

Honeybee

Tree Swallow

Over 100 pesticides used in the US have been identified as causing direct mortality in birds. Particularly worrisome is emerging evidence that neonicotinoids, the most widely used insecticides worldwide and known for their association with bee declines, are also lethal to birds (*see more about this under the Eastern Meadowlark case study*). In fact, the use of pesticides may be the primary factor behind grassland bird declines in high-intensity agricultural areas, as well as being responsible for the wholesale decline of aerial insectivores—predominantly swallows, flycatchers, and swifts—that rely exclusively on insects in the air for their food *(read more about this in the Cliff Swallow case study)*.

HEAVY METALS

Lead and mercury, as well as other heavy metals, are toxic to birds. Most shot used in hunting still contains lead, as do many fishing weights, and poisoning can occur when waterbirds mistakenly ingest fragments or pellets. Lead poisoning has been an especially debilitating factor for Common Loon populations in the Northeast. Fortunately, in Massachusetts we are beginning to combat this issue with new laws that prohibit the use of small lead sinkers for freshwater fishing.

Mercury, similarly dangerous to birds, enters the environment primarily as methylmercury, a byproduct of burning coal. This highly toxic form of mercury is known to be widespread throughout the Northeast. Songbirds such as Wood Thrushes have been shown to suffer neurological disorders caused by mercury exposure, and wrens and sparrows may change their singing behavior in response to high mercury levels. All of these factors can disrupt breeding processes and lead to declines (*see more about this under the Saltmarsh Sparrow case study*).

Common Loon

PRESSURES ON THE WINTERING GROUNDS

American Redstart

Although our breeding birds pass a very important few months with us in Massachusetts, the rest of the year for many species is spent beyond Massachusetts borders during migration and over the winter. The greatest threat that migrants overwintering in Central and South America face is habitat loss, which results in some individuals having to settle in suboptimal habitats. Some birds that spend the winter in these poor-quality habitats may fail to survive until the breeding season. Those that do survive may arrive on their breeding grounds underweight and in poor condition, reducing their breeding success.

Climate change is also predicted to affect our breeding birds on their wintering grounds. Furthermore, although migratory songbirds are not typically hunted in the tropics, many migrant shorebirds and terns are, which can have devastating effects on their populations.

BIRD STRIKES

There are estimates that bird strikes, or collisions with human structures and vehicles, are the number two direct killer of birds. During migration or as they travel through their daily lives, millions of birds collide with human structures such as buildings, power lines, radio towers, and wind turbines, as well as with automobiles, trucks, and aircraft.

Buildings, particularly multi-story ones, are among the greatest threats, prompting programs like Lights Out Boston, which involves participating commercial building managers agreeing to turn off all lights during critical periods like migration. As most of us have witnessed firsthand, house windows can also injure or kill birds, and with construction of large homes still occurring, a majority of which have two or more stories, this threat will only continue to increase.

The number of automobiles and trucks on the road in the Commonwealth also continues to proliferate. Cars registered in Massachusetts reached the 5 million mark in 2010, a number that is growing and putting birds in increased peril as they attempt to live alongside our roads and highways.

As wind turbines increase across the landscape, there will inevitably be an added strike risk to birds, and it will be imperative that these structures be sited in a way to minimize that risk.

CATS

Indoor cat (Ibby)

The domestic cat represents one of the most serious threats to breeding birds in North America. Recent analyses indicate that at least one billion birds are taken by cats annually in the US, and the total number may be much higher. The species most affected are native songbirds, which have a total US population estimated at only 10 to 20 billion so that this annual loss is quite significant. Predators are the number one cause of nest failure for our breeding birds, and domestic cats, which we can control, contribute substantially to this source of mortality.

DEER

Another serious threat to our breeding birds is an overabundance of White-tailed Deer, particularly in the eastern region of the Commonwealth. While deer are native, their statewide population has grown exponentially. State biologists consider 10 to 20 deer per square mile to be sustainable in most regions, but numbers are substantially higher in the east, with the density on Nantucket exceeding 45 to 55 per square mile.

High densities of deer in an area can browse the understory of a forest or shrubland to the point that there is little or no ground cover. When the understory is removed or extensively thinned, nests are more vulnerable to predators. Overgrazing can also cause a decline in the insects that are necessary to feed nestlings; and, although they are primarily herbivores, deer will eat eggs and nestlings.

White-tailed Deer

Northern Cardinal

CLIMATE CHANGE

Human activities have elevated the concentrations of heat-trapping gases in our atmosphere. As global temperatures climb and sea levels rise, birds in Massachusetts have begun responding to some of these environmental shifts and will continue to face the challenges of climate change into the future.

Atlas 2 demonstrates the recent northward expansion of the breeding ranges of a number of historically "southern" species, including familiar and popular birds like Northern Cardinals and Tufted Titmice. Overall, Massachusetts breeding birds considered most at risk from climate change include species that migrate to the tropics, species associated with northern forests, and coastal breeders. *(Read more about climate change in the Saltmarsh Sparrow case study.)* However, it is important to recognize that all breeding birds will be affected by climate change to some degree, and it is difficult to predict exactly which species will be most negatively impacted and how they will adjust.

Black-throated Blue Warbler

CLIMATE AND FORESTS

It is predicted that the composition of our forest birds will change markedly as the climate warms. The current forest cover in Massachusetts is predominantly composed of oak, hickory, and pine in the eastern part of the state, and northern hardwoods and hemlock are abundant in central and western sections. Predictions are that it will eventually become too warm in the Commonwealth to support the northern forests so that the oak, hickory, and pine forests will eventually cover most of the state. Along with these changes, we can expect to see increasingly fewer bird species associated with northern forests such as the Black-throated Blue Warbler and Yellow-rumped Warbler. Many of these species are also long-distance migrants, so they will also be encountering the challenges faced by this group of birds.

CLIMATE AND LONG-DISTANCE MIGRANTS

Atlas 2 revealed that long-distance migrants that breed in the Commonwealth are more likely to have declined than resident species. Some scientists believe that such patterns result in part from migratory species not having adequately adjusted their migration schedules to coincide with the shifting "peaks" of their food sources, such as fruiting plants and insect emergences. These so-called decoupling effects can have adverse impacts on breeding birds, especially if food is insufficient to raise young when peak abundance periods are missed or otherwise become out of sync. More research is needed in this area to make this connection explicit, but the delicate balance of seasons and climate on which migration depends may be in danger of serious disruption.

Bobolink

CLIMATE AND COASTAL-NESTING BIRDS

The increased flooding and coastal erosion already occurring in Massachusetts as a result of climate change will continue to impact many of our coastal breeding birds. For instance, it is unlikely that Massachusetts salt marshes will be able to expand inland to sufficiently offset habitat loss caused by current and future rates of sea-level rise, which is right now occurring at approximately 3 mm per year. This overall decline in the extent of marshes will remove habitat for salt marsh specialists like Saltmarsh Sparrows, Seaside Sparrows, Willets, and Clapper Rails—birds that already face a variety of threats to their habitats caused by development, filling, draining, diking, and pollution. High-intensity storms will also continue to degrade and destroy habitat for beach-nesting species such as the Piping Plover, Roseate Tern, and American Oystercatcher.

American Oystercatchers

Winners and Losers by Habitat

Below are the breeding birds in each habitat that are increasing as well as those that are declining and that Mass Audubon ranks as Conservation/Monitoring Needed or Conservation Action Urgent. Species with names in italics are Whispering species—those with a stable or increasing Atlas 2 footprint, but with declining abundance reports from other studies.

WOODS AND FORESTS

Increase

Sharp-shinned Hawk
Red-bellied Woodpecker
Black Vulture
Wild Turkey
Common Raven
Blue-gray Gnatcatcher
Acadian Flycatcher
Cooper's Hawk
Evening Grosbeak
Barred Owl
Fish Crow
Worm-eating Warbler
Pine Warbler
Turkey Vulture
Orchard Oriole
Pileated Woodpecker

Yellow-throated Vireo
Warbling Vireo
Ruby-throated Hummingbird
Northern Saw-whet Owl
Yellow-bellied Sapsucker
Winter Wren
Pine Siskin
Brown-headed Cowbird
Cerulean Warbler
Great Crested Flycatcher
Red-tailed Hawk
Blue-headed Vireo
Golden-crowned Kinglet
Hermit Thrush
Tufted Titmouse

Red-breasted Nuthatch
Great Horned Owl
Black-throated Blue Warbler
Magnolia Warbler
Yellow-rumped Warbler
Brown Creeper
Hairy Woodpecker
White-breasted Nuthatch
Downy Woodpecker
Veery
Black-throated Green Warbler
Ovenbird
Chipping Sparrow
American Crow
Blackburnian Warbler

Decrease

Green Heron
American Robin
Eastern Wood-Pewee
Blue Jay
Scarlet Tanager
Baltimore Oriole
Rose-breasted Grosbeak
Northern Flicker
Least Flycatcher
Ruffed Grouse
Wood Thrush
Broad-winged Hawk
Black-and-white Warbler
Northern Goshawk
Canada Warbler
Olive-sided Flycatcher
Eastern Whip-poor-will
Long-eared Owl
Purple Finch

GRASSLANDS, AGRICULTURE, AND OPEN FIELDS

Increase

Wild Turkey
Eastern Bluebird
Brown-headed Cowbird
Bobolink

Decrease

Savannah Sparrow
Song Sparrow
Eastern Kingbird
Red-winged Blackbird
Grasshopper Sparrow
Barn Swallow
Bank Swallow
Horned Lark
Sedge Wren
Upland Sandpiper

Vesper Sparrow
Barn Owl
Cliff Swallow
American Kestrel
Eastern Meadowlark
Short-eared Owl
Northern Bobwhite
Ring-necked Pheasant (INTRODUCED)
Henslow's Sparrow

a. Evening Grosbeak **b.** Purple Finch **c.** Eastern Bluebird **d.** Horned Lark

Winners and Losers by Habitat

SHRUBLANDS, EDGE, AND EARLY SUCCESSIONAL

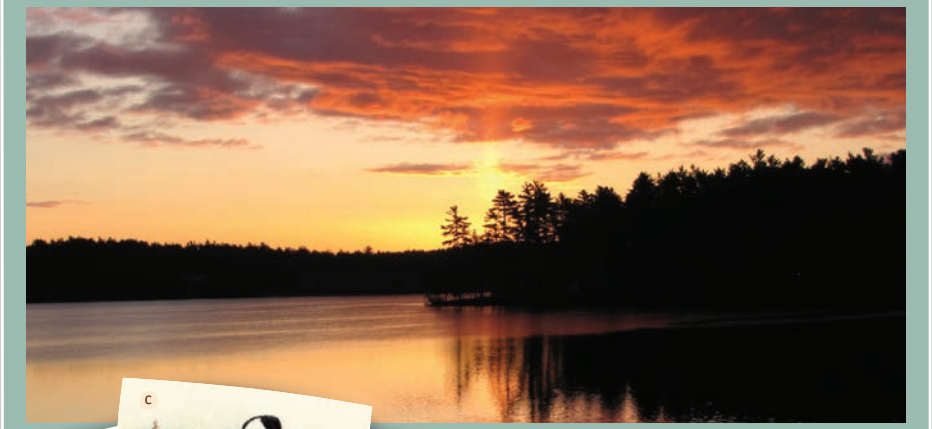
Increase

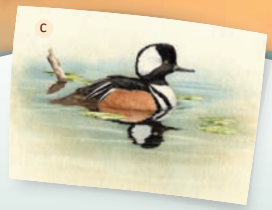
- Carolina Wren
- Wild Turkey
- Eastern Bluebird
- Willow Flycatcher
- Yellow-throated Vireo
- Warbling Vireo
- Ruby-throated Hummingbird
- Alder Flycatcher
- Brown-headed Cowbird
- Yellow Warbler
- Great Crested Flycatcher
- Cedar Waxwing
- Northern Cardinal
- Yellow-billed Cuckoo
- Eastern Phoebe
- Indigo Bunting
- American Goldfinch
- Mourning Dove

Decrease

- Northern Harrier
- *Prairie Warbler*
- *Song Sparrow*
- *Eastern Kingbird*
- *House Wren*
- *Common Yellowthroat*
- *American Robin*
- *Blue Jay*
- Chestnut-sided Warbler
- *Least Flycatcher*
- Field Sparrow
- Ruffed Grouse
- Black-billed Cuckoo
- Eastern Towhee
- Brown Thrasher
- White-eyed Vireo
- Nashville Warbler
- Golden-winged Warbler
- Eastern Whip-poor-will
- White-throated Sparrow
- Common Nighthawk
- Northern Bobwhite
- Ring-necked Pheasant (INTRODUCED)

RIVERS, LAKES, PONDS





Increase

- Double-crested Cormorant
- Great Egret
- Mute Swan (INTRODUCED)
- Canada Goose
- Great Blue Heron
- Hooded Merganser
- Common Merganser
- Belted Kingfisher
- Mallard
- Wood Duck
- Northern Rough-winged Swallow

Decrease

- Snowy Egret
- Black-crowned Night-Heron
- Green Heron
- American Black Duck
- Bank Swallow
- Blue-winged Teal

a. Cedar Waxwing **b.** Northern Bobwhite **c.** Hooded Merganser **d.** Blue-winged Teal

WOODED FRESHWATER WETLANDS

Canada Goose
Red-bellied Woodpecker
Carolina Wren
Blue-gray Gnatcatcher
Acadian Flycatcher
Barred Owl
Great Blue Heron
Hooded Merganser
Red-shouldered Hawk
Pileated Woodpecker
Eastern Bluebird
Willow Flycatcher
Yellow-throated Vireo
Warbling Vireo
Northern Saw-whet Owl
Ruby-throated Hummingbird
Alder Flycatcher
Yellow-bellied Sapsucker
Northern Waterthrush
Winter Wren
Louisiana Waterthrush
Northern Parula
Hooded Warbler
Belted Kingfisher
Mallard
Wood Duck
Brown-headed Cowbird
Yellow Warbler
Tufted Titmouse
Great Horned Owl
Great Crested Flycatcher
Swamp Sparrow
Brown Creeper
Hairy Woodpecker
White-breasted Nuthatch
Downy Woodpecker
Veery

Increase

Decrease

Black-crowned Night-Heron
Green Heron
Song Sparrow
Red-winged Blackbird
Eastern Kingbird
House Wren
Common Grackle
Common Yellowthroat
Northern Flicker
American Black Duck
European Starling
Canada Warbler
Olive-sided Flycatcher

FRESHWATER MARSH

Great Egret
Mute Swan (INTRODUCED)
Canada Goose
Virginia Rail
Hooded Merganser
Red-shouldered Hawk
Spotted Sandpiper
Belted Kingfisher
Marsh Wren
Mallard
Wood Duck
Brown-headed Cowbird
Sora
Yellow Warbler
Swamp Sparrow

Increase

Decrease

Least Bittern
Northern Harrier
Pied-billed Grebe
Green Heron
Song Sparrow
Red-winged Blackbird
Common Yellowthroat
Green-winged Teal
American Black Duck
Sedge Wren
American Bittern
Common Moorhen
Blue-winged Teal

a. Great Blue Heron **b.** Canada Warbler **c.** Belted Kingfisher **d.** Green-winged Teal

Winners and Losers by Habitat

SUBURBAN

Increase

Mute Swan (INTRODUCED)
Sharp-shinned Hawk
Canada Goose
Red-bellied Woodpecker
Common Raven
Wild Turkey
Cooper's Hawk
Carolina Wren
Fish Crow
House Finch (INTRODUCED)
Pine Warbler
Blue-gray Gnatcatcher
Orchard Oriole
Barred Owl

Pileated Woodpecker
Eastern Bluebird
Warbling Vireo
Ruby-throated Hummingbird
Red-shouldered Hawk
Yellow-bellied Sapsucker
Pine Siskin
Belted Kingfisher
Red-tailed Hawk
Marsh Wren
Mallard
Northern Rough-winged Swallow

