The State of the Birds
2010 Report on Climate Change
United States of America

Laysan Albatross Chick by Brad Bortner

In this 2010 State of the Birds report, we consider one of the greatest environmental challenges of our time, climate change. How will the impacts of climate change influence our bird populations and their habitats? Accelerated climate change as a result of human activities is altering the natural world as we know it, diminishing the quality of our environment. This report calls attention to the collective efforts needed to protect nature's resources for the benefit of people and wildlife.

Contents

Foreword

Birds are telling us an important story about climate change

The first State of the Birds report in 2009 revealed troubling declines of bird populations in the United States during the last 40 years—a warning signal of the failing health of our ecosystems. It also highlighted heartening evidence that concerted conservation efforts can make a positive difference in restoring habitats and reversing declines.

In this 2010 State of the Birds report, we consider one of the greatest environmental challenges of our time, climate change. How will climate change affect birds and their habitats? Accelerated by human activities, climate change is altering the natural world as we know it and is diminishing the quality of our environment. Habitat loss and degradation not only threaten birds and other wildlife, but also threaten human and societal well-being.

Because birds are good indicators of environmental conditions, their predicted changes illustrate how ecosystems are likely to change and they are telling us an important story. Some bird species will adapt and succeed, others will struggle and decline, and some will disappear. Instead of describing what has happened to bird populations, this report presents the first systematic analysis of what may happen to bird populations in each major biome of the United States as a consequence of climate change.

This new assessment will aid in prioritizing and planning for conservation management. As the world works to stabilize climate change by reducing greenhouse gas emissions and managing lands, immediate actions are needed to give birds a fighting chance to survive.

This report contains information about birds and their habitats, gives examples of what could happen due to climate change, and outlines suggested solutions and efforts needed to help address these issues. By following the conservation actions in this State of the Birds Climate Change report, together we can help ensure that future generations will enjoy the birds we are working to protect today.

North American Bird Conservation Initiative, U.S. Committee

American Bird Conservancy

Association of Fish and Wildlife Agencies

Cornell Lab of Ornithology

Klamath Bird Observatory

National Audubon Society

National Fish and Wildlife Foundation

The Nature Conservancy

U.S. Fish and Wildlife Service

U.S.D.A. Forest Service

U.S. Geological Survey

Sanderlings, Adak IIslandF.Deines USFWS

Pelican Island USFWS

SUMMARY

Birds in Every Habitat Will be Affected by Climate Change

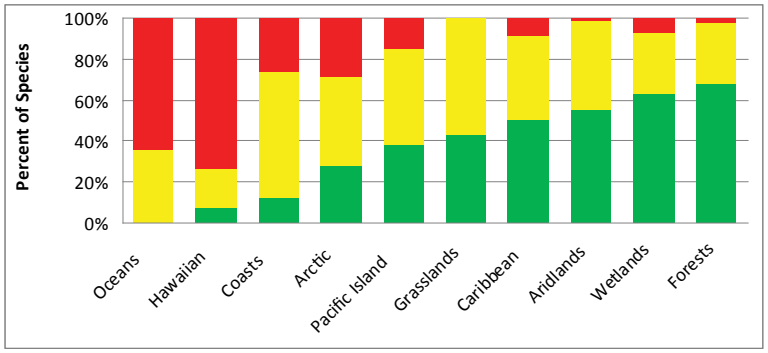
In this report, we address climate change - focusing attention on what may be in store for our nation's birdlife, and the stories the birds themselves are telling us about the changes that are happening even now.

Birds in every terrestrial and aquatic habitat will be affected by climate change, although individual species in each habitat are likely to respond differently. We assessed the relative vulnerability of each United States bird species, based on five biological aspects of sensitivity to climate change, as well as the exposure of each species' habitat to climate change in the near future. We then categorized species as showing High Vulnerability (a vulnerability score of four or more), Medium Vulnerability (a vulnerability score of two or three), or Low Vulnerability (a vulnerability score of zero or one).

The results indicate that a majority of birds dependent on oceans, and birds on Hawaiian Islands, are highly vulnerable to climate change. Birds in coastal, arctic/alpine, and grassland habitats, as well as those on Caribbean and other Pacific islands show intermediate levels of vulnerability. Most birds in aridlands, wetlands, and forests show lower overall vulnerability (see bar graph).

Across all habitats, species of conservation concern showed higher levels of vulnerability to climate change than species not threatened by other factors. Vulnerability to climate change may hasten declines or prevent recovery.

At the same time, increased conservation concern may be warranted for groups of birds, such as waterfowl and aerial insect-eating birds that are abundant now but that will be increasingly stressed as climate change impacts intensify.



Relative Vulnerability of U.S. Bird Species by Habitat

Red = high vulnerability

Yellow = medium vulnerability

Green = low vulnerability

Big Changes are in Store for Oceanic Birds

All 67 oceanic bird species, including albatrosses, petrels, tropical terns, tropicbirds, frigatebirds, and puffins are vulnerable because of their low reproductive potential, use of islands for nesting, and reliance on rapidly changing marine ecosystems. Seabirds such as Laysan Albatross and Bonin Petrel that are restricted to nesting on low-lying islands are in danger of losing their breeding habitat as sea levels rise. To provide oceanic bird populations with the best chances of adapting to climate change, we must reduce existing threats from overfishing, fisheries bycatch, and pollution. We must also take proactive measures such as removing invasive species and protecting existing or potential breeding colonies on high islands.