Wood Duck
Tufted Titmouse
Great Horned Owl
Great Crested Flycatcher
Cedar Waxwing
Northern Cardinal
Hairy Woodpecker
White-breasted Nuthatch
Brown-headed Cowbird
Eastern Phoebe
Downy Woodpecker
Chipping Sparrow
American Goldfinch
Mourning Dove
American Crow

Decrease

Rock Pigeon (INTRODUCED)
Eastern Wood-Pewee
Song Sparrow
Baltimore Oriole
Chimney Swift
Rose-breasted Grosbeak
House Wren
House Sparrow (INTRODUCED)
Common Grackle
Red-winged Blackbird

Common Yellowthroat
American Robin
Barn Swallow
Northern Flicker
Blue Jay
Bank Swallow
Barn Owl
European Starling (INTRODUCED)
Purple Martin
Cliff Swallow
American Kestrel
Common Nighthawk

URBAN

Increase

Mute Swan (INTRODUCED)
Canada Goose
House Finch (INTRODUCED)
Red-tailed Hawk
Mallard

Decrease

Rock Pigeon (INTRODUCED)
Chimney Swift
House Sparrow (INTRODUCED)
Herring Gull
European Starling (INTRODUCED)
American Kestrel
Common Nighthawk

a. House Finch **b.** Common Yellowthroat **c.** Red-tailed Hawk **d.** Common Nighthawk

COASTAL

Willet
Double-crested Cormorant
Great Egret
Rock Pigeon
(INTRODUCED)
Common Eider
Belted Kingfisher
Spotted Sandpiper
Osprey

Increase

Decrease

Black-crowned Night-Heron
Savannah Sparrow
Piping Plover
Snowy Egret
Least Tern
Great Black-backed Gull
Common Tern
Green Heron
Song Sparrow
Herring Gull
Roseate Tern
Arctic Tern
Horned Lark
Bank Swallow

SALT MARSH

Willet
Mute Swan
(INTRODUCED)
Canada Goose
Virginia Rail
Marsh Wren
Belted Kingfisher
Osprey

Increase

Decrease

Saltmarsh Sparrow
Northern Harrier
Common Tern
Red-winged Blackbird
Seaside Sparrow
American Black Duck
Barn Owl

a. American Oystercatcher **b.** Bank Swallow **c.** Osprey **d.** American Black Duck

CASE STUDY: EASTERN MEADOWLARK

STATUS

Local and strongly declining; conservation action urgent; State Wildlife Action Plan listed

"Have the breezes of time blown their blossomy faces / Forever adrift down the years that are flown? / Am I never to see them romp back to their places, / Where over the meadow, / In sunshine and shadow, / The meadow-larks trill, and the bumblebees drone?"

– James Whitcomb Riley,
"The Boys"

The Eastern Meadowlark is only distantly related to the true larks. Despite its bright coloration, the meadowlark is actually a member of the blackbird family, Icteridae. No idyllic scene of a grassy pastoral landscape is complete without a meadowlark singing from atop a fencepost, but unfortunately this sight is becoming increasingly rare in the Commonwealth these days. The Eastern Meadowlark's cheerful song can still be heard by those willing to seek it out, but all evidence points to a serious decline for this iconic bird of our countryside.

DRIVERS OF DECLINE

- Agricultural habitat loss associated with natural succession and urbanization.[7]
- Reduction in habitat quality due to intensification of agricultural practices.[7,8,12]
- Reduction in the size of grasslands and a resulting increase in the amount of edge.[3,9]

BREEDING HABITAT PREFERENCES

Eastern Meadowlarks prefer grasslands that have moderately tall live grass, an abundance of dead grass cover, moderate to high "weed" density, and very little woody vegetation. They are known to breed in tallgrass prairie, planted cover, pastures, hayfields, reclaimed surface mines, and semidesert grasslands.[6,12] They nest on the ground in dead grass clumps or under overhanging grasses. Habitat edges are avoided because predation rates are known to be higher at edges.[9] Because nest predation rates decrease as the size of the habitat increases, larger (>250 acres) grasslands are very important for this species.[3]

AGRICULTURE AND EASTERN MEADOWLARKS

Some agricultural practices may negatively affect Eastern Meadowlark breeding success.[7,8,9] Haying and mowing during the breeding season can cause egg, chick, and adult mortality. Livestock grazing may significantly alter grassland habitat, making it unsuitable for Eastern Meadowlarks, particularly if the grazing intensity is high or if grazing occurs during the breeding season. Livestock can also trample nests and will occasionally eat the eggs if they stumble across a nest. Additionally, pesticide use can be detrimental to Eastern Meadowlarks as well as other grassland species.

POTENTIAL MANAGEMENT OPTIONS

Management of Eastern Meadowlarks should focus on restoring and preserving suitable habitat. Regular management is required to retain grasslands in the appropriate stage, promote vegetative diversity, and prevent woody vegetation encroachment. With appropriate frequency and timing, mowing, haying, grazing, and/or burning can be successful management methods.[2,5,6,7,10,13,14,15]

Researchers suggest:

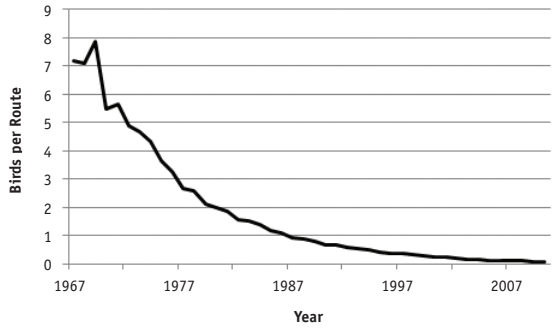
- A rotational schedule of management practices.[6,7]
- Mowing and haying only outside of the breeding season.[2,5,13,15]
- Low- to moderate-intensity grazing when employed in a rotational system.[6,7,14]
- Incomplete burning every 3 to 5 years, not annually.[2,6,7,10,13,14]

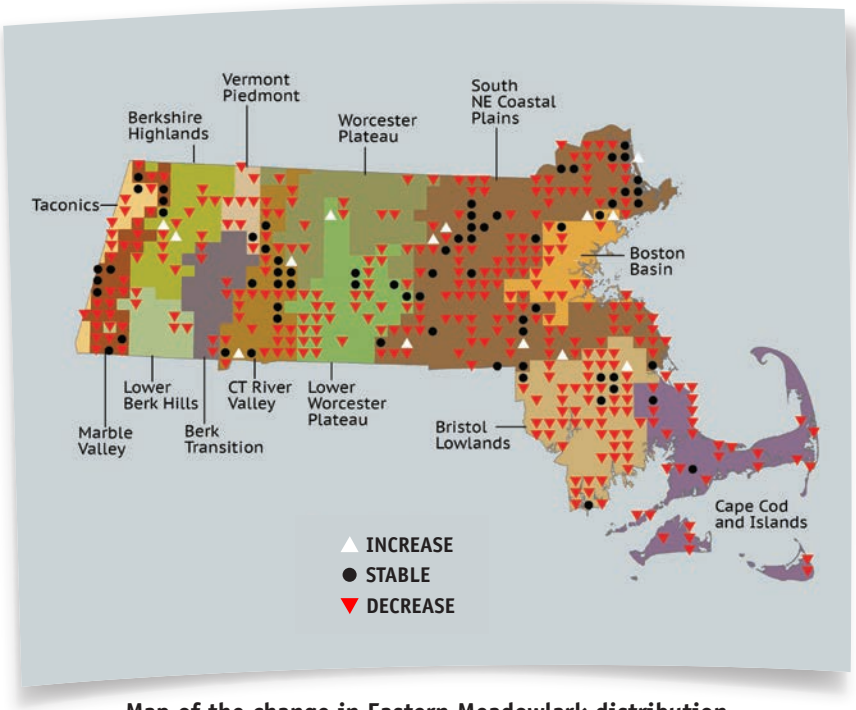
Eastern Meadowlark breeding habitat.

CONSERVATION PLANS

No comprehensive national conservation plans exist for Eastern Meadowlarks, though the USGS Northern Prairie Wildlife Research Center has issued a report titled "Effects of management practices on grassland birds: Eastern Meadowlark."[6] Eastern Meadowlarks are also included in Partners in Flight's *North American Landbird Conservation Plan*,[11] and their regional plans for northern[4] and southern New England.[1]

Breeding Bird Survey estimate of the trend for Eastern Meadowlark in Massachusetts from 1966-2008.





Map of the change in Eastern Meadowlark distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

We've Seen This Movie Before—A Lesson from the UK

In 1999 the British bird conservation community published its first annual *The State of the United Kingdom's Birds*. It contained a number of success stories about species rescued from the brink of extinction. But the big revelation in the report was the unhappy news that many "common" birds had declined disastrously during the preceding 30 years. Perhaps the most iconic of these familiar denizens of the European farmscape was Shelley's blithe spirit, the Skylark.

With the passage of time, the similarities between our successes and incipient failures in bird conservation and those in the UK have become more and more striking. Here in Massachusetts, we too have had admirable successes in "bringing back" the Bald Eagle, Osprey, and Piping Plover. Likewise, we have until recently tended to overlook the plight of our own iconic farmland birds, notably another aerial songster, the Eastern Meadowlark.

Meadowlarks are not larks, but members of the New World blackbird family and kin to orioles and that other grassland specialist the Bobolink. In matters of size, structure, plumage characteristics, and voice, meadowlarks and Skylarks have little in common. Their likeness—and their shared misfortune—lies in their dependence on their grassland habitat. Both nest on the ground and in the absence of trees or shrubs both sing either from a fence post or on the wing. And until recently both thrived in the cultivated grasslands of once-dominant farmland.

Meadowlarks are known to nest in a wide variety of grassland types, but they prefer fields dominated by fairly tall grasses with lots of plant litter at ground level, a good deal of nongrass herbs (forbs), and few or no trees or shrubs. The ground nest, typically concealed in a slight depression amidst dense grasses and weeds, is constructed from surrounding vegetation and fitted with a domelike structure of the same materials. The species also forages almost entirely on the ground with large insects, mainly crickets and grasshoppers, making up three-quarters of its diet, and seeds most of the rest.

During the agricultural period in Massachusetts, meadowlarks became abundant, forming migratory flocks of over a thousand birds in the fall. And while perhaps no American poet has yet penned a meadowlark poem to equal Shelley's tribute to the Skylark, it is probably fair to say that the meadowlark held a similar place in the hearts and minds of rural Americans. Many would have heard the song of this early-spring harbinger as Mabel Osgood Wright did: "It has a breezy sound, as fresh and wild as if the wind were blowing through a flute."

The fate of the Eastern Meadowlark has always been closely tied to that of farming, which has now been in decline in Massachusetts for more than a century. Just since 1971, nearly 150,000 of the approximately 400,000 acres of cropland and pasture then remaining in the Commonwealth have been converted to other

Eastern Meadowlark

Field with nesting meadowlarks in Williamstown, Massachusetts.

uses. So, in the broadest sense, it is possible to understand the flagging meadowlark population as a simple matter of habitat loss. But the species' distribution shrank by 76% between the two Massachusetts Breeding Bird Atlases (1979-2012), and the North American Breeding Bird Survey reports an *annual* population decrease of 10.4% in southern New England over the last 40 years, a population drop so precipitous that one is compelled to look for other causes of the decline.

The steep decline of common farmland birds in Britain was ultimately linked to "agricultural intensification" mandated by the Common Agricultural Policy (CAP) of the European Union (EU). This policy essentially eliminated all bird habitat in order to make the most efficient use of acreage, and it has successfully maximized crop yields. But it has also resulted in massive declines in farmland birds in EU member states. Massachusetts grassland birds also suffer to some extent from modern farming methods that increase productivity. A high-quality hay field, for example, will have been "cleaned" of the thick herbaceous growth that meadowlarks prefer. And in order to get two hay crops a year, farmers must do their first haying in June when the nesting meadowlarks are highly prone to disturbance.

The ground-nesting and foraging habits of meadowlarks also put them at increased risk compared with arboreal species. Of the 82 species of birds that nest on or near the ground in Massachusetts, 42% are already on the state endangered species list; another 32% are deemed in need of urgent conservation action; and 16% more are showing signs of decline. In the past, ground-nesting birds were able to sustain their populations despite mortalities from native predators such as skunks and raccoons.

Today, however, our fields are prowled by feral and free-ranging domestic cats, which have recently been shown to kill between 1.4 and 3.7 *billion* birds annually in the US It is a problem we could easily solve.

Finally, there is the pervasive problem of indiscriminate use of chemicals known to be toxic to both birds and people. Organophosphates, carbamates, polychlorinated biphenyls, and polybrominated diphenyl ethers are among the best known of the more than 100 toxic substances that have been measured in the tissues of at least 23 species of birds in many different families. The newest chemical threat is the so-called neonicotinoids, neurotoxins that have recently been implicated in colony collapse disorder in honeybees. Following a scientific investigation, a two-year moratorium has been declared on the use of neonicotinoids throughout the European Union, but not in the US. The substance presents two particular threats to meadowlarks: (1) It is very effective in killing plant eaters such as grasshoppers and crickets, which as noted are the meadowlark's principal food source; and (2) it is applied directly to seeds (so that the poison invades the plant tissue as it matures), another staple of a meadowlark's diet.

Perhaps we need to adjust our avian metaphor for detecting deadly threats in the environment. It seems that now the meadowlark is the canary and the meadow is the coal mine.

CONSERVATION CHALLENGES

- **Loss of farmland, grasslands, and open fields**
- **Pesticide use on farms**
- **Agricultural intensification that diminished the quality of breeding bird habitat on farms**

RECOVERY: FIRST STEPS

- **Develop a "best practices" guide for Bird-friendly Farms**
- **Map locations of all occupied breeding habitat**
- **Enhance quality of unoccupied habitats that may have recently been abandoned**
- **Advocate for keeping disturbance low in occupied nesting sites**

WHAT YOU CAN DO

- **Buy produce, eggs, and meat from local, sustainable, low-intensity farms. Visit farm stands and farmer's markets, or buy shares in a farm through Community Supported Agriculture (CSAs) programs**
- **Support open-space initiatives, farmland preservation activities, and grassland restoration projects in your area**
- **Keep cats indoors**

CASE STUDY: BROWN THRASHER

Brown Thrasher

STATUS

Fairly widespread and strongly declining; conservation action urgent; State Wildlife Action Plan listed

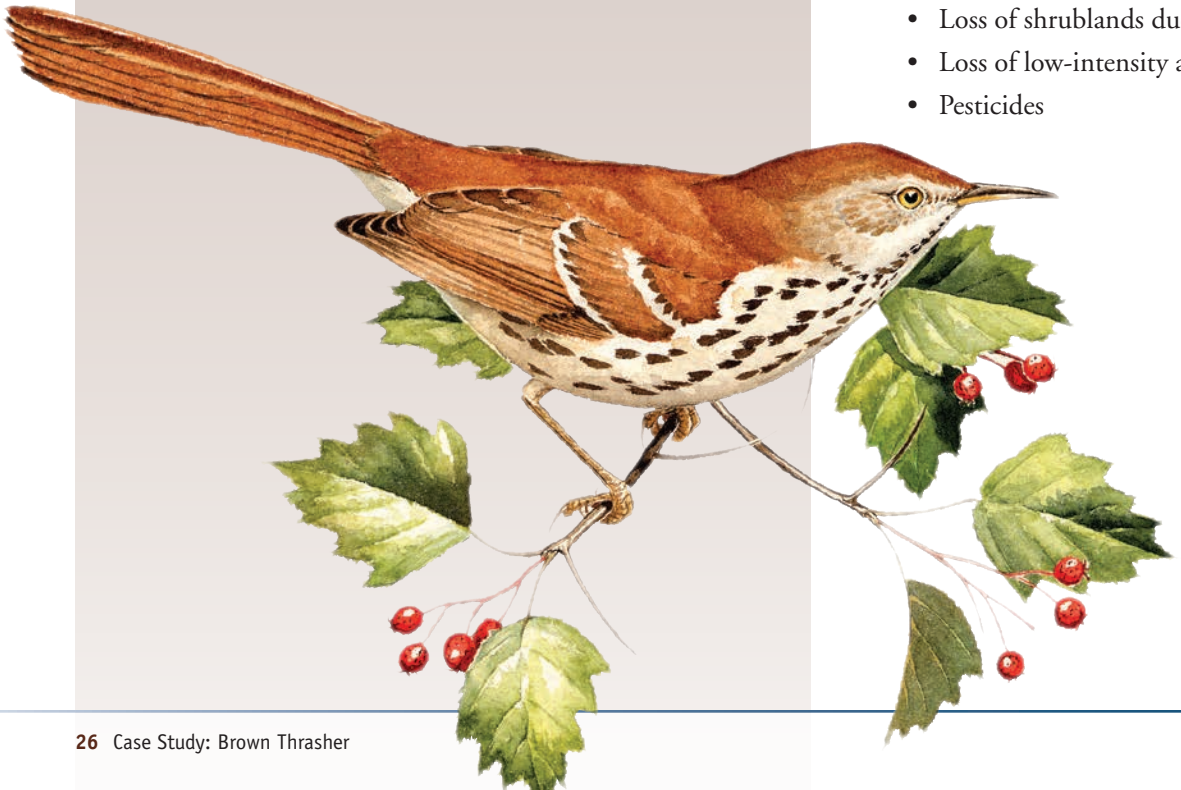
"Yet, without fail, every spring, since they first fished and hunted here, the brown thrasher has heralded the morning from a birch or alder spray,…"

– Henry David Thoreau, *A Week on the Concord and Merrimack Rivers*

The Brown Thrasher is the least often seen of our breeding mimids, and it is also the only thrasher species to breed east of the Mississippi. It's not hard to see why this bird is called a "thrasher" because it forages through the leaf litter, tossing leaves aside with vigorous sweeping motions until it uncovers a tasty morsel. As it happens, the bird's common name is actually a decayed form of the old name "thrusher," in reference to the bird's many thrush-like characteristics. Brown Thrashers seem less willing than the other mimids, catbirds, or mockingbirds to move into the suburbs alongside humans, and their numbers appear to be dropping accordingly. The fire-maintained scrub forests of southeastern Massachusetts were historically prime thrasher habitat, but times are changing.

DRIVERS OF DECLINE

- Loss of shrublands due to urbanization and natural succession
- Loss of low-intensity agriculture
- Pesticides



BREEDING HABITAT PREFERENCES

Brown Thrashers breed in habitats with dense low woody vegetation, including shrub thickets, hedgerows, mid-successional forest, and forest edges.[1,3,7,9,10] They typically build their nests in shrubs, particularly ones with thorns, and sometimes on the ground. Dense vegetation and the concealment it provides are very important for Brown Thrasher nest success because shrub-nesting species typically experience high rates of nest predation.[3,7]

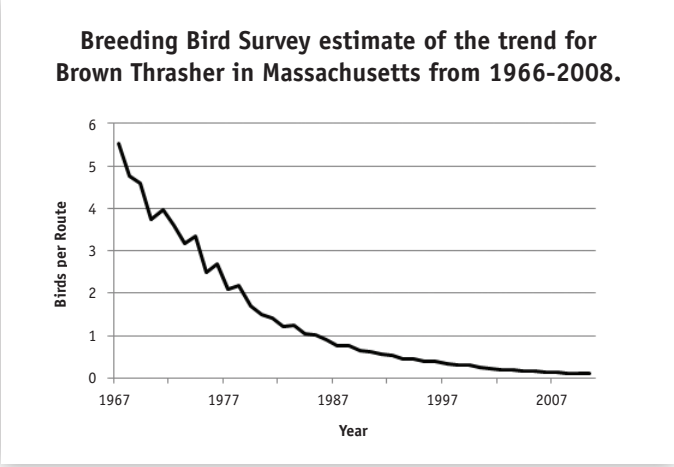
POTENTIAL MANAGEMENT OPTIONS

Brown Thrasher management should focus primarily on creating and preserving shrubby habitats.

Researchers suggest:

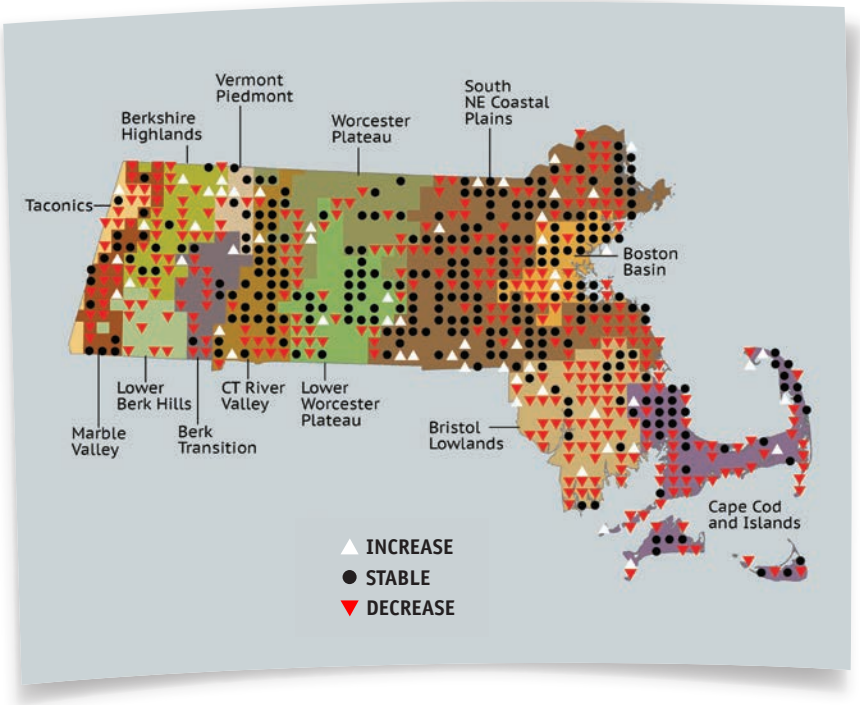
- Partial removal of woody canopy.[9]
- Low-intensity farming that includes hedgerows.[9]
- Reduction in the use of pesticides.[5]

Burning and grazing as management practices have received mixed reviews. Some researchers report that burning and grazing can be detrimental to Brown Thrashers[2] whereas others have found grazing to be beneficial to Brown Thrashers, perhaps because the presence of cattle may increase insect diversity.[5] Additionally, local information on the effects of grazing and burning on Brown Thrashers is needed before they are considered as primary management tools for this species in Massachusetts.



CONSERVATION PLANS

No comprehensive conservation plan currently exists for Brown Thrashers, though they are included in Partners in Flight's *North American Landbird Conservation Plan*,[8] as well as in their regional plans for northern[6] and southern New England.[4] Additional state-specific information is needed for this species in Massachusetts because most of the information on Brown Thrashers is from a limited portion of the species' range.[3]



Map of the change in Brown Thrasher distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

Living in Between

When we speak of "forest birds" or "grassland birds," our mind's eye sees a fairly clear picture of a distinctive habitat type. But if we want to discuss the kinds of places where Prairie Warblers or Eastern Towhees or Field Sparrows nest, we have a communications problem because they thrive in a landscape that seems to be neither. And the names that we have attached to these in between places—"transition zone," "successional habitat," "ecotone"—tend either to reinforce the vagueness or compound it by sounding "technical."

This "in between" habitat it is called "shrubland" for want of a more vivid label, and it supports a diverse and distinctive bird community that contains many of our most severely threatened species. In Massachusetts there are 53 species that use shrublands for nesting. Thirty six (36) of those species use shrublands along with other habitats for nesting, and 17 species are obligate shrubland nesters—they rely solely on shrublands for breeding. Of the obligate shrubland breeders, it is sobering to note, 9 of the species are declining and only 5 are increasing.

One of the most charismatic of the shrubland birds is the Brown Thrasher, whose graceful form, elegant rust-colored plumage, and somewhat secretive ways have made it a favorite among birdwatchers. Those who have taken the trouble to search it out in the dense hedgerows and briar patches in which it prefers to skulk may be rewarded with its distinctive song of paired phrases, or maybe the discovery of one of its bulky nests of sticks.

It was once familiar to farmers as the "planting bird" because its song, rendered as *drop it, drop it, cover it, cover it, I'll pull it up, I'll pull it up* accompanied the earliest tasks of the growing season. It remained common through the 1950s, not just in agricultural landscapes but also in suburban neighborhoods. In those days, before our current landscape aesthetic that focuses so much on neatness, neighborhoods had glorious "wastelands" of rank scrub and weed patches where snakes and caterpillars and other treasures of undomesticated childhood also found cover. These thickets and briar patches were home for nesting Brown Thrashers.

Thrashers retain tentative strongholds in coastal shrublands such as the heathlands of the South Shore, Cape Cod, and the Islands and the thickets of the North Shore, but elsewhere they are vanishing rapidly. Results from Atlas 2 demonstrate that they have lost 38% of the territory they occupied during Atlas 1—they colonized only a few blocks, and were extirpated from nearly as many blocks as those in which they were found. More alarming still, the North American Breeding Bird Survey records an *annual* population decrease of 8.4% between 1966 and 2010, and BBS also shows a decline of similar magnitude throughout the species' range.

The causes for the decline of this once-familiar and widespread songbird seem to be linked to a pattern of vulnerability strongly related to its habitat preferences.

- Because their nests are typically sited not far off the ground, thrashers are more likely to be vulnerable to predation by feral cats and natural predators, especially as shrubland habitat becomes increasingly rare and fragmented.

Brown Thrasher breeding habitat.

- Its affinity for agricultural habitats has resulted in significant mortalities of both adults and nestlings from pesticide applications (e.g., dieldrin and heptachlor), and, because thrashers habitually forage on the ground for insects and seeds, they are likely to be susceptible to ingesting the new nicotinoid insecticides such as imidacloprid.
- Thrashers are killed in unusually high rates of collisions with cars (among the top five species hit in some areas) and, during migration, with communications towers.
- Ultimately, it appears that the greatest single factor driving the thrasher's calamitous decline is loss and degradation of its shrubland habitat—that uncharismatic vegetation community characterized by bushes, tangles, hedgerows, and woodland edges.

There is no mystery surrounding the disappearance of shrublands. Before European colonization, natural cataclysms such as unchecked wildfires, floods, and blowdowns cleared forested areas sometimes over hundreds of square miles, returning the land to an earlier stage of vegetation. The cover of the land then grew back, and a "succession" of plant communities followed each other as the land tried in stages to return to forest. This is an altogether natural process and from a biodiversity perspective a highly beneficial one. Many of our native plant and animal species have evolved as functional members of defined successional stages. They arrive on stage for their appointed roles, and then exit, making way for new players. The Brown Thrasher, like many of our butterfly larvae and adults, depend on early-successional plants for their survival.

The land use practices of the colonists at first greatly expanded grasslands and shrublands, and because succession takes time these persisted long after the famers began to leave for the cities. But more recently, many of our tangles and briar patches large enough to support healthy populations of Brown Thrashers have reverted to forest. Most remaining farmland is so efficiently managed that unproductive hedgerows and the fallow fields that used to be a strategic part of working farms are no longer tolerated; wildfires are also extinguished as quickly as possible. If you are listening to a Prairie Warbler these days, another nesting bird found only in shrublands, you are most likely standing in a utility corridor where shrubland management is a byproduct of infrastructural maintenance.

Save the Shrublands! does not seem like a very promising slogan for a conservation campaign, but saving what we have, and creating more high-value shrublands when the opportunities are presented by other management activities, will be key to the survival of the nine obligate shrubland species urgently in need of conservation action.

Massachusetts has already lost the Golden-winged Warbler as a breeding bird, the Eastern Towhee is declining, and the Northern Bobwhite may slip away without intervention. Indeed, saving the shrublands will require management through methods such as mowing and grazing to keep the fields as young forests, and research shows that logging creates most of the new shrublands in the Commonwealth. Those *living in between*, it seems, may soon have nowhere left to breed if we do not *Save the Shrublands!*

CONSERVATION CHALLENGES

- **Loss and degradation of shrubland habitat**
- **No new habitat is being created, and understanding the role of appropriately sited forestry activities is important**
- **Most shrubland nesting birds nest on or near the ground. Ground predators (including cats) are increasing, and breeding bird reproduction may not be adequate**

RECOVERY: FIRST STEPS

- **Map the location of persistent breeding sites to create a monitoring program**
- **Measure habitat and disturbance variables in occupied breeding sites**
- **Develop a "best practices" guide for maintaining/creating shrubland habitat**
- **Understand the role utility rights-of-way (power and gas lines)can take in shrubland bird recovery**

WHAT YOU CAN DO

- **Keep your cat indoors**
- **Reduce use of pesticides**
- **Support low-intensity agriculture**
- **Support open space initiatives**

CASE STUDY: WOOD THRUSH

STATUS

Very widespread and likely declining; action/monitoring needed; State Wildlife Action Plan listed

"The thrush alone declares the immortal wealth and vigor that is in the forest."

– Henry David Thoreau, Journal

Thoreau wrote these words about the song of the Wood Thrush, the only forest thrush with enough tolerance for people to live in the modest woods near Thoreau's Concord home during the 1800s. The Wood Thrush's willingness to live near humans has allowed it to become the most widespread forest thrush in the Commonwealth. Its beautiful song can still be heard in nearly any deciduous or mixed forest of moderate size throughout the state, but there is evidence that this familiar songster is undergoing a quiet decline.

Wood Thrush nest.

DRIVERS OF DECLINE

- Forest fragmentation
- Habitat loss in wintering grounds

BREEDING HABITAT PREFERENCES

Wood Thrushes breed in mature broadleaf or mixed broadleaf and pine forests that have closed canopies, moderate subcanopies and moderate shrub density, with moist soil and good amounts of decaying leaf matter.[1,2,5,9] Wood Thrushes build their nests in the crotches of shrubs or trees, particularly saplings, so forests with a good density of saplings or shrubs are ideal for Wood Thrushes.[3,5,15] Moist soil with a decaying layer of leaf litter is important for Wood Thrushes because leaf litter increases the abundance of the soil invertebrates that constitute the majority of the Wood Thrush's diet.[5,16] In *A Land Manager's Guide to Improving Habitat for Forest Thrushes*, the authors report that Wood Thrushes focus more on the structure of the forest than on the degree of forest fragmentation when they are selecting suitable nesting habitat in the East/Midwest Forest Region.[15]

FOREST FRAGMENTATION AND WOOD THRUSHES

Forest fragmentation and edge effects have been a growing concern of bird conservationists as more large tracts of forest have been fragmented primarily by development. Fragmentation introduces "edge effects," most notably increased abundances of predators and brood parasites (e.g., Brown-headed Cowbirds) on bird species that are not adapted to dealing with these new challenges. However, the extent of the challenges of forest fragmentation on Wood Thrushes appears to be regionally specific. It was once believed that small forest fragments could not support self-sustaining

Wood Thrush populations. Recently, however, research has identified self-sustaining Wood Thrush populations in small (<50-acre) fragments[7] as well as non-self-sustaining populations in large (>2,500-acre) forest fragments.[18]

The *Birds in Forested Landscapes* project, started in 1997 by the Cornell Lab of Ornithology, has amassed a huge amount of data on forest fragmentation and forest birds. It found that Wood Thrushes in the East/Midwest Forest Region and in the Northern Forest Region were area sensitive and that the patches of forest most suitable for Wood Thrushes were at least 200 acres. Moderate suitability could be provided by smaller (e.g., 50-acre) fragments of forest that contain the appropriate habitat structure and composition.[15]

The variety of results regarding forest fragmentation and Wood Thrushes make it very important for managers to focus on data only from their region when assessing the quality of small forest fragments for Wood Thrushes, and to explicitly take into account the quality of the surrounding landscape.