Sea Level Rise and Increased Storm Activity Threaten Coastal Birds

Rising sea levels are expected to inundate or fragment low-lying habitats such as salt marshes, sandy beaches, barrier islands, and mudflats. Increasing frequency and severity of storms and changes in water temperatures will impact quality and quantity of coastal habitats and alter marine food webs. Beach-nesting terns, highly specialized Saltmarsh Sparrows, and birds dependent on marine waters are among the most vulnerable species. Migratory species such as shorebirds are also vulnerable to changes in stopover and wintering habitats. Conserving coastal habitats will require planning and management to facilitate birds' movement and resilience.

Accelerated Changes in Arctic/Alpine Regions

Increased temperatures will drastically alter surface water and vegetation in the arctic, resulting in major changes in bird abundance and distribution. White-tailed Ptarmigan and rosy-finches may disappear from mountaintops as alpine tundra diminishes. Species that depend on grass-sedge tundra for breeding, such as the Black Turnstone, could lose their tundra breeding habitat. Minimizing human-caused disturbance to low-lying tundra and high-elevation alpine habitats may help the most vulnerable species adapt to changes.

Island Birds Face Rising Sea Levels and Reduced Habitats

Birds of Hawai'i and other Pacific islands already face multiple threats and are increasingly challenged by mosquito-borne diseases and invasive species as climate change alters their native habitats. Protection and restoration of natural systems is essential to endangered species such as Puaiohi and ʻAkiapōlāʻau in Hawai'i and the Puerto Rican Parrot. Decreased rainfall will reduce habitat for high-elevation forest birds and may result in breeding failures among resident birds and reduced overwinter survival of migrants in the Caribbean.

Laysan Finch by James H Breeden USGS

Changes in Rainfall and Temperature will Impact Wetland Birds

Predicted changes in temperature and rainfall will probably reduce vital habitats for waterfowl and other wetland birds. Additionally, these changes will reduce the ability of wetlands to provide functions such as flood control, sediment capture, and replenishing groundwater. Climate change could reverse the positive effects of conservation actions that have increased waterfowl populations. In the Prairie Pothole region alone, increased drought conditions and loss of wetlands could lead to significant reductions in breeding waterfowl. Conservation programs must be expanded to include climate change impacts in biological planning, conservation design, and habitat protection initiatives.

Grassland and Aridland Birds Face Warmer and Drier Habitats

Aridlands and grasslands are predicted to become warmer and drier. Many aridland birds are at increased risk because of drought and the potential for summertime temperatures greater than they can tolerate. Important wintering areas for many grassland birds may become unsuitable due to increased drought, invasive species, and invasion by woody shrubs. Prairie grouse and sage-grouse are vulnerable because of high site fidelity and their lack of tolerance for intensifying agricultural and energy development. Habitat corridors will be vital to allow birds to move to more suitable areas. Habitat conservation and the protection of core areas in cooperation with farmers and ranchers will be required for grassland and aridland birds.

Subtle Changes for Forest Birds

Forests will gradually change as precipitation changes, and as fire, insect pests, and diseases alter forest communities. Forest types in eastern states are predicted to shift northward, whereas western forest types will shift to higher elevations. These changes will alter bird communities, although most forest birds will probably be resilient because of their large distributions and high reproductive rate. However, long-distance migrants, especially aerial insect-eaters such as swifts and nightjars, may face multiple challenges such as the timing of food resource availability throughout their migratory range. Long-term management solutions should include protecting large forest blocks with the highest carbon stores and connecting landscapes by creating corridors.

Sonoran Desert

OCEANS

Big changes in store for the nation's ocean birds

Masked Booby by Eric VanderWerf

Noteworthy

- All 67 ocean bird species such as albatrosses, petrels, shearwaters, boobies, tropical terns, tropicbirds, frigatebirds, puffins and related species in U.S. waters show a medium or high vulnerability to climate change.
- Many seabirds possess traits that make them sensitive to effects of climate change, such as low reproductive potential; nesting on low-lying islands that may be inundated by rising sea levels; strong fidelity to breeding sites; and reliance on marine ecosystems that are sensitive to sudden change.
- Many effects have already been documented including increased water temperatures; decreased ice cover; altered water chemistry; more intense storms; and changes in marine diversity, population sizes, movements, and life cycles.

Magnificent Frigatebird USFWS

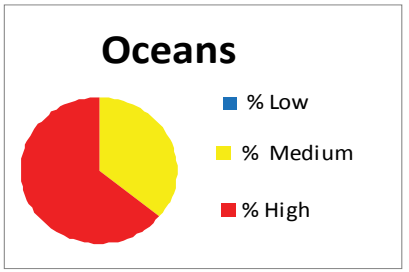
Observations and Predictions

It is difficult to predict and measure climate change in marine systems because natural large-scale changes occur naturally. These systems shift much more rapidly and over larger areas than in terrestrial systems where rooted plants and other physical conditions restrict the pace of change.

Warmer temperatures and changing wind patterns are predicted to affect the movement of ocean waters which can significantly alter ocean productivity and food webs. If upwellings are slowed or fail to occur, fewer nutrients are available for phytoplankton, which form the foundation of marine food chains. Birds may also be affected by changes in marine food webs as changing water temperatures cause coral bleaching and as increasing atmospheric carbon dioxide acidifies the ocean, preventing marine species from creating and maintaining their shells or skeletons.

Bird Species Vulnerability

Ocean birds are slow to adapt or recover from adverse conditions and are vulnerable to climate change because of their low reproductive potential (advanced age of first breeding, production of one egg each year or every other year, and the high mortality rate for young birds). Many seabirds forage over vast areas of ocean and are highly sensitive to the availability of marine food. This sensitivity is especially pronounced during breeding, when providing food for chicks can place enormous physiological strain on the parents.



The 67 ocean birds assessed have medium to high vulnerability to climate change; 43 are at the highest level.

Potential Impacts

Even where scientists have determined that changing climate has influenced seabird populations, the exact mechanisms are not completely known. What is known is that climate influences reproduction, food resources, and population dynamics. Some species will be favored, others will not.

Reproductive failure of seabirds resulting from changes in marine productivity is a documented natural occurrence, such as when Pacific Coast seabird chicks starve during El Niño years. If catastrophic events become more frequent, intense,

To provide ocean bird populations with the best chances of adapting to climate change, we must reduce existing threats.

or longer as a result of climate change, population recovery is less likely. Warmer waters have apparently led to decreases in the abundance of fish in Prince William Sound, the Gulf of Alaska, and the California Current region, which is likely to reduce the abundance of fish-eating birds.

Seabirds such as Common Murres that time their breeding based on temperature cues may fail to raise any young if their chicks hatch at the wrong time, missing the window when food is abundant. Climate change may also cause prey to shift ranges, leading to declines in bird populations if the birds are unable to follow. For example, receding sea ice could make it difficult for arctic-breeding seabirds to reach productive foraging areas distant from their nesting sites.

Key Steps

Because ocean birds are highly vulnerable to climate change, we must reduce existing stressors, including fishing operations that result in bycatch of birds; pollution; introduced predators and plants that destroy nesting colonies; and overharvest of fish by fishing fleets.

Vernon Bryd

Horned Puffin

Some seabirds now nesting on low-lying islands may be subject to sea level rise. The future of these birds is dependent on intense restoration and site protection on higher islands to provide them with suitable, predator-free breeding sites.

Because oceans are so important to birds, fish, and other resources, cooperative conservation efforts must be expanded to include marine and aquatic cooperatives. New marine protected areas, national wildlife refuges, monuments, and sanctuaries will protect important resource areas.

Conservation in Action

Translocation of very threatened ocean birds is a possibility. During the last few years, Bermuda Petrel chicks have been moved from small, low, rocky islands to nearby Nonsuch Island where the higher elevation provides more security from hurricanes and sea-level rise. The chicks survived and produced the first record of petrels breeding on Nonsuch Island in more than 400 years. In New Zealand, eight species of burrow-nesting petrels and shearwaters have been translocated successfully.

Regulations and voluntary measures to reduce bycatch have greatly reduced the number of seabirds accidently killed by long-line fisheries in Alaska and Hawai'i. The designation of National Wildlife Refuges and Marine National Monuments conserves foraging areas and many remote islands where seabirds nest.

Laysan and Black-footed albatross by Eric VanderWerf

COASTS

Birds in already beleaguered habitats will be hard hit by climate change

Black Oystercatcher by Roy Lowe

Noteworthy

- The great majority of coastal species show medium or high vulnerability to climate change.
- The quality and quantity of coastal habitats is likely to decrease as a result of sea-level rise, increased storm damage, and effects on marine productivity.
- Losses of habitat and food sources due to climate change are the largest concerns for coastal birds.
- Populations may decline if climate change disconnects the timing of prey availability or abundance with coastal birds' breeding or migration cycles.

Bonaparte's Gull by Philina English

Observations and Predictions

Observed and predicted impacts of rising sea levels vary depending on latitude, marine currents, and subsidence or elevation of land mass. In the United States, the Gulf of Mexico and mid-Atlantic coasts have experienced the highest rates of relative sea level rise and recent wetland loss. Continued sea-level rise is expected to inundate or fragment existing low-lying habitats such as salt marshes, barrier islands, and mudflats. Movement of coastal wetlands may offset some losses; however, this possibility is limited in areas with cliffs and steeper topography, such as areas on the Pacific Coast, or where shorelines are extensively developed, such as around San Francisco Bay.

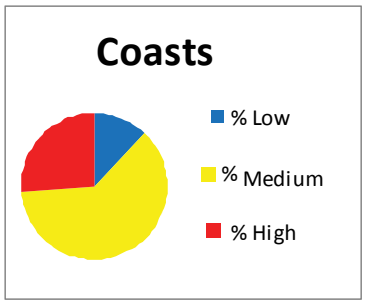
On all coasts, flooding and erosion are predicted to increase with more frequent and severe storms, as a result of rising ocean temperatures. Loss of sea ice buffers around Alaska leaves its coasts more exposed to storms. For example, the Bering Sea had a 39% reduction in the extent of sea ice in the last decade that has led to loss of coastal habitat.

The trend toward heavier rainfall events is likely to increase the harmful effects of runoff that introduces excess nutrients or salinity changes in coastal areas. Warmer temperatures and increased nutrient inputs may exacerbate phytoplankton blooms that can cause coastal dead zones. Warmer temperatures are also causing a northward shift in the distribution of marine organisms and facilitating the introduction of invasive species to new areas.