TROUBLE ON THE WINTERING GROUNDS

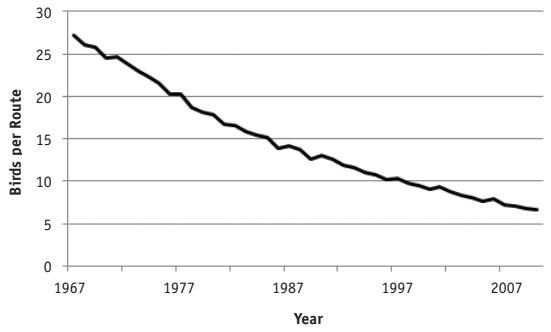
Forest fragmentation and degradation on the wintering grounds may be more significant for Wood Thrushes than the conditions on the breeding grounds.[5,6,11,14] Fast-disappearing tropical forests are increasingly being transformed into patchworks of habitat made up of stands of vastly differing quality. In these settings, less-dominant individuals, particularly females and young birds, are pushed out of the better quality patches and forced to survive the winter in typically drier sites with substantially less food. In *Ecology and Conservation of Neotropical Migrant Landbirds,* the author argues that forest fragmentation on the breeding grounds may not be the underlying factor causing the decline of Wood Thrush populations in many areas, but that tropical deforestation in the wintering grounds may be causing a low return rate of breeding individuals to their breeding grounds.[11]

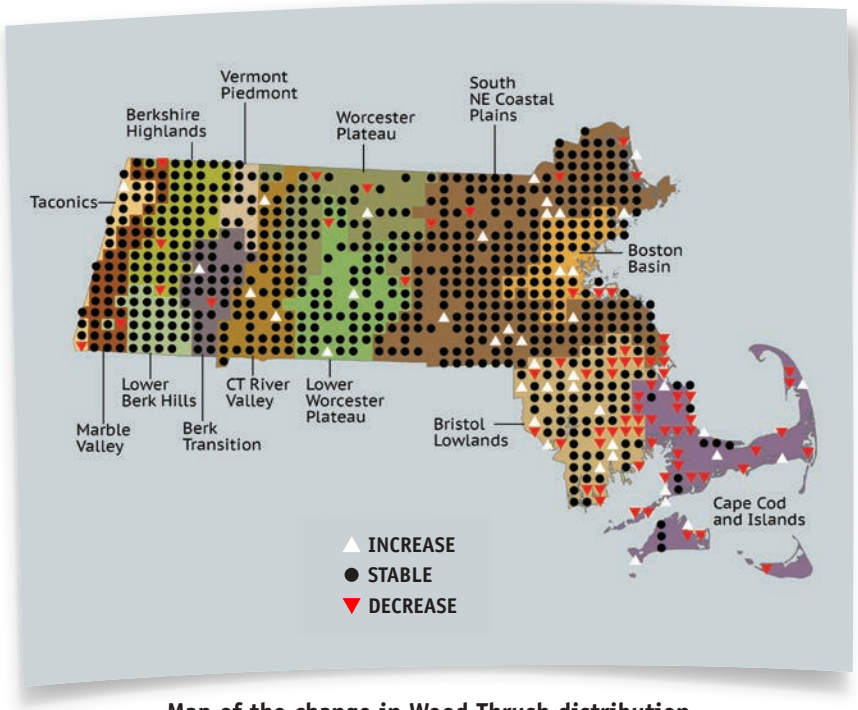
POTENTIAL MANAGEMENT OPTIONS

Closely evaluate the literature regarding patch size, determine limiting factors for the Wood Thrush in Massachusetts, and design models to identify potential areas of high productivity.

- Top management priority should be to identify, restore, and preserve large unfragmented tracts of forests with robust Wood Thrush populations.
- Small occupied forest parcels should be monitored for productivity.
- Advocate for development adjacent to forest patches rather than within the forest to reduce the negative effects associated with habitat edges.[12]

Breeding Bird Survey estimate of the trend for Wood Thrush in Massachusetts from 1966-2008.





Map of the change in Wood Thrush distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

Bambi vs the Swamp Angel

First the good news: Forest birds in Massachusetts, on the whole, are doing well. Great Horned Owls are on the rise, and current populations of Cooper's Hawks, Pileated Woodpeckers, Warbling Vireos, and others are breaking records. This will come as no surprise to anyone who has driven across the Commonwealth recently: from Cape Ann to the Berkshire Hills, the forests are back. From the colonial period until the industrial revolution, we cleared the land with abandon, creating a prairie-like landscape where Upland Sandpipers, Vesper Sparrows, and other farmland birds prospered and multiplied. But we live where the climate and most of the soils, left to their own devices, will grow trees, and when the farmers left and the felling and mowing and grazing ceased, the forest returned.

Our new forests are different from the precolonial ones. They lack Timber Wolves and Cougars, are crisscrossed by thousands of miles of roads, and are surrounded and inhabited by 6.6 million human beings, whose ways profoundly affect the ecology of the forests. Some of these ways suit many forest birds just fine. Our leafiest suburbs are made to order for White-breasted Nuthatches, Chipping Sparrows, and the other "winners" listed. But we have also made life harder for some forest birds, often in ways that are hard to see until you look closely.

White-tailed Deer

Early colonists called the Wood Thrush the Swamp Angel. Our first State Ornithologist, Edward Howe Forbush, thought its song "seems like a vocal expression of the mystery of the universe, clothed in a melody so pure and ethereal that the soul still bound to its earthly tenement can neither imitate nor describe it." It is a bird of the deep, moist, shady forest, though it will sometimes nest in a shady patch of woods in the corner of a park or suburban garden. Its nest is a variable combination of forest products, bark fibers, mosses, often with a strong component of damp leaves from the forest floor, and is usually placed in a shrub or small tree about 7 to 8 feet from the ground. While nesting, adults and young subsist on worms, snails, and other soil invertebrates. All of these traits imply that the ideal Wood Thrush forest is one with a full canopy, a subcanopy and shrub layer, and moist soil with a layer of leaf litter and some shade-tolerant herbs. This applies to the tropical forests where the birds winter as well.

Relatively easy to locate and sample, the decline of Wood Thrushes has been well documented since the 1970s. The proposed causes of the problem include many of the familiar suspects: pesticides, acid rain, collisions with windows and towers, parasitism by Brown-headed Cowbirds, and, especially, habitat loss, fragmentation, and degradation. More recently, however, another factor has been identified as a possible culprit in the decline not only of Wood Thrushes but also other nesting forest birds. The new threat has been nicknamed the "Bambi Plague."

On a larger scale the "deer problem" consists of three elements: collisions with motor vehicles, tick-borne diseases such as Lyme, and crop and garden destruction, all of which have reached near-crisis proportions in some areas because of the population explosion of White-tailed Deer. However, some long-term studies on the effects of large deer populations on forest structure and diversity have also revealed a fourth issue: the ability of deer to drastically restructure the forest ecosystem.

White-tailed Deer are primarily browsers and grazers that, at normal population levels, eat leaves of shrubs and small trees selectively in forest edges, and then move out into glades and fields at dawn and dusk. When deer densities become too high, competition for food pushes some deer farther into the forest and forces them to expand their diet. In experiments that enclosed different-sized deer populations into fenced-off forest plots, the structure of the forests in the plots with the highest deer densities were drastically altered. The overcrowded deer ate pretty much everything they could reach including the seeds and seedlings of the canopy trees, and weeds and grasses from the forest floor, essentially killing the shrub layer by overbrowsing; they were even observed eating eggs and nestling birds. The plants the deer ate least were invasive weeds that were filling in the gaps left by the decimated native species. The result was an aging forest with no possibility of regeneration, without an understory to give shade and nesting sites, and no herb layer to nurture a diversity of forest-floor invertebrates. In short, a deer desert and a Wood Thrush's worst nightmare.

In the early 1900s, the deer population of New York State was estimated at 20,000, small enough for wildlife managers to promote the creation of more deer habitat. Today, the Empire State, which also has declining Wood Thrush populations, has more than a million deer. Observers in New York point to several causes for the

decline of the Wood Thrush in the state, but the growing desertification scenarios like the experimental one described previously are likely contributing to their decline.

The Massachusetts deer population is currently estimated at about 95,000, which may sound relatively modest until you remember that our state's land area is 20% the size of our western neighbor. If Massachusetts were as big as New York, the current density of deer, by crude extrapolation, would stand at about 475,000; not a reassuring number. Given the absence of natural predators, a marked decline in hunting, and a suburban landscape that mimics a deer's ideal habitat and provides supplementary food in the form of ornamental landscaping plants, the population of White-tailed Deer has few effective limiting factors. If we plan on sustaining the Swamp Angel in our forests we must learn from our neighbors, and plan on having refuges for our deep forest breeding birds.

CONSERVATION PLANS

Although Wood Thrushes have been extensively studied, no comprehensive conservation plan exists for them. *A Land Manager's Guide to Improving Habitat for Forest Thrushes* details habitat guidelines for the Wood Thrush in the East/Midwest Forest Region and the Northern Forest Region in North America.[15] Several projects have developed habitat models that identify suitable habitat for Wood Thrushes and that will be very useful in future Wood Thrush conservation efforts.[10,17] Also, the United States Forest Service produced a report in 1992 entitled, "Status and Management of Neotropical Migratory Birds," which details the habitat needs of Wood Thrushes on their breeding grounds, during migration, and on their wintering grounds.[6] The Wood Thrush is also included in Partners in Flight's *North American Landbird Conservation Plan*,[13] as well as in their regional plans for northern[8] and southern New England.[4]

CONSERVATION CHALLENGES

- **Forest fragmentation**
- **Breeding habitat alteration by deer**
- **Habitat loss and degradation on wintering grounds**

RECOVERY: FIRST STEPS

- **Map location of persistent breeding sites to create a monitoring program**
- **Identify factors associated with successful breeding sites**
- **Determine effects of forest size and deer browse on breeding success**
- **Partner in studies to establish linkages with overwintering areas**

WHAT YOU CAN DO

- **Support open-space initiatives, farmland preservation, and grassland restoration projects**
- **Reduce pesticide use**
- **Keep your cat indoors**

Wood Thrush breeding habitat.

CASE STUDY: KILLDEER

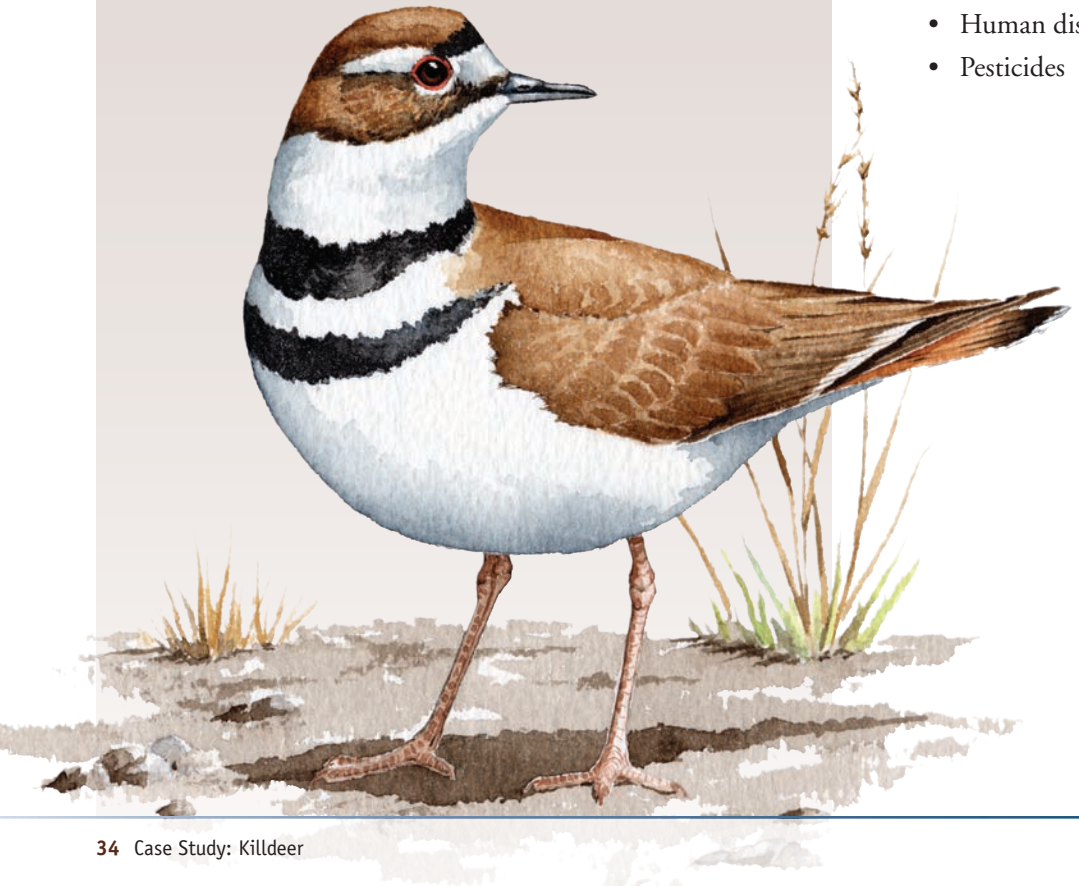
Killdeer

STATUS

Very widespread and likely increasing in Massachusetts; declining in eastern region of BBS

"If you don't know the little killdeer plover, it is surely not his fault, for he is a noisy sentinel, always ready, night or day, to tell you his name."

– Neltje Blanchan, *Birds That Every Child Should Know*



The Killdeer is larger, louder, and more numerous by far than its cousin the Piping Plover. The insistent cries that give the species its name can be heard over fields, parking lots, beaches, gravel pits, and a host of other open spaces throughout spring and summer. Though today the Killdeer is well established in Massachusetts, this widespread and familiar shorebird once came very close to disappearing forever from the Commonwealth.

POSSIBLE DRIVERS OF DECLINE

- Loss of natural habitat
- Human disturbance
- Pesticides

BREEDING HABITAT PREFERENCES

Killdeers nest on the ground in open habitat, both natural and constructed by humans.[5,8] Historically, Killdeers were limited to coastal beaches, riverine sandbars, mudflats, and open dry upland meadows. While human encroachment and natural degradation have caused the loss of much of this natural habitat, humans have also provided Killdeers with new places to breed in the form of agricultural fields, golf courses, road margins, graveled or broken-asphalt parking lots, graveled rooftops, athletic fields, and the like.[5] Ideal Killdeer nesting sites have minimal dead plant matter,[4] abundant bare ground,[4] and short, sparse, or absent vegetation.[8] Killdeers are also commonly found nesting near a water source, even if that water source is a lawn sprinkler.[5]

HUMANS, PESTICIDES, AND KILLDEERS

A Killdeer's tendency to nest in human-made sites near people makes them vulnerable to disturbance. Unfortunately, they often nest in harm's way, such as in the center of a gravel road or on a soccer field,[5] and nests can easily be destroyed by being stepped on, mowed, or driven over.[6] Nests are also susceptible to predation or destruction by cats, dogs, and curious children.

Pesticides, which are often used in open-habitat areas managed by people, can be detrimental to Killdeers both directly, as has been demonstrated with pesticides containing strychnine,[9] and indirectly, by severely reducing their primary food sources. Killdeers are insectivores and eat mostly beetles and grasshoppers, as well as centipedes, spiders, worms, and snails.[3,5,8] The effects of pesticides on Killdeers have not been extensively studied but should be a focus of future research.