Coastal ecosystems include coastlines, nearshore islands, nearshore waters, estuaries, and tidally-influenced sections of rivers and creeks—productive habitats for abundant wildlife.

Bird Species Vulnerability

Many of the coastal species that show medium or high vulnerability to climate change are coastal seabirds such as the arctic Ivory Gull, Aleutian Tern, and Kittlitz's Murrelet. These species are vulnerable to climate change because they rely on marine food webs and because they have low reproductive potential. Beach-nesting Black and American oystercatchers and specialized Saltmarsh Sparrows are among the most vulnerable coastal birds because they rely heavily on limited, low-elevation coastal habitats.



The great majority of coastal species (74 of 84 assessed) have medium or high vulnerability to climate change.

Potential Impacts

Like many other organisms, coastal bird species are expected to shift distributions northward, as warmer temperatures cause shifts in food resources and nesting opportunities.

If coastal habitats are lost, bird populations may decline. Based on projections of marsh habitat loss in Chesapeake Bay, significant declines of many marsh species are predicted. Birds such as the rare Black Rail that relies solely on irregularly flooded high marsh could disappear from the Bay if breeding sites are submerged.

Seabirds breeding on coasts may be unsuccessful in raising chicks if their hatch dates do not match patterns in the availability of food resources. Migrating shorebirds stopping at coastal feeding grounds with reduced numbers of invertebrates may be unable to gain the body weight necessary to reach their breeding grounds and raise their young.

Some large ecosystems may fundamentally change. For example, Everglades National Park is very vulnerable to sea-level rise because the park lies at or near sea level. Some projections show a loss of tidal flats and inland freshwater marshes, which would adversely impact some wading birds and the federally endangered Cape Sable Seaside Sparrow. However, these same projections show an increase in the area of shallow basins, mangroves, and brackish marshes, which could favor some species.

Saltmarsh Sparrow by Kenneth V. Rosenberg

Key Steps

Conserving coastal habitats already extensively altered by development requires strategic planning and management. Communities must take climate change into account as they develop zoning and building codes. In areas with rising sea levels, development plans should avoid restricting the inland migration of coastal beaches, marshes, mangroves or other wetlands. The placement of hard barriers for construction or flood control on shorelines can squeeze wetlands out of existence. Some coastal states, including Massachusetts and Rhode Island, have restricted the construction of seawalls and other barriers in some estuaries, and other states should as well.

Conservation in Action

A number of strategies can make existing coastal habitats more resilient to sea-level rise. For example, at the Alligator River National Wildlife Refuge in North Carolina, The Nature Conservancy and U.S. Fish and Wildlife Service are removing ditches to restore the hydrologic regime and limit saltwater intrusion, assisting vegetation movement by planting salt-tolerant species, and building oyster reefs to buffer shorelines from waves and storms. Along the Pacific Coast, dikes and drainage ditches are being removed from Bandon Marsh, Nisqually, and several other National Wildlife Refuges to restore natural hydrology and expand tidal marsh habitat.

American Avocet by John Bedell

Specialized Saltmarsh Sparrows are among the most vulnerable coastal birds because they are extremely sensitive to changes in water levels in tidal habitats.

ARCTIC & ALPINE

Climate change will be accelerated and dramatic for birds in arctic regions

Long-tailed Jaeger USFWS

Noteworthy

- 72% of the 83 arctic and alpine species have medium or high vulnerability to climate change.
- Temperature increases in the arctic in the last 50 years are twice that of the rest of the globe.
- Increases in temperature will result in major alterations to the abundance and distribution of surface water in the arctic and major vegetation changes in arctic and alpine regions, which will affect bird abundance and distribution.
- Timing of long distance migrations and food availability at migration stopovers and on breeding grounds may become mismatched.

Arctic National Wildlife Refuge USFWS

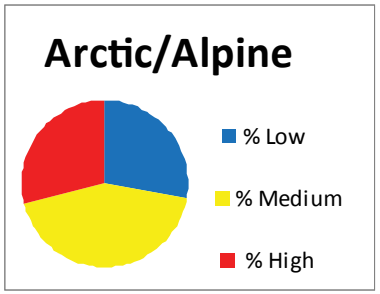
Observations and Predictions

Average annual temperatures will continue to rise over the next century. However, these increases are not uniform across the arctic. There is a greater temperature rise in Alaska (3–4°F in summer) than in the eastern Canadian arctic. As average annual temperatures rise and the permafrost thaws, the active soil layer becomes deeper. This allows the spread of trees and shrubs into tundra now composed of sedges, grasses, and dwarf shrubs, and will affect bird abundance and distribution.

Although highly variable, precipitation is increasing at a greater rate in the arctic than elsewhere around the globe and it is occurring primarily as rain. Precipitation will probably increase and warmer temperatures will result in higher evaporation, which will reduce soil moisture and reduce tundra wetlands in the western and central arctic. An increase in the number and extent of tundra fires will also alter these drier habitats.