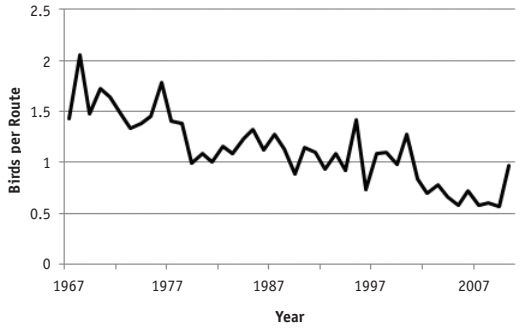
POTENTIAL MANAGEMENT OPTIONS

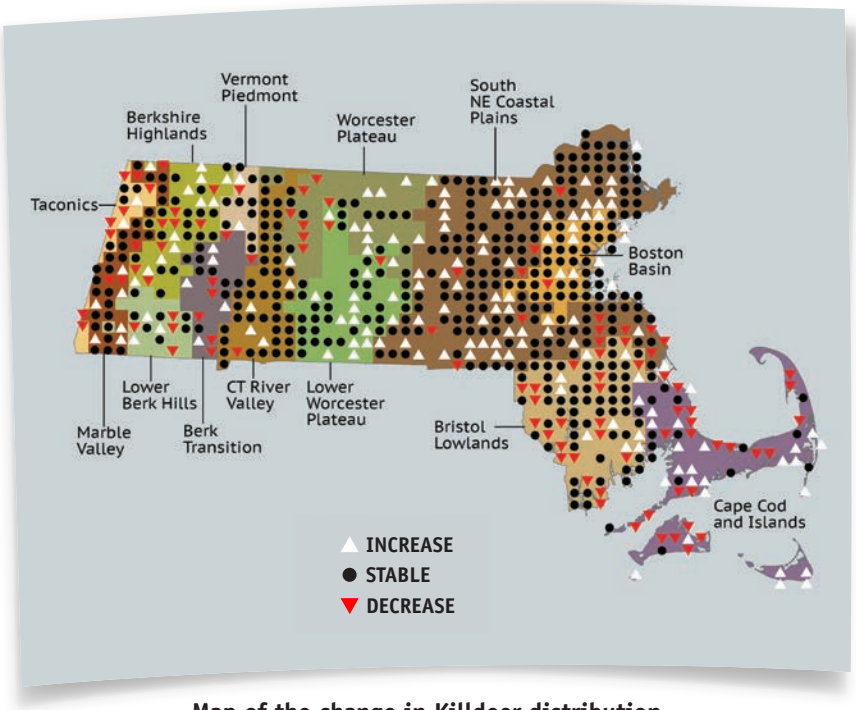
- Wire enclosures placed over nests to prevent predation[5]
- Grazing and burning regimes that can create more suitable Killdeer habitat[7]

CONSERVATION PLANS

Management of Killdeers has not been a priority because the species is still considered fairly common despite its statistically significant negative Breeding Bird Survey trend. Therefore, no conservation plan exists yet for the species. More extensive and long-term studies on Killdeer populations are needed to begin to more definitively understand why the species is declining. Killdeers are included in the *United States Shorebird Conservation Plan*[1] and in Partners in Flight's southern New England bird conservation plan.[2]

Breeding Bird Survey estimate of the trend for Killdeer in Massachusetts from 1966-2008.





Map of the change in Killdeer distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

The Whisperer

Among birds considered amenable to the ways of people, the Killdeer—a large noisy plover we named for its call—moved into our agricultural and recreational clearings with an alacrity that could be mistaken for affection. Confined in precolonial times largely to coastal barrens and river bars, Killdeers found the open edges of the new settlers' farms and villages just as suitable as natural habitats for nesting. By the early 1800s, Killdeers had become common summer residents throughout the Commonwealth.

In more recent times this affinity for our most sterile cleared spaces has approached the absurd as this "shorebird" has aggressively occupied our driveways, baseball diamonds, highway shoulders, even our flat gravel rooftops. And though Killdeers will complain with ear-splitting cries and melodramatic displays of feigned injury if you approach their eggs or young, they seem irresistibly drawn to locate their nests in a place of maximum vulnerability.

Killdeer frequently nest on playing fields and on school playgrounds.

To our discredit, we have not always returned the Killdeer's implied compliment. In the late nineteenth and early twentieth centuries, when shorebirds began to replace the Passenger Pigeon as preferred table birds and the species' pretty tail feathers came to be seen as attractive accents to ladies' hats, Killdeers became exceedingly rare in southern New England. The pioneering ornithologist and conservationist William Brewster (1851-1919) saw a Killdeer alive only once in eastern Massachusetts, though he was constantly in the field looking for birds.

By the 1950s, Killdeers had substantially recovered and reoccupied their previous range here, but the species is once again losing ground according to Breeding Bird Survey records for the Eastern US.

Killdeer and chick

As with many species, the current long-term decline cannot be attributed to a single obvious cause. It is undoubtedly true that as Massachusetts becomes increasingly urbanized, the ground-nesting Killdeers will be squeezed onto recreational fields and into parking lots where they are at great risk of increased predation and nest destruction. As farms become ever scarcer and modern farming more efficient, the marginal agricultural edges that enabled the Killdeer's first population boom are becoming rare habitats. While Killdeers have shown themselves to be the quintessential adapters—able to find those little unused patches of bare dirt on the golf course or playground that will help keep their population steady—evidence from the Eastern US BBS results says this may not be enough.

Another factor contributing to the Killdeer's plight is the unprecedented tons of toxic chemicals that homeowners and other land managers are flooding onto their lawns, gardens, and croplands. Few targeted studies have yet been done on the relationship between the Killdeer's decline and effects of pesticides and other atmospheric pollutants. But studies on other species with similar nesting and feeding habits make it clear that birds suffer effects from manufactured pesticides and poisons including direct mortality, impairment of physiological systems leading to gradual decline and death or the inability to successfully rear young, and the eradication of the insect food on which both adults and chicks depend for survival.

The Killdeer is a classic example of a bird we have come to recognize as a "Whisperer." These are birds that we are used to thinking of as abundant and widespread and that are still fairly common. Killdeers were actually found in a few more blocks during the recently completed *Massachusetts Breeding Bird Atlas 2* than they were during Atlas 1. But the BBS, now in its 48th year of collecting data on nesting birds, shows a gradual but steady decline in the numbers of Whisperers like the Killdeer. These birds seem to be telling us something important—but in a very soft voice. This gives us an unsettling new interpretation of the Killdeer's shrill alarm call: "I'm whispering as loud as I can!"

CONSERVATION CHALLENGES

- Loss of open field habitats
- Lack of bird-friendly landscaping and landscaping practices
- Pesticide use
- Predation by domestic cats

Killdeers will feign injury to lure you away from their nest if they are disturbed.

RECOVERY: FIRST STEPS

- Educate children and adults about protecting this species
- Develop school curricula to identify, protect, and monitor Killdeer nesting sites
- Organize and implement "bird-friendly" landscaping solutions in neighborhoods, public recreation areas, and commercial campuses
- Develop "best practices" for protecting Killdeer nests on public land

WHAT YOU CAN DO

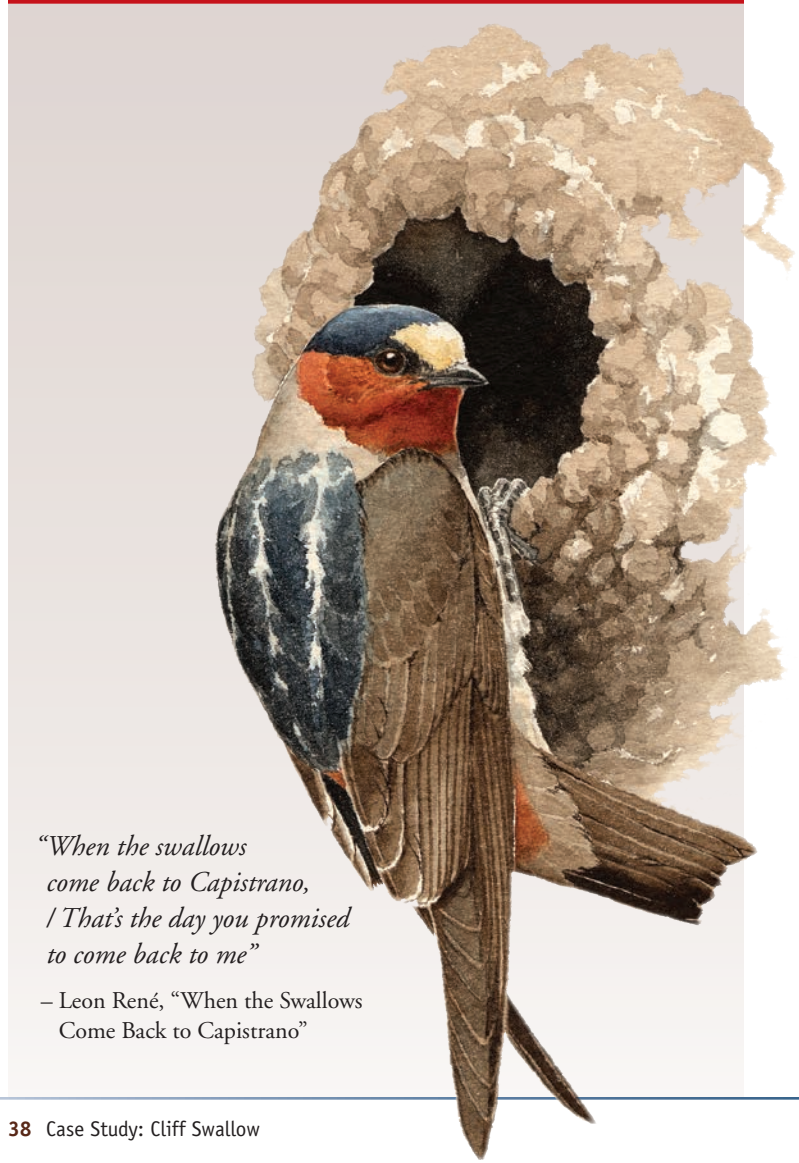
- Avoid moving or disturbing active Killdeer nests
- Keep dogs away from nesting Killdeers
- If a Killdeer nest is located, mark the nest to warn people and cars away
- If you know of a Killdeer's nest that may be in danger of disturbance, alert the property owner and suggest limiting access until the nest hatches
- Adult Killdeers fake injury to lure predators (including humans) away from their nest or young. Do not panic! The adult is just trying to protect its eggs or young
- Advocate for reduced pesticides or fertilizers on recreational property, and your own property
- Keep your cat indoors

CASE STUDY: CLIFF SWALLOW

House Sparrow

STATUS

Local and strongly declining; conservation action urgent



"When the swallows come back to Capistrano, / That's the day you promised to come back to me"

– Leon René, "When the Swallows Come Back to Capistrano"

The Cliff Swallow is the species immortalized in Leon René's famous song, but in addition to nesting in the arid Southwest it also breeds right here in Massachusetts. In recent years, the swallows have failed to return to Mission San Juan Capistrano, and their numbers in Massachusetts are dwindling as well. Highly colonial, Cliff Swallows have clusters of nests that are typically constructed in corners, with wall behind and ceiling above. A lack of appropriate nesting places and serious pressure from invasive species such as House Sparrows are threatening to push Cliff Swallows over the edge in many areas.

Cliff Swallow in a nest

DRIVERS OF DECLINE

- Competition with House Sparrows
- Habitat loss
- Climate change
- Pesticides

BREEDING HABITAT PREFERENCES

Cliff Swallows breed in colonies and typically build their nests on vertical walls with a horizontal overhang.[2] Nest sites can be natural cliffs, the undersides of bridges, or the eaves on the outside of buildings.[2,3] In Massachusetts Cliff Swallow nests are almost always built on buildings.[7] Their nests are constructed of mud and grass, necessitating a suitable water and mud source, whether rain puddle, stream, or lake.[1,2,3] They also require a nearby grassy area, water body, or other location with abundant flying insects.[2]

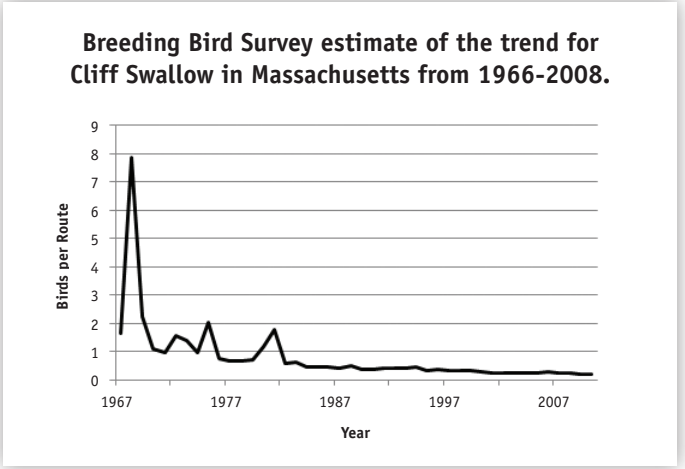
HOUSE SPARROWS VS CLIFF SWALLOWS

While some of the Cliff Swallow's decline can be attributed to habitat loss, the primary cause is believed to be the historic introduction of House Sparrows (*Passer domesticus*).[2,4,6,7] House Sparrows readily take over the nests of many birds, including Cliff Swallows, for their own use and are very aggressive about it. When a House Sparrow usurps a Cliff Swallow nest, it typically destroys the eggs in not only one nest, but in as many as 12 to 15 adjacent nests, before selecting one in which

to nest.[2] Researchers have found that Cliff Swallow nesting success is much lower when House Sparrows are nesting within the colony, especially since House Sparrows aggressively defend a broad zone around their own nest.[4]

Defunct farms may be better for Cliff Swallows than active farms because the grain in livestock feed and manure attracts House Sparrows to active farms.

Cliff Swallows collect mud to build their nests.



OTHER PRESSURES

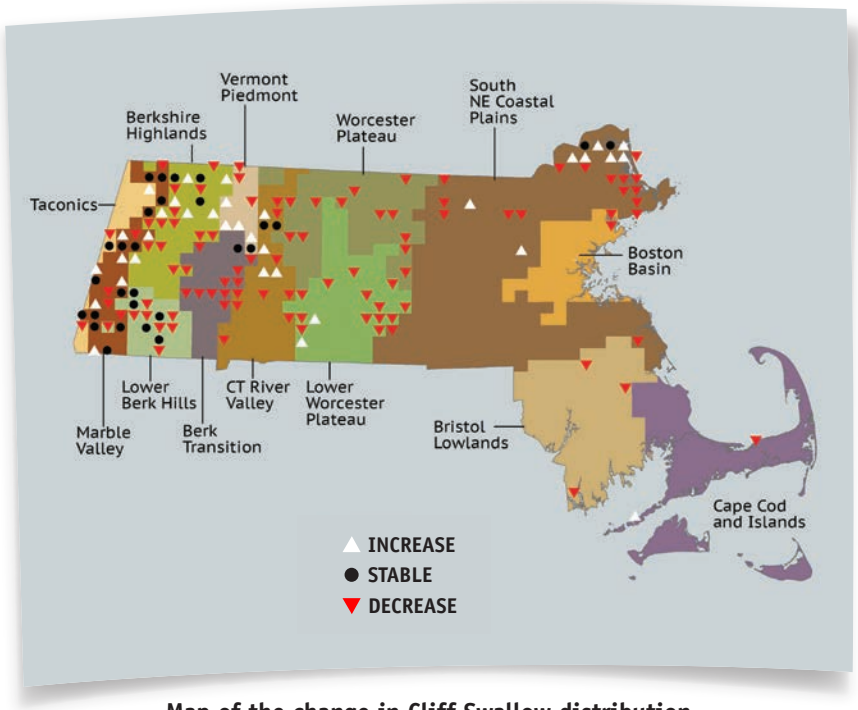
Aerial insectivores (birds that eat insects on the wing) like Cliff Swallows are suspected to be at risk from pesticide use in their breeding habitats, along their migration routes, and on their wintering grounds in South America. Unfortunately, relatively little is known about the current and potential effects of contaminants on this group of birds and the flying insects upon which they depend. Less still is understood about the migratory pathways and wintering areas that New England Cliff Swallows use. There is a clear and well-recognized need for more research to clarify these uncertainties, and timing is of the essence as the threats of climate change will undoubtedly exacerbate changes in insect abundance as well as the timing of peak food availability.

In some areas the availability of suitable nesting material has become a concern. Where there were once reliable sources of mud, human intervention (e.g., ditching, draining, and filling of large puddles) has resulted in less nesting substrate for Cliff Swallows, sometimes leading to the use of less suitable material that is unlikely to adhere throughout the nesting period. Certain paints used on the outside structures of barns may also cause nest adherence problems. Nests that fall from the eves rarely if ever survive.

POTENTIAL MANAGEMENT OPTIONS

At least one local ornithologist has been working on Cliff Swallow management in Massachusetts since the early 1990s. Three main management methods have been explored:

- House Sparrow control
- Installation of human-made ceramic nest ledges to help support the nests
- Adding clay to the Cliff Swallow's mud source and monitoring the water levels of the mud source throughout the season



Map of the change in Cliff Swallow distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

Trials of an Avian Architect

Faced with the decline of a beloved bird species, we would all prefer to combat a single obvious cause: Pesticides! Habitat loss! But given the complexities of nature—and human nature—things are rarely so simple. Consider the Cliff Swallow, whose tightly clustered colonies of exquisite vaselike nests sculpted from mud pellets place them among the bird world's greatest architects and engineers. Before Europeans established their own colonies on the North American continent, the species was concentrated in our western mountain ranges, where natural rock faces provided the vertical foundations for their horizontal apartment blocks. Pre-European settlement, relatively few Cliff Swallows are thought to have bothered with our inferior Northeastern geology.

But changes came quickly, though at first they augured well for Cliff Swallow prosperity. Rough-hewn barns with broad eaves were raised, and roads were laid with bridges and culverts placed near muddy waterways; forests—useless to swallows—were cleared in favor of open fields, soon to be swarming with the aerial insects on which all members of this family depend. By 1850, Cliff Swallows were locally abundant continent-wide and familiar residents of village and farmstead. Unfortunately, that year also brought a counterbalance to the species' population peak: the House Sparrow. Introduced more than 100 times to combat the ravages of tree-eating moths, the invader multiplied prodigiously, causing early bird conservationist William Brewster to write of "the ceaseless din of swarming House Sparrows" and the alarming absence of once common native birds in his old Cambridge haunts.

The House Sparrows were devastating to Cliff Swallows and other cavity-nesting birds. A single sparrow may evict eggs or chicks from 12 to 15 swallow nests and then occupy just one. By 1955 Cliff Swallows had become "rare and local in most localities," according to Griscom and Snyder's *The Birds of Massachusetts*. While the species continues to hold its own in the Great Plains and is actually increasing slightly in the Southeast where it has historically been scarce or absent, it has been a no-show in recent years at its most famous venue, the San Juan Capistrano Mission in California. And in Massachusetts, the continuing decline is striking. Statewide they were recorded in only 69 blocks during Atlas 2 compared to 144 blocks in Atlas 1, and regionally the species has all but disappeared as a breeder east of the Worcester Plateau.

So how can we explain the ongoing decline in one of the Commonwealth's most interesting and people-friendly birds? As noted in what follows, we will find no single mortal bullet, but rather a series of wounds.

- Agricultural acreage has dwindled markedly in the last century and with it the barns, farmhouses, muddy cow yards, and extensive buggy pastures and hayfields that are the mainstays of a Cliff Swallow's existence.
- Many farm buildings that remain have (unintentionally) been made Cliff Swallow proof, exchanging the broad eaves and rough unpainted wood of yesteryear for sleeker, more maintenance-free exteriors on which the swallows' adobe homes will not stick.
- Like barns, many of the bridges that harbored Cliff Swallow colonies here for many years are being replaced with new spans that the birds have not recolonized. In the Midwest, by contrast, bridges and large culverts made largely of concrete continue to be swallow magnets.
- The eradication of pest insects in agriculture with broad-spectrum insecticides, such as the relatively new neonictotinoids (neurotoxins), can effectively eradicate much of an aerial insectivore's food.
- In a densely populated state like Massachusetts, homeowner use of pesticides on lawns and gardens—which tend to be applied in far greater concentrations than in agricultural applications—may also be reducing insect densities in the air column.
- The human-caused threats to Cliff Swallows noted above are heaped, of course, *on top of* a variety of *natural* stresses that affect their reproductive success and survival over their short (11 years maximum) life spans. Among these are:
  - The "Swallow Bug," a parasite related to bedbugs, is the single greatest cause of nestling mortality in a Cliff Swallow's tiny apartment.
  - Unstable weather, increasing with global climate change, brings more frequent storms that can take out an entire complex of fragile mud nests; prolonged rain also suppresses insect activity that can lead to starvation of nestlings.
  - The natural hazards of an exceptionally long migration to wintering grounds from southern to south-central Argentina.

If we add the aforementioned human-induced pressures to the hits that a Cliff Swallow must endure in the course of its normal life cycle, it isn't hard to imagine at least some populations of the species reaching a tipping point at which new hatches can't keep up with annual losses.

Other researchers suggest:

- Removal of used Cliff Swallow nests in winter to prevent winter roosting of House Sparrows and to help reduce the number of House Sparrows in the colony during the breeding season.
- Removal of shrubby vegetation near the colony since House Sparrows like to use shrubs as roosts.

CONSERVATION PLANS

Although there have been many local conservation efforts in the Northeast, no comprehensive conservation plan exists yet for Cliff Swallows, though they are included in Partners in Flight's *North American Landbird Conservation Plan*.[5]

A classic New England barn, submitted to our *Big Barn Study*.

CONSERVATION CHALLENGES

- **Loss of fallow and lightly used agricultural land leading to declines in aerial insects**
- **Pesticide use**
- **Shortage of, and changes in, suitable nesting sites**
- **Unknown challenges to prey on the wintering grounds**

RECOVERY: FIRST STEPS

- **Map all occupied and known historic breeding sites**
- **Identify unoccupied sites for developing possible recovery locations**
- **Investigate effects of enhancing nesting substrate on nest quality**
- **Develop "best practices" for managing House Sparrow and Cliff Swallow interactions**

WHAT YOU CAN DO

- **Leave old barns standing**
- **Remove vegetation near barns to discourage House Sparrows**
- **Reduce pesticide use**
- **Buy produce, eggs, and meat from local, sustainable, low-intensity farms. Visit farm stands and farmer's markets, or buy shares in a farm through Community Supported Agriculture (CSA) programs**
- **Support open-space initiatives, farmland preservation activities, and grassland restoration projects**

CASE STUDY: SALTMARSH SPARROW

Saltmarsh Sparrow

STATUS

Local and likely increasing; State Wildlife Action Plan listed

"The nests were all built among the stems of short, upright grasses, their bottoms 2 or 3 inches above the ground, which was wet and shiny but in no instance actually covered with water."

– William Brewster, in Arthur Cleveland Bent's *Life Histories of North American Birds*

The Saltmarsh Sparrow, one of our most beautiful breeding sparrows, is a quiet and reclusive "mouse" of the state's salt marshes. Despite its low profile, this sparrow relies on the salt marshes of Massachusetts for a considerable portion of its global breeding habitat. As a result of having a small global breeding range, relying on a dynamic breeding habitat, and nesting within inches of the high-tide mark, this species is predicted to be one of the early casualties of sea-level rise brought on by climate change. Also, the Saltmarsh Sparrow uses large salt marshes for breeding; and fragmentation of marsh areas, as well as introduced vegetation, can exclude them from breeding. However, in the face of these likely future challenges, the species appears to be thriving in the Bay State currently.

DRIVERS OF DECLINE

- Habitat loss and degradation
- Climate change (sea-level rise)
- Invasive plants
- Chemical contamination (mercury)

Saltmarsh Sparrow nest with young.

BREEDING HABITAT PREFERENCES

Saltmarsh Sparrows breed exclusively in salt marshes. They prefer short (4 feet) to medium-height (10 feet) native grasses.[1,2,3,6,7,10] Their dependence on salt marshes for breeding habitat historically made them vulnerable to extirpation as humans sought to remove the malodorous brackish water from salt marshes. Importantly, southern New England harbors about 60% of the world's breeding population of Saltmarsh Sparrows, and they are considered a "species of responsibility" for Massachusetts.

SEA-LEVEL RISE AND SALTMARSH SPARROWS

Sea-level rise precipitated by climate change is the most pressing threat to Saltmarsh Sparrow populations. Flooding during the highest tides is typically the primary cause of Saltmarsh Sparrow nest failure. It is believed that the most successful females nest between peak tides (e.g., the nesting period of 23 to 27 days falls within the approximate 28-day lunar cycle), and therefore they have the greatest chance of avoiding flooding and also of fledging young.[1,9] Sea levels, which are estimated to rise by 0.5 to 2.0 meters by 2100 globally, and which are currently rising about 0.1 inches per year in Massachusetts, pose a legitimate threat to Saltmarsh Sparrows because not only will they cause more frequent flooding of nests but also eventually reduce available breeding habitat.[2] Recent research indicates that high nitrogen output from fertilizers may further exacerbate habitat loss by weakening the roots of marsh grasses.[5]

MERCURY AND SALTMARSH SPARROWS

Saltmarsh Sparrows often carry high levels of mercury in their blood.[4,9,10] Mercury enters the atmosphere from the combustion of fossil fuels and from medical and municipal waste.[10] It then accumulates in wetlands where it is converted by microbes into the more bioavailable methylmercury—a potent neurotoxin.[9,10] Saltmarsh Sparrows obtain methylmercury through the amphipods and spiders that form the majority of their diet during the breeding season.[4,9,10] Methylmercury has been demonstrated to affect behavior (e.g., nest synchronization with the tides), physiology, and reproductive success in wildlife.[9,10]

POTENTIAL MANAGEMENT OPTIONS

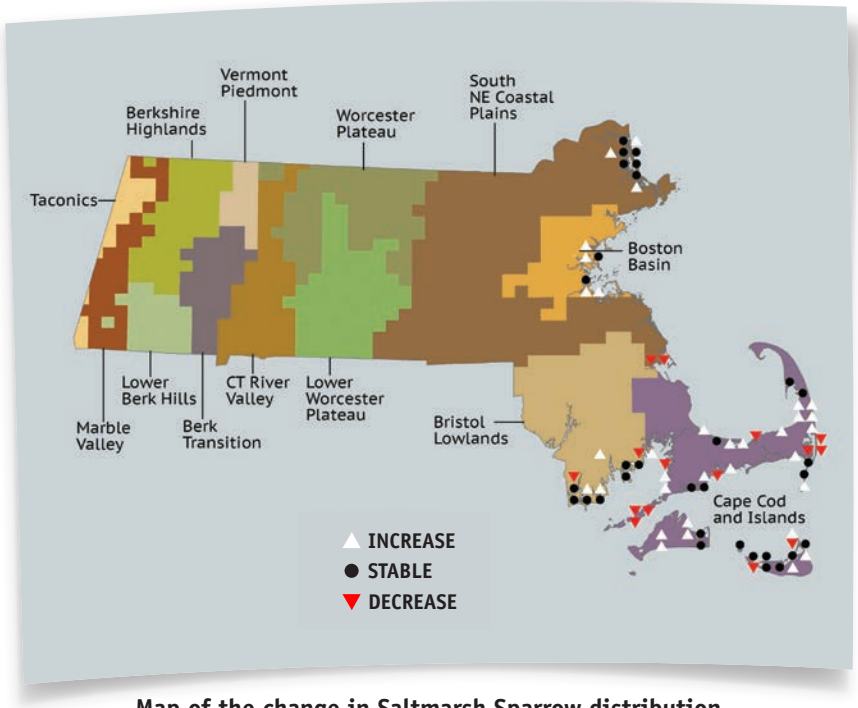
Researchers suggest:

- Habitat protection including low-lying uplands bordering marshes
- Reduction of the magnitude of tidal flooding (e.g., with tide gates)
- Removal of invasive plants and restoration of native short-meadow grasses
- Reduction of the mercury exposure threat on breeding grounds

CONSERVATION PLANS

No comprehensive conservation plan exists yet for the Saltmarsh Sparrow because the species has not been listed. However, in the past few years researchers in the Northeast have begun to extensively study all aspects of the breeding ecology of Saltmarsh Sparrows. We anticipate that by 2014 the research currently underway will begin to lay the groundwork for recovery options for this species. The Saltmarsh Sparrow is also included in Partners in Flight's *North American Landbird Conservation Plan*,[11] as well as in their regional plan for northern New England.[8]

Saltmarsh Sparrow



Map of the change in Saltmarsh Sparrow distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

The Fall of a Sparrow

"There is special providence in the fall of a sparrow." (*Hamlet*, Act 5, Scene 2)

The Saltmarsh Sparrow is not particularly graceful compared with many of its fellow sparrows; its standard behavior is to skulk around like a vole under the dense cordgrasses of its salt marsh habitat, only rarely rising above to utter a "song" that Edward Forbush described in 1929 as "short and gasping, followed or preceded by two ticks, which can be heard only when near at hand." It is still locally common in the great expanses of salt marsh that grace our Commonwealth's coast, though a recent estimate of the global population showed a precipitous drop from 250,000 to 30,000 individuals. Yet it is the life history of the Saltmarsh Sparrow that may presage its imminent doom—and perhaps give us an unpleasant hint of our own future as well.

It should surprise no one to hear that Saltmarsh Sparrows live in salt marshes, but it is important to understand that they will tolerate no other habitat for nesting. If you're looking at a Saltmarsh Sparrow in the breeding season, you must be standing in or near a salt marsh. Or, to put it another way, if there were no salt marshes there would be no Saltmarsh Sparrows. This means that their distribution is literally marginal, confined to the narrow band of salt marshes that line the Atlantic shore, and they occupy only the portion of that band running from the Canadian Maritime Provinces to the Delmarva Peninsula.

Saltmarsh Sparrows nest in loose colonies in the so-called high salt marsh dominated by the relatively short, dense Saltmeadow Cordgrass (*Spartina patens*). The nest is placed very close to the marsh floor and is supported and concealed by the dense grasses. The term "high marsh" is somewhat deceptive since these grasslands are completely covered by seawater at the highest tides of the lunar cycle. The cycle reaches the tidal maximum about every 28 days, and it takes 23 to 27 days to bring off a brood of Saltmarsh Sparrows from egg laying to mobile nestlings. This means that to reproduce successfully, a female sparrow must align her domestic schedule quite precisely with the full and new moons.

Surprisingly, the nests can withstand some flooding—but only to a point. Quite a lot of Saltmarsh Sparrows lose their nests to flooding, either because their timing is off or because a coastal storm causes a surge that tops the normal tidal height. They can re-nest, which may be successful or not, but given the precision timing and meteorological luck required to maintain a mostly dry nest on the ground floor of a flood zone for four weeks, it is a wonder that Saltmarsh Sparrows exist at all.

And while it is reckless to proclaim a trend based on the frequency or severity of a few recent storms, we have a good understanding of the link between a warming climate and the development of tropical storm systems. The trend is likely to become clearer as the years pass.

If the seas continue to rise and the storms come, many bird species will be (if you'll pardon the expression) in the same boat as the Saltmarsh Sparrow. The much rarer (and declining) Seaside Sparrow is also a salt marsh endemic, and a number of barrier beach-nesting species—Piping Plover, American Oystercatcher, and several tern species—are similarly threatened.

In more dire, but not implausible, long-range scenarios, the ecological integrity of the entire barrier beach/salt marsh system—which is an important component of the marine food web encompassing hundreds of species of birds, fish, and invertebrates—becomes imperiled. It has been suggested by the optimists among us that when the floods come, the coastal habitats and their inhabitants will simply "migrate" inland. This could happen in a few localities where there is enough of a coastal plain above the current flood level, but along much of the New England coast the inland edges of the salt marshes are bounded by a wall of Ordovician granite.

Saltmarsh Sparrow is an icon of the potential loss of the ribbon of salt marsh that guards our coastline. But in addition to birds and cordgrass, of course, there is us. The human costs of coastal flooding in Massachusetts (and the world) are likely to increase in the coming decades if we don't come to terms with the climate controls in our greenhouse, and the losses are incalculable.

Like us, Hamlet was a procrastinator, and things didn't turn out so well for him—or for anyone else in his play. In the end, he took action, but too late. If "providence" is indeed controlling the fate of Saltmarsh Sparrows, we can sit back and see what happens or we can use our wits to avoid what the best science tells us could be the mother of all catastrophes. In either case, as Hamlet says, "Readiness is all."