Bird Species Vulnerability

Vulnerability of arctic and alpine birds is primarily due to their long-distance migrations, their obligatory use of these biomes, and the exposure of many arctic and alpine habitats to effects of climate change. Shorebirds, in particular, are dependent on arctic and alpine habitats for breeding. Habitat exposure was highest for alpine breeding species and those using low-elevation wet tundra. Simple interactions among bird species and their food resources increased sensitivity for some species. Because many arctic birds are long-distance migrants, these species could also experience climate change-induced alterations to the habitats they use at other times of the year, which might increase their overall exposure and vulnerability.



Of 83 arctic and alpine species, 72% are moderately or highly vulnerable to climate change.

Research and monitoring programs are being initiated in arctic regions to increase our understanding of how birds will respond to a changing climate and to develop effective conservation strategies.

Potential Impacts

Melting permafrost may result in changes to surface water and plant communities, changing the distribution and abundance of waterfowl, shorebirds, and gulls. Melting permafrost may also release contaminants, such as mercury and organic pollutants, into the aquatic environment, exposing species such as the Spectacled Eider, Yellow-billed Loon, and Sabine's Gull to new threats. Advancement of trees and shrubs will have dramatic effects on arctic and alpine breeding birds by narrowing or eliminating tundra and alpine breeding habitats used by species such as Surfbird, Black Turnstone, and Brown-capped Rosy-finch. As boreal forest birds expand into the arctic, new avian communities will develop.

The earlier onset of spring might initially increase productivity of nesting shorebirds, although migration schedules of long-distance migrants would have to change so they raise their young at the time when the most insects are available. Changes in weather and tundra habitats could decrease the abundance of lemmings and their predators, such as jaegers and Snowy Owls. A decrease in lemmings could also cause predators to switch to eating other birds and their eggs.

Key Steps

Because of the exposure of low-elevation tundra and alpine zones to climate change effects, minimizing additional human-induced stresses on these habitats is necessary. Increasing the network of protected areas in the arctic should keep pace with any further industrial development there.

Few monitoring systems are in place to understand the status of arctic and alpine birds and how they are responding to climate change during their annual cycle. Monitoring systems should be deployed to understand how arctic and alpine birds are responding to changing climatic conditions and what steps could be taken to offset negative effects. Reducing atmospheric carbon will be necessary to maintain arctic and alpine biodiversity.

Conservation in Action

Arctic and alpine birds that rely on shrubs for breeding habitat will increase in these regions. Research and monitoring programs are being initiated in arctic regions to increase our understanding of how birds will respond to a changing climate and to develop effective conservation strategies.

Willow Ptarmigan by David Benson

Arctic avifauna will likely experience climate change-induced alterations to their habitats throughout their annual cycle.

Spectacled Eider USFWS

Islands

Rising sea levels and temperatures threaten birds

Laysan Duck by Roy Lowe

Noteworthy

- 93% of Hawaiian birds and 62% of all U.S. Pacific island birds exhibit medium or high vulnerability; 49% of Caribbean birds also show medium or high vulnerability to climate change.
- Characteristics of islands such as small size, frequency of natural disasters, and high degrees of bird endemism contribute to island birds' high exposure to impacts of climate change.
- Increases in temperature and rising sea levels are expected to reduce natural habitats on islands where bird species have restricted ranges and a limited ability to respond to change.
- Lower rainfall in the Caribbean will cause changes in the distribution of habitat types, reduction in the amount of moist forests, and disruptions in food supplies.

Hanawi Natural Area Reserve in Maui by George Wallace

Observations and Predictions

Increases in temperature and rising sea levels are expected to reduce the extent of natural habitats on islands where many bird species have restricted ranges and a limited ability to respond to change. Species that depend on mountain forests, coastal wetlands, and low-lying islands are expected to be most severely affected by this direct habitat loss.

Eric VanderWerf

Akekee

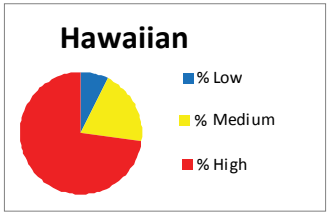
Over the last century, average annual temperatures in the Caribbean have increased by more than 1°F and during this century they are expected to rise by an additional 4°F. In the U.S. Pacific islands, temperatures have risen by 0.5°F during the past century and are expected to rise by an additional 4°F by 2090. The Caribbean has been drying in recent decades and this trend is expected to continue with a reduction in summer rainfall.

Tropical cyclones are expected to increase in intensity. Sea-level rise is expected to reduce the area of low-lying islands and eliminate or degrade inshore habitats, including mangroves and other coastal wetlands. In addition, sea-level rise will cause saltwater intrusion into freshwater underlying islands, causing salinization of soil and freshwater wetlands, especially on low-lying islands.

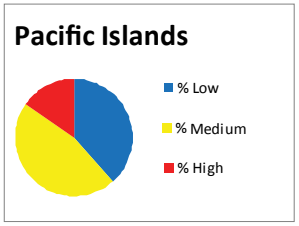
Bird Species Vulnerability

For this report, island birds refers to upland (for example, forest or scrub) and wetland birds occurring in Hawai'i or on U.S. associated islands in the Pacific and Caribbean. (See Oceans on page 5 for a discussion of island-nesting seabirds).

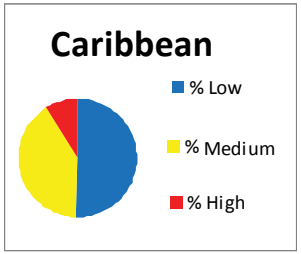
Hawaiian birds are severely threatened by climate change. Among the 42 native and endemic species of the Hawaiian Islands, only one is not considered of conservation concern. Multiple attributes contribute to their vulnerability to climate change. Attributes that are most important include single island endemism, reduced dispersal ability, and exposure to climate change of the habitats on which these birds depend, particularly high-elevation mountain forests.



93% of Hawaiian birds exhibit medium or high vulnerability to climate change.



62% of all U.S. Pacific Island birds show medium or high vulnerability.



49 % of U.S. Caribbean island birds assessed have medium or high vulnerability to climate change.

Potential Impacts

In Hawai'i , species restricted largely to high elevation forest, such as Puaiohi and 'Akiapōlā`au, will be highly susceptible to increases in temperature. Elsewhere, mountain species such as Elfinwoods Warbler on Puerto Rico and the Rota Bridled White-eye in the Northern Mariana Islands will face similar threats. Sea-level rise will also reduce habitat for species such as Laysan Duck and Laysan Finch in Hawai'i and Greater Flamingo in the Caribbean, and may threaten coastal forests important to the Micronesian Megapode in Northern Mariana Islands.

Jack Jeffrey

`Akiapōlā`au

There is a strong relationship between precipitation and insect abundance. With climate change, rainfall is expected to decline in the Greater Antilles, potentially leading to a persistent pattern of low insect abundance and a reduction in bird breeding success, which could result in significant long-term population declines, especially among insectivorous species of concern such as Puerto Rican Vireo. In addition, reduced rainfall may reduce the survivorship of overwintering Nearctic-Neotropical migrants.

Cyclones disrupt the food supplies of some bird species, especially those that depend on fruit and nectar, causing post-storm population decreases among species with limited ability to disperse long distances in search of food. The intensification of subtropical and tropical cyclones expected with rising temperatures and shifting ocean currents will exacerbate the impacts of invasive plants by causing large-scale habitat disturbance, creating opportunities for invasive species to rapidly expand their ranges.

On the main Hawaiian Islands, avian malaria and pox spread by introduced mosquitoes pose a significant threat to native Hawaiian birds, which have little or no natural resistance to these diseases. At temperatures below 55°F, which occur today, typically around 5,000 feet above sea level and higher, the malaria parasite will not completely develop in birds. An increase in temperature of slightly less than 4°F, which is predicted by some models, would raise the 55°F threshold by nearly 1,000 feet, greatly reducing the areas in which there is a low risk of disease transmission. For example, the Hanawi Natural Area Reserve on Maui could lose 57% of its remaining low-risk area, increasing the risk of malaria to endangered Maui Parrotbill and Ākohekohe.

All forested areas on Kaua'i and O'ahu are warm enough for some level of malaria transmission. However, warming on Kaua'i would result in an 85% decrease in the area where transmission is currently highly seasonal and limited, contributing to further declines among imperiled species such as 'Akeke'e and 'Akikiki.

Key Steps

On all U.S. islands, immediate protection and restoration of natural systems is critical to counteract the negative effects of climate change. Protected areas need to be large and numerous to ensure that each important habitat type is protected across islands. Protection and restoration of high elevation habitats is essential.

Programs to control invasive plants and animals must be supported and implemented. In Hawai'i, until more sophisticated methods are developed to directly control mosquitoes and the diseases they transmit, fencing and removal of ungulates are the most effective means of maintaining habitat quality and reducing the amount of mosquito breeding habitat.

It is important to focus species recovery efforts now on the species most in danger of becoming extinct. Translocations to create new species populations in multiple locations will be an important strategy. In some cases, it will be necessary to establish captive populations of species that might become extinct.

Conservation in Action

In Hawai'i, watershed partnerships have been effective at pooling resources to undertake more restoration efforts. Strides have also been made in protecting and restoring remaining natural forest. Partnerships including the Hawai'i Department of Lands and Natural Resources, U.S. Fish and Wildlife Service, National Park Service, conservation organizations, and native Hawaiians are working to fence key areas and remove nonnative species. Additionally, predator removal has successfully provided safe places for birds to nest.

Akohekohe by Jack Jeffrey

ARIDLANDS

Aridlands birds will be susceptible to warmer and drier habitats


Sonoran Desert

Noteworthy

- More than 50% of airidland bird species show medium or high vulnerability to climate changes.
- Aridlands, already drier and more variable than other habitat types, are predicted to get even drier, warmer, and more variable.
- Most aridlands will be altered by increased invasion of trees, shrubs, and other woody plant species, which will decrease their quality as habitat for bird species that prefer aridlands dominated by grasses and other desert vegetation.
- Aridlands ecosystems are highly susceptible to invasion by nonnative species. Facilitated by climate change, invasion by nonnative species could alter the type and quantity of food for birds.


Phainopepla John Bedell

Observations and Predictions

Aridlands of the United States, already subject to some of the highest extremes of climate variability in the country, are at great risk from climate change. The major predicted effects of climate change on all types of aridlands suggest that they will become warmer and drier. Associated with this will be increasingly variable precipitation, particularly in areas such as deserts, where summer and winter precipitation patterns help determine plant and animal distribution.