CONSERVATION CHALLENGES

- Sea-level rise
- Disturbance of habitat and nesting sites
- Accumulation of mercury and other contaminants

RECOVERY: FIRST STEPS

- Support recovery of salt marsh restoration sites that have been identified along the Massachusetts coastline
- Continue established monitoring programs
- Map occupied and unoccupied but suitable breeding locations

WHAT YOU CAN DO

- Take steps to reduce your carbon footprint
- Minimize use of fertilizers on your own property
- Support wetland conservation laws, land acquisition, and salt marsh restoration projects

Saltmarsh Sparrow habitat.

CASE STUDY: AMERICAN BITTERN

American Bittern

STATUS

Local and strongly declining; conservation action urgent; State Endangered Species

"But the yellow bittern, my heartsome namesake /
With my looks and locks, he's the one I mourn."

– Cathal Buí Mac Gíolla Ghuna,
by Seamus Heaney, "The Yellow Bittern"

The unmistakable pumping call of courting American Bitterns once echoed over many marshes and wet meadows in Massachusetts. These oft-heard (if not oft-seen) herons pass their time standing patiently amongst the reeds, waiting for prey to swim within reach of their daggerlike bills. Today, however, those marshes and meadows are not nearly so numerous as they once were. As this habitat disappears, the American Bittern appears to be following suit.

DRIVERS OF DECLINE

- Habitat loss
- Loss of habitat quality
- Pesticides
- Invasive plants
- Acidification

American Bittern fledgling

BREEDING HABITAT PREFERENCES

American Bitterns breed in freshwater wetlands containing tall, dense, shallow- or deep-water emergent vegetation. On occasion they will nest in upland hayfields adjacent to freshwater wetlands. Native vegetation (e.g., cattails) is preferred. American Bitterns tend to build their nests along the edges of wetlands, typically at the base of emergent plants in densely vegetated areas.[1,4,5,7] Although American Bitterns have been found inhabiting wetlands of varying sizes (0.25-2,500 acres), they are most abundant in larger wetlands,[5] tending to prefer wetlands exceeding 7 acres.[1] Since bitterns forage for their prey along vegetated fringes and shorelines, wetlands with greater edge density provide the best foraging habitat.

LOSS OF HABITAT AND HABITAT QUALITY

The primary cause of the American Bittern's decline is habitat loss and degradation.[5] Much wetland habitat has been lost to development over the past 100 years, and American Bitterns, along with many other wetland-dependent species, have correspondingly suffered. A number of remaining

wetlands are often degraded in some way. Wetland degradation can be caused by eutrophication (nutrient overloading), siltation, acidification, and chemical contamination,[3,5] and the main danger of this degradation is damage to the prey abundance of American Bitterns.[5]

Invasive and often exotic plant encroachment can also degrade wetland habitat.[5,7,9] The most common invasive wetland plants in Massachusetts are Purple Loosestrife (*Lythrum salicaria*) and an exotic form of Common Reed (*Phragmites australis*). Both of these non-native plants can quickly take over a wetland, preventing native emergent vegetation from growing.[7] These non-native plants change the physical structure of wetlands, and their dense structure can make it difficult for American Bitterns to navigate.

POTENTIAL MANAGEMENT OPTIONS

Since habitat loss and degradation are the primary causes of the decline of American Bitterns, management efforts should focus on preserving shallow-water wetlands, particularly wetlands larger than 25 acres.[5]

RESEARCHERS SUGGEST

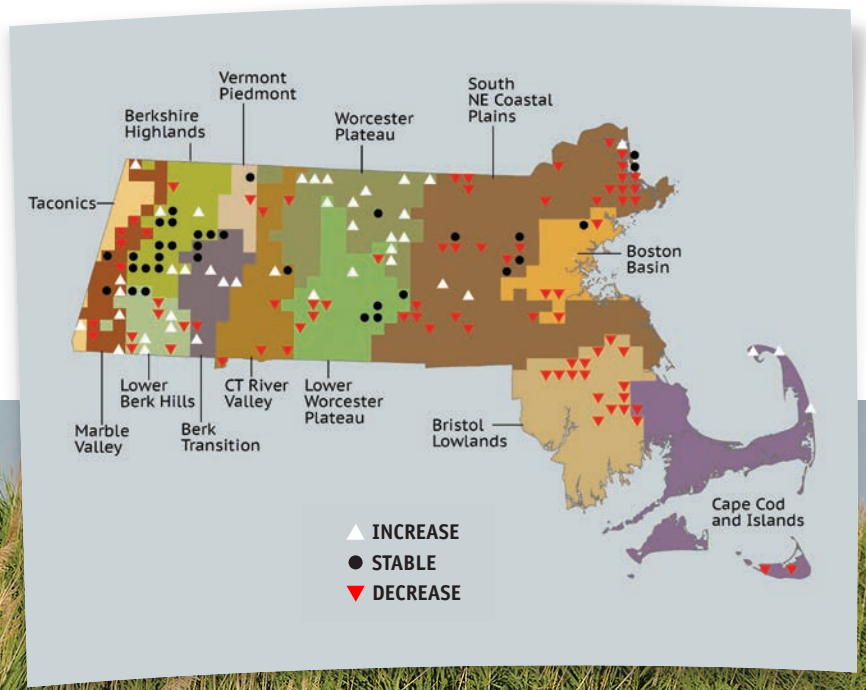
- Maintaining a complex of wetlands of 50 to 450 acres in size with water levels shallower than 2 feet and a wide margin of surrounding vegetation.[1]
- Wetlands should be managed to increase edge density.[8]
- Any disturbance methods used to maintain the tall, dense, upland vegetation adjacent to a wetland where American Bitterns sometimes nest should not be implemented more often than every 2 to 5 years.[1]
- Note: In Massachusetts wetlands alterations are strictly regulated.

CONSERVATION PLANS

Much remains to be learned about the secretive American Bittern. Little is known about its breeding biology (e.g., diet, home range, sources of mortality, etc.). There is no comprehensive management plan for the American Bittern. They are included in the *Waterbird Conservation Plan for the Mid-Atlantic/New England/ Maritimes Region*[6] and in Partners in Flight's regional bird conservation plan for southern New England.[2]

American Bittern

Map of the change in American Bittern distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).



Phragmites, and other invasive non-native wetland plants, can make marshes unsuitable for breeding American Bitterns.

Bird Protection Laws: Necessary But Not Always Sufficient

Massachusetts birdlife is protected by several layers of detailed legislation. The Migratory Bird Treaty Act (MBTA), first passed in 1918 and broadened several times since, includes treaties with Canada, Mexico, Japan, and Russia and provides degrees of protection for all migratory birds. The signatory countries and their citizenry may not hunt, kill, possess, sell, purchase, import, export, or transport listed birds, their parts (including feathers), nests, eggs, or products made from their materials—except as allowed by a permit or license.

Rare species are afforded even greater protection. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which has been signed by over 150 nations, is the principal mechanism for protecting bird species (and other animals and plants) that have a high commercial value as pets, ornamentation, medicine, and other human uses. The federal Endangered Species Act of 1973 (ESA) authorizes the listing of endangered and threatened species (including nonmigratory ones), prohibits the kinds of activities listed above, and provides for the "conservation of ecosystems upon which threatened and endangered species…depend."

In 1990 the Commonwealth's legislature passed the Massachusetts Endangered Species Act (MESA), which lists and provides protections for species that are endangered, threatened, and of "special concern" in Massachusetts. The act also affords local protection for all of the federally listed species that occur in Massachusetts. The habitat of these bird species is protected at their breeding locations—MESA site review does not extend to their migratory or wintering locations. This means that having accurate breeding locations is critical to protecting these species, and during Atlas 2 hundreds of new locations for MESA-listed species were gathered.

Our state Endangered Species Act is one of the strongest in the nation. The Massachusetts Natural Heritage & Endangered Species Program (NHESP) produces maps of endangered species habitat, and owners of mapped habitat wishing to develop their property are obliged to work with NHESP biologists to ensure that the project will not result in a taking. Most projects are allowed to proceed, although sometimes conditions are imposed, such as limitations on the seasons when work can be done or requirements for protection of a portion of the property. Mass Audubon is working to defend the law against efforts to repeal key provisions.

There is no question that MESA has been effective in conserving rare birds and their habitats. Species such as the Common Loon, Bald Eagle, and Peregrine Falcon, once thought to be headed for extinction, have made strong recoveries and continue to increase, both in Massachusetts as well as nationally. Other species (e.g., Piping Plover, Least Tern, Northern Harrier), though still below their historic high points, are nevertheless doing far better than they were in the recent past as a result of active and aggressive management.

American Bittern breeding habitat

Data from our Atlas 2 help to underscore the fact that, despite these successes, of the 28 bird species listed under MESA, 18 registered a rating of either Urgent Conservation Action Needed or Continuing Action or Monitoring Needed. Four of the listed species such as the Leach's Storm-Petrel, Arctic Tern, and Blackpoll Warbler reach the extreme edge of their range in Massachusetts and have always been rare and local here. Others, notably some of our sharply decreasing grassland species, have suffered dramatic habitat losses in recent decades, and hopefully may yet recover with expanded management regimes. But for the state-listed breeding birds in the Urgent Conservation Action Needed category, either the specific cause(s) for their decline have not been identified, or else we have limited power to reverse the perceived problems. The story of the American Bittern is an example of a case study illustrating this.

Once described as a common summer resident in freshwater wetlands throughout Massachusetts as recently as the 1950s, during Atlas 2 the American Bittern was only found in 66% of the blocks they had occupied in Atlas 1. There is no shortage of possible causes to explain this lamentable loss.

- Thousands of acres of freshwater marshes were drained in Massachusetts for agricultural, commercial, or residential use from the colonial era until wetlands protection laws were passed in the 1960s, and loss of and degradation of wetlands continues today as a result of exceptions in the laws and lack of protection of buffering uplands.
- An unprecedented amount and variety of toxic chemicals are entering the atmosphere today. Many of these tend to concentrate in wetlands because of runoff and eventually become concentrated in the tissues of fish, amphibians, and insects, all primary food sources for bitterns.
- Many of our wetlands have been altered by invasive plant species such as Common Reed and Purple Loosestrife. Stands of these aggressive plants are too dense for bitterns and other marsh birds to nest and feed in.
- Other factors commonly contributing to the degradation of marshland, especially in densely populated places such as Massachusetts, are siltation, eutrophication, acidification, and changes in the water flow brought on by human use.

It is surely no coincidence that 6 of the 29 bird species on the state rare or endangered species list nest exclusively in freshwater wetlands. And yet, due to the complexity of the problem (and the difficulty of identifying an effective solution), our efforts to stop the losses for the American Bittern have not been successful.

CONSERVATION CHALLENGES

- **Habitat loss and degradation**
- **Chemical contamination**
- **Invasive plants**

RECOVERY: FIRST STEPS

- **Monitor occupied breeding sites**
- **Monitor breeding site quality**
- **Advocate for increasing the amount of permanently protected breeding sites, and potential breeding sites**

WHAT YOU CAN DO

- **Advocate for the Massachusetts Endangered Species Act (MESA)**
- **Support wetland conservation laws, land acquisition, and wetland restoration projects**
- **Support community agriculture, particularly at farms that reduce pesticide use**
- **Support the Massachusetts Natural Heritage & Endangered Species Program (NHESP) by contributing to the annual income-tax checkoff**

CASE STUDY: ROSEATE TERN

STATUS

Very local and strongly declining; conservation action urgent; State Endangered Species

"And to lose the chance to see…myriad terns flashing in the bright light of midday as they hover in a shifting maze above the beach—why, the loss is like the loss of a gallery of the masterpieces of the artists of old time."

– Theodore Roosevelt

As an Endangered Species in the Commonwealth of Massachusetts, the Roseate Tern has been justifiably receiving a lot of attention. Named for the pinkish wash that appears on their breast feathers during the breeding season, Roseate Terns are slender and graceful birds that make their living diving for fish. Roughly half of the entire North American population of this species breeds in the Bay State. An even larger proportion relies on favored Cape Cod localities like Monomoy and Nauset as staging areas during fall migration. Though they are protected and closely monitored, the future of Roseate Terns remains uncertain.

Presently, 90% of the Northeastern population of Roseate Terns nests on three islands in the Northeast: Bird Island and Ram Island in Buzzards Bay, Massachusetts, and Great Gull Island, New York.

DRIVERS OF DECLINE

- Habitat loss and degradation
- Climate change (sea-level rise)
- Competition with gulls
- Predation
- Human predation on wintering grounds
- Female-biased sex ratio

Roseate Tern

BREEDING HABITAT PREFERENCES

Optimal nesting habitat for Roseate Terns is an offshore island that has good vegetative cover, no predators, and is close to an abundant supply of fish.[1,3,4,5,6,8,9] They rarely nest on the mainland anymore.[6] Roseate Terns place their nests under or adjacent to objects that provide shelter, whether it be a clump of vegetation, a rock, or a nest box.[1,2,4,6,7,8,9] Currently, Roseate Terns in the Northeast nest only at sites where there is an established colony of Common Terns[3,4,6,8] since the Common Terns are very aggressive toward intruders and serve as added protection for the more passive Roseate Terns.

GREATEST THREATS TO ROSEATE TERNS

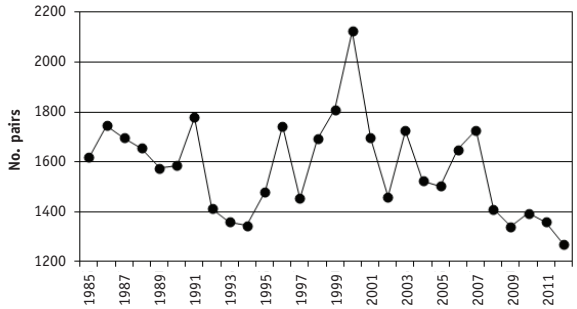
While there are many factors contributing to the continued decline of Roseate Terns, the factors of most concern are habitat degradation, the concentration of almost the entire Northeastern population on three islands, and the challenges facing them in their wintering grounds. Habitat degradation can be caused by erosion, storms, and sea-level rise. Erosion occurs gradually with the ebb and flow of the tides but can become devastating during a bad storm or a hurricane, like Hurricane Sandy. Natural succession can also cause an island to become unsuitable for both Roseate and Common Terns since the vegetation in tern colonies typically grows very quickly due to the constant large supply of fertilizer in the form of guano.

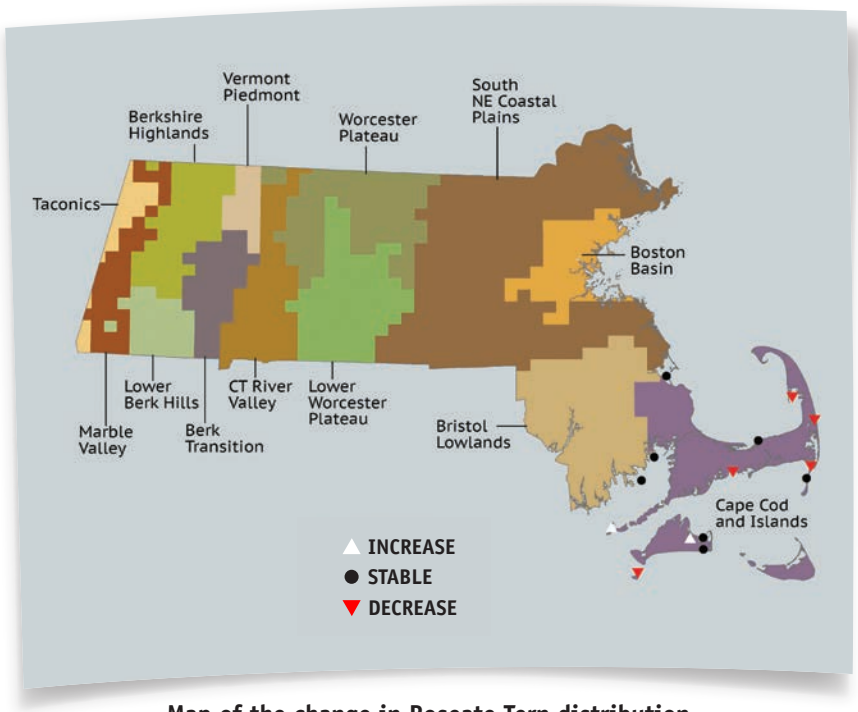
The concentration of the majority of the Northeastern Roseate Tern population on three islands makes them extremely vulnerable. If some large event such as an oil spill were to wipe out or somehow make unsuitable even one of those islands, the population would be seriously affected. Roseate Terns lost most of their nesting sites in the twentieth century to erosion, predation, and most notably to occupation by Herring and Great Black-backed Gulls. Gulls like the same habitat as Roseate Terns, and, because they arrive earlier in the year to the breeding grounds, they outcompete Roseate Terns for the best habitat.[4,5] Gulls will also occasionally eat Roseate Tern eggs and chicks, making them unwanted neighbors.