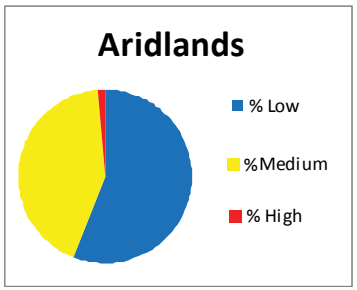
Linked to these climatic changes, aridlands will be highly susceptible to changes in plant species composition, particularly increasing tree cover in areas now dominated by shrubs (such as the vast expanses of sagebrush in the Colorado Plateau) and increasing density and surface area of shrubs in regions now dominated by grasses and other desert plants.

Invasion by nonnative species is expected to be exacerbated by changes in climate, which could promote devastating changes in fire frequency as well as alter the type and quantity of food for birds.

Bird Species Vulnerability

Compared with other habitat types, relatively few aridland bird species are vulnerable to climate change, though vulnerable species are found in all major aridlands types. Examples include Greater and Gunnison's sage-grouse of sagebrush habitats of the Colorado Plateau and Great Basin, Costa's Hummingbird and Gilded Flicker of the Sonoran Desert, Bendire's and Crissal thrasher of the Chihuahuan Desert, Black-capped Vireo of the Edwards Plateau, and Wrentit of the coastal California chaparral. Aridland birds are primarily vulnerable because of their exposure: the probability that their habitats will undergo major changes due to climate change.

Fifty aridland species are considered vulnerable due to habitat exposure. A significant number are obligate breeding species of aridlands, which contributes to their vulnerability. Fourteen aridland species show medium or high vulnerability, but are not currently considered of conservation concern. These should be considered at much higher risk in the future and should be given special attention. Of these, the Lesser Nighthawk, Common Poorwill, Lucifer Hummingbird, and Phainopepla deserve special attention. The nighthawk and poorwill have increased vulnerability because of their dependency on large flying insect prey and their low reproductive potential. Lucifer Hummingbird and Phainopepla are dependent on seasonal flower and fruit resources and are only found in aridlands, thus increasing their vulnerability.



Of 79 aridlands species, 44% have medium or high vulnerability to climate change.

Potential Impacts

Climate change could decouple the availability of food resources such as flowers and seeds from the time that they are needed by various aridlands species. A great unknown for aridlands birds is the extent to which extreme climatic events, especially heat waves and drought, will push different species' physiological tolerances for heat and dehydration to or above their limits, resulting in increased mortality. Some evidence already exists that these events can stress small-bodied species such as hummingbirds and Verdin and there is evidence of reproductive failure and catastrophic mortality from heat waves in the United States and elsewhere.

USFWS

Allen's Hummingbird

Birds associated with riparian systems in aridlands, such as Phainopepla and Lucy's Warbler, will be especially affected due to changes in water availability and vegetation of these systems. Aridlands, especially those in the Southwest, also provide important wintering habitat for numerous species from grasslands and other habitat types. If aridlands undergo the changes predicted, their suitability for a large number of these wintering species will decline.

Most aridland birds are adapted to the dry and variable climates in which they live, so it is expected that many will adjust their behavior, distribution, or movement patterns in response to climate change. It is expected that many aridlands species and the habitats they use should be able to expand to the north, east, and to higher elevations. Significant northward range expansions have already been observed for some aridlands species such as Cactus Wren, Cave Swallow, and White-winged Dove. Examples of species that are currently rare or of restricted distribution in the U.S., but are likely to expand, include Bronzed Cowbird, Crested Caracara, and Northern Beardless-Tyrannulet.

Key Steps

Given the nature of aridlands and the predicted effects of climate change, we need to preserve additional airidland habitats so birds can move as change occurs, particularly to the north, east, and up in elevation; barriers that prohibit this movement should be identified and removed or minimized. Riparian areas will increase in their importance for aridland birds. They need to be protected and restoration efforts implemented to increase the quantity and quality of this generally scarce habitat type.

Management tools such as prescribed burning can be used to reduce shrubs and promote grasses in areas susceptible to woody plant invasion. Analyses of current and predicted climate change must be conducted to identify areas within the subtypes of aridlands that are less likely to show temperature increases or higher variability; these areas could serve as refuges for aridlands birds in the future. Special attention and monitoring must be paid to nonnative invasive plants; if they are not controlled, they may spread so rapidly that they become impossible to control.

It is highly likely that species that are either very rare or nonexistent in the U.S. at present will expand their ranges into our country from the south, thus increasing bird species diversity in some geographic areas.

Conservation in Action

The San Pedro River National Conservation Area, designated by Congress as a Riparian National Conservation Area, is home to more than 100 species of breeding birds and an additional 250 species of migratory and wintering birds occur in the area.

In cooperation with state and local conservation planning partners, the Bureau of Land Management is maintaining and restoring sagebrush landscapes on public lands in 11 western states to conserve sage-grouse populations.

Crested Caracara by Melissa Meadows

WETLANDS

Temperature rises will have severe impacts on wetland birds

Northern Pintail by John Bedell

Noteworthy

- A third of the 165 wetland breeding species in the United States show medium or high vulnerability to climate change.
- Wetlands are susceptible to even minor changes in precipitation and temperature and may be degraded or eliminated if no action is taken to counteract climate change impacts.
- Shallow breeding wetlands (potholes) and wetland-dependent breeding birds that use them appear acutely threatened, especially in the north-central states.
- Wetland breeding birds are primarily vulnerable because of the water level and distribution impacts of climate change on breeding habitats.