On their wintering grounds in South America, Roseate Terns are not afforded the same protection they receive in Massachusetts. The Roseate Tern population declines of the 1970s were attributed by some in part to human predation in their wintering grounds. It is unknown if human predation of Roseate Terns is still occurring in South America. Much more research on Roseate Terns at their wintering grounds is needed because, while they have been given extensive protection in the Northeastern US, their populations are still declining.

Roseate Tern chick

Surveys from the state Natural Heritage and Endangered Species Program, Division of Fisheries and Wildlife, estimating the number of breeding pairs of Roseate Terns in Massachusetts from 1985-2012.





Map of the change in Roseate Tern distribution from Atlas 1 (1974-79) to Atlas 2 (2007-11).

Lost at Sea: What's Happening to Roseate Terns After They Leave Massachusetts?

Once considered abundant in the huge mixed-species tern colonies that formerly existed on Cape Cod and the Islands, the Roseate Tern suffered its first significant losses in the 1800s when eggers and plume hunters decimated the colonies. After a short-lived recovery, this and other terns began to be displaced from the most favorable island nest sites by Herring and Great Black-backed Gulls that were rapidly increasing in the mid-twentieth century, thanks to increased fish waste available at sea and edible garbage from open dump sites. This forced the terns onto mainland sites on barrier beaches where they were more vulnerable to predators and human disturbance.

Despite these pressures and with aggressive management, the total Roseate Tern population stood at over 4,300 pairs in 2000. Since then, however, the population has again dropped steeply by around 25%. A special peril lies in the fact that about 85% of the North American population of the species nests on just three small islands. Aside from the Great Gull Island colony in eastern Long Island Sound, Bird and Ram Islands in Buzzards Bay are the only other islands that host large numbers of Roseate Terns anywhere in North America. This makes the Roseate Tern a species of responsibility for us, and our ability to provide safe haven for this species is critical to the species' survival.

The Commonwealth also finds itself at another nexus in the Roseate Tern's life—we host masses of Roseates after they have finished breeding but before they set off to their southern winter homes. These flocks of terns, some still in families, seem to be using the Cape to "stage" before beginning their mostly offshore migration to South America. A huge percentage of the breeders and the young from the three northeastern colonies congregate on the Cape, and the effects of disturbance on either their food or resting areas are not well known.

Many current threats can be cited as possible reasons for this elegant bird's decline, including predation, toxins, depletion of food sources (mainly small fish), and erosion of breeding sites by severe storms. However, unlike many declining species, the Roseate Tern is monitored intensively, and there is a strong consensus among collaborating biologists that the main problem today lies not on the breeding grounds but on the wintering grounds in South America and during the long journey back-and-forth.

These wintering sites and migratory routes are still poorly known, but include an extensive area of the western Atlantic Ocean and remote shores from Colombia to the state of Bahia in Brazil. What we do know from the few explorations that have been undertaken is that the trapping of large numbers of terns for food along the coasts of developing countries in the presumed wintering and migratory regions has been well documented. In these places, wildlife protection laws are weak or nonexistent, and where they are on the books there is little or no enforcement.

A few insights emerge from the inconclusive accounts of troubled bird species such as Roseate Tern.

- Good laws strictly enforced are necessary and important but are not sufficient in many cases to keep bird populations stable.
- There are now so many verified and potential threats to birdlife in our age that accurately assessing the most important drivers of decline is increasingly difficult and finding solutions is even more challenging. There is an urgent need for more research to identify the key elements causing the striking decline in species such as the Roseate Tern.
- Conservation within the winter ranges and migratory routes of birds that nest in North America is problematic. On many species' Neotropical wintering grounds, birds are legally taken in large numbers by subsistence hunters. This is a challenging issue that will require international cooperation at the national and local levels to resolve.

Roseate Tern postbreeding roost on Cape Cod

POTENTIAL MANAGEMENT OPTIONS

There are several long-term management projects for this species in the Northeast, and they have been successful in restoring Roseate Tern habitat and protecting the species in the Northeastern US. It is crucial that the Northeastern Roseate Tern population expand to more than three islands.

Management techniques include:

- Gull control on the islands with the greatest tern colonies (not on islands with gull colonies since Herring and Great Black-backed Gulls are declining as well).[6]
- Bringing in dredged material to counteract erosion.[8,6]
- Annual vegetation control.[6]
- Construction of nest boxes.[6]
- Social attraction through the use of tern decoys and broadcasts of tern calls to lure terns to a new or not recently used island.[5,6]
- Predator deterrence when feasible.[6]
- Reduction of human disturbance.[6]

CONSERVATION PLANS

The Northeast Roseate Tern Recovery Team created the "Roseate Tern Recovery Plan—Northeastern Population" in 2001 for the U.S. Fish and Wildlife Service, and in 2004 the "Tern Management Handbook: Coastal Northeastern United States and Atlantic Canada" was put together. Both reports detail how best to conserve Roseate Terns and hopefully return the population to a stable level.

Roseate Tern breeding habitat.

CONSERVATION CHALLENGES

- **Sea-level rise**
- **Human disturbance at colonies**
- **Breeding habitat loss**
- **Predation**
- **Hunting on the wintering grounds**

RECOVERY: FIRST STEPS

- **Continue to monitor and protect occupied breeding sites**
- **Investigate options for increasing the Roseate Tern's breeding footprint**
- **Continue to research, monitor, and protect postbreeding staging sites**
- **Manage existing breeding habitat to maintain or enhance suitability**

WHAT YOU CAN DO

- **Support tern protection and recovery programs (Mass Audubon's Coastal Waterbird Program and Natural Heritage's Buzzards Bay Tern Recovery Project)**
- **Follow directions on community signs near tern colonies and roost sites, and encourage others to also do so**
- **Support the Massachusetts Natural Heritage & Endangered Species Program (NHESP) by contributing to the annual income-tax checkoff option**

Roseate Tern in flight.

Take Action to Help Birds: *What You Can Do*

Peppers from Verrill Farm in Concord, Massachusetts.

This report focuses on breeding birds, but there are simple steps we can take to enrich the Commonwealth for all wildlife, as well as ourselves. Planting gardens, supporting your community farms, living lightly, and sharing your passion for nature all help us stay connected to our homes, and to nature. We are making a difference.

AROUND THE HOME AND IN THE WORKPLACE

- **A Simple Step that Matters.** Keep your cats safely indoors, and do not feed stray or feral cats.
- **Bring Nature Home.** Landscape your property in a bird-friendly way and encourage the manager of your office landscape to do the same.
  - Plant native trees, shrubs, and flowers, which provide food and shelter and are usually easier to maintain. Native plants that provide fruit or berries can also grace your yard with winter or fall color.
  - Reduce or eliminate pesticides or fertilizers on lawns or in homes. Look for natural alternatives instead.
  - In smaller yards provide nest boxes for House and Carolina Wrens, Black-capped Chickadees, and Tufted Titmice.
  - Host a small dripping water feature to attract birds in summer.
- **Be a Good Host.** Reduce bird-window collisions.
  - Advocate for a seasonal Lights Out policy at your office if you work in a high-rise building (http://www.massaudubon.org/lightsout/).
  - Install decals or other treatments to reduce reflections.
  - Turn off lights in empty rooms at night.
  - Move bird feeders so they are not directly next to windows.

Indoor cat (Tyler).

Shade-grown, bird-friendly coffee plantation in San Juan, Puerto Rico.

WHEN YOU ARE SHOPPING

- **Buy local!** Choosing sustainably grown produce, eggs, dairy products, and meat helps birds by keeping farms in our communities. Farmer's markets and Community Supported Agriculture (CSA) "farm shares" are great options to start. (http://www.mass.gov/agr/massgrown/map.htm)
- **Coffee Break for Birds.** At home and at work, buy Smithsonian Certified Bird Friendly coffee. It comes from bird-friendly farms in the tropics and will directly benefit long-distance migrants. It can be found at Mass Audubon gift shops, as well as other shops (http://www.birdsandbeans.com/retailers.html).
- **Less is More.** If you are buying new appliances, purchase Energy Star appliances to reduce your energy consumption.
- **If available, buy green energy** from your electric provider to further reduce your carbon footprint.

FARMERS AND LANDSCAPERS

- **Detoxify.** Minimize or eliminate the use of insecticides and herbicides.
- **Give Them a Home.** Allow swallows to nest in the barns and outbuildings by leaving openings, or adding ledges to the outside of barns. Provide nest boxes for American Kestrels, Eastern Bluebirds, Tree Swallows, and House Wrens.

Barn Swallow

- **Keep your fields "bird-friendly".**
  - Rotate your fields, leaving some free of disturbance for nesting birds.
  - Avoid mowing between April and August to give grassland breeders a chance to fledge.
  - Maintain hedgerows, weeds, and brush along streams, field borders, and fence lines.
  - Diversify. Growing a variety of crops creates better habitat structure for birds.

IN YOUR COMMUNITY

- **Get involved!**
  - Learn how through Mass Audubon's Shaping the Future of Your Community Program: www.massaudubon.org/shapingthefuture.
  - Support Open Space Protection Plans and projects.
  - Advocate for your town to adopt Conservation Design Zoning and local wetlands, floodplain, and buffer zone protections.
  - Work to have your town adopt the Community Preservation Act and Green Communities Act.

Marsh Wren

- **Support bird-friendly management of town parks, conservation lands, and land trusts.**
  - Manage lands for declining bird species, focusing on old fields, grasslands, agricultural lands, and other declining habitats.
  - Eliminate chemical pesticides and fertilizers on town property, including recreational fields.
  - On municipal conservation lands, keep old fields open by mowing after July.

USE YOUR VOICE

- **Join us and advocate for wildlife and people! www.massaudubon.org/advocacy**
- **Sign up to receive Mass Audubon's Advocacy Department's action alerts at http://www.massaudubon.org/advocacy/beaconhill.php**
- **Ask your representative to focus on the following.**
  - Support the Massachusetts Endangered Species Act and oppose attempts at repeal.
  - Support programs to fund land protection and habitat management, particularly the Environmental Bond and environmental agencies, in the annual state budget.
  - Support state agency action to coordinate policies for renewable energy development with bird habitat conservation and wetlands protection.

Support Mass Audubon's bird conservation efforts: www.massaudubon.org/birds

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The Mass Audubon staff and Board of Directors are always there to lead by example, to build good teams, and to help refine our work. To you we send a fraternal salute.

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The field volunteers for the Atlas 1 and Atlas 2 projects did all of the fieldwork. They took on a massive task that stretched on for years, they printed forms and maps, plotted routes, drove to their field sites before dawn, talked to landowners, explained to law enforcement professionals exactly why they were out at dawn with binoculars, tracked down birds, recorded data, transcribed data, entered data, proofed data, then went out and did it again the next day and the next year. This is your work, you made a difference, and you built a benchmark in our ornithological literature that will be used forever.

Space does not permit us to list everyone who helped make this project a success, and errors of omission are solely the responsibility of the editor. But to all of you who helped, thank you.

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Richard Alvarnaz: Song Sparrow (8); **Anonymous**: Red barn (41); **Michelle Bacon**: Indoor Cat, Ibby (15), Indoor Cat, Tyler (54); **Katie Blake**: Roseate Tern chick (51), Roosting terns at staging site (52), Roseate Tern habitat (53); **Phil Brown**: Birders (8), Eastern Meadowlark (24), Saltmarsh Sparrow (42), Saltmarsh Sparrow close-up (43); **Shawn P. Carey (Migration Productions)**: Scarlet Tanager (1), Eastern Towhee (3), White-throated Sparrow (3), Black-and-White Warbler (13), Grassland at Mass Audubon Daniel Webster Wildlife Sanctuary (17); **Sheila Carroll**: Blue-gray Gnatcatcher (4); **Patrick Comins**: American Bittern habitat (48); **Donald David**: Kingbirds at nest (4); **Eduardo del Solar**: Killdeer with chick (36); **Mary Dineen**: Freshwater marsh with invasive Purple Loosestrife (14); **Jim Fenton (jfenton@natureandwings.com)**: Northern Cardinal (16), Bobolink (16), Tattersal Farm in Haverhill, MA (23), Brown Thrasher (26), American Bittern with curved neck (46), American Bittern in flight (47), Phragmites (47), Saltmarsh Sparrow (Back Cover); **Ben Flemer**: Saltmarsh Sparrow nest (42); **Lee Fortier**: Marsh Wren calling (55); **Michael Francis**: Piping Plover (2); **Frank Gallo**: Brown Thrasher habitat (28); **Wayne Gifford**: Coastal habitat (21); **Google Earth, MassGIS, USGS**: Google Earth images (12); **John Harrison**: Brown Creeper (1), Red-tailed Hawk young (1), Does in the meadow (2), Peregrine Falcon feeding young (7), Nashville Warbler (12), American Redstart (15), Black-throated Blue Warbler (16), Killdeer (34); **Pam Hays**: Lake at sunset (18); **Kenneth Herbert**: Black-capped Chickadee (Inside Cover); **Ashley Keleher**: Barn Swallow (54); **Mary Keleher**: Kids playing soccer (36); **David Larson**: Brown-headed Cowbirds (13), Canada Warbler (13), Wooded freshwater wetland (19), Freshwater marsh (19), Suburban neighborhood (20), Cliff Swallow nest (38); **Ken Lee**: Sandhill Crane (8); **Ron Levenson**: Salt marsh (45); **Jerry Liguori**: House Sparrow (38); **Evan Lipton**: American Oystercatchers (16); **Patrick Lynch**: Roseate Tern standing on rock (50); **Paul McCarthy**: Northern Bobwhite (8); **Suzanne Niles**: Robin feeding chicks (4); **Jennifer O'Brien**: Raccoon (13); **Mona Obremski**: Deer (15); **Robert Payne**: Salt marsh habitat (21); **Wayne Petersen**: Shrubland (18), Killdeer distraction display (37), Cliff Swallows collecting mud (39); **Michael Phillips**: Common Loon (14); **Michael Ross**: Honeybee on Flower (14), Wood Thrush on nest with chicks (33); **Steve Schroeder**: Roseate Tern in flight (53); **Sandy Selesky**: Least Tern with chick (7); **Margo Servison**: Baltimore Oriole (1), Indoor Cat, Mia (2), Woods (17), Urban neighborhood (20), Woods (33), Peppers at Verrill Farm in Concord, MA (54); **Barbara Spencer**: American Bittern fledgling (46); **Molly Stark**: Fawn (32); **Mark Thorne**: American Kestrel (12); **Joan Walsh**: Field with nesting meadowlarks in Williamstown, MA (24), Developed recreational fields (37); **Larry Warfield**: Tree Swallow feeding chicks (14); **Steven Webster**: Turkey chicks (8); **Zachary Webster**: Tree Swallow nest (5), Bluebird feeding chick (7); **Scott Weidensaul**: Shade-grown coffee plantation in San Juan, Puerto Rico (54).

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