Marsh Wren by Amy Liest

Observations and Predictions

Projected temperature rises without comparable increases in precipitation will have severe impacts on wetland ecosystems, especially related to loss of water inputs, reduced storage capacity, timing of wetland recharge, and frequency of drought. The extent of semi-permanent and seasonal wetlands may be further reduced by increases in evaporation and reduced summer soil moisture, particularly in the prairie regions of the United States.

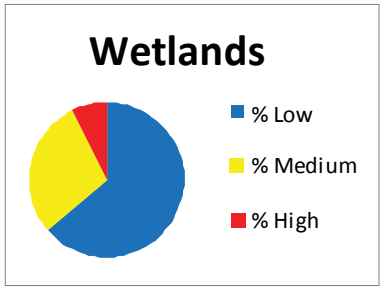
Impacts will probably be high on mountainous wetlands where temperature-sensitive plants and animals will be unable to move upslope. Wetlands that depend on snowmelt will diminish or disappear. An increase in the severity of storms and tornadoes will increase the incidence of flash-flood erosion events or alter the length of time that a wetland holds water.

Carbon stores in wetland soils in the U.S. may be released following wetland drainage or if permafrost wetlands melt. Bacteria which live in aerated conditions will oxidize the carbon and return it to the atmosphere.

Bird Species Vulnerability

Slightly more than one-third (36%) of the 165 wetland breeding species in the United States show medium or high vulnerability to climate change. Wetland breeding birds such as Western and Clark's grebe and Northern Pintail are primarily vulnerable to changes in water level and distribution that affect breeding habitats. Thirty-two wetland breeding bird species exhibiting medium or high vulnerability are currently not considered of conservation concern including Sabine's Gull, Pomarine Jaeger, and Arctic Loon.

Excessive chemicals, nutrients, and sediments from unsustainable agriculture can disrupt the function of wetlands, dramatically reducing clean water and other environmental benefits, and eliminating critical areas needed by wetland birds.



Of 165 wetland breeding species 36% show medium or high vulnerability due to climate change.

Global climate change will degrade wetlands, affecting birds and other wildlife. Warming temperatures and more storms, droughts, and floods will cause unpredictable changes in hydrology, plant communities, and prey abundance.

Potential Impacts

Wetland-dependent breeding birds are at risk because the shallow wetlands (potholes) where they breed appear to be acutely threatened, especially in the north-central United States. The distribution of birds is influenced by the surrounding landscape and the birds' ability to find suitable habitat. It is possible that changes in climate and habitat conditions will make areas uninhabitable for some species.

Warming temperatures and storms, droughts, and floods of greater frequency and severity will cause unpredictable changes in wetland water levels, plant communities, and prey abundance and, ultimately, the abundance of wetland birds. The effects of climate change may cause birds to shift to areas with lower quality wetland habitats that may only partially fulfill their needs during critical portions of their annual cycle.

Key Steps

Carbon sequestration incentives can help to mitigate the effects of climate change and protect wetlands for birds as well as for the environmental goods and services that wetlands provide to people. Federal land management programs can help increase the amount of carbon stored, including programs that retire farmland from crop production and convert it back into grasslands or wetlands. During droughts small wetlands should receive special protection because of their vulnerability to conversion to agriculture at these times.

Conservation in Action

The 2008 Farm Bill included another million acres in the Wetland Reserve Program that could provide more reliable wintering habitats for wetland-dependent birds. In 2010, Congress appropriated a record $47 million to the North American Wetland Conservation Act (NAWCA) to promote wetland conservation efforts. Organizations such as Ducks Unlimited conserve and restore some of the most critical habitat needed for waterfowl.

A wetland landscape simulator (WETLANDSCAPE) is now being developed to calculate the effect of climate variability simultaneously on wetlands and other water resources within a landscape. This next-generation model is expected to reflect regional differences that may exist in wetland water depth across the Prairie Potholes. The WETLANDSCAPE model can be used to evaluate which farming practices can reduce the impacts of climate change by producing more favorable water budgets for prairie wetlands.

Clark's Grebe USFWS

King Rail USFWS

Wetland breeding birds are primarily vulnerable because of the water level and distribution impacts of climate change on breeding habitats.

GRASSLANDS

Declines in grassland birds will be exacerbated by climate change

Western Grassland by Terry Rich

Noteworthy

- More than half of grassland species are expected to face additional pressures because of climate change.
- Grassland habitats may dry out so much that they become uninhabitable for many grassland birds.
- The southwestern grasslands, which are vital to both breeding and wintering bird species, are threatened by many stressors in addition to climate change.
- Several bird species that are now common will probably be added to conservation concern lists in the near future unless additional measures are taken.

Sasha Keyel

Grasshopper Sparrow

Observations and Predictions

Grasslands in the Great Plains of the United States and southern Canada are predicted to get warmer with climate change. Southwestern grasslands are expected to become drier because of declining precipitation and higher temperatures, especially the Chihuahuan Desert grasslands of the southwestern U.S. and northern Mexico, which are critical wintering areas for many grassland birds.

In northern grasslands, additional precipitation is expected, but all or most grasslands are expected to become drier because warmer temperatures will cause increased evaporation. Variability in precipitation is also expected to increase; droughts, flooding, and extreme storms (such as hailstorms) are all expected to become more common. Increased atmospheric carbon dioxide will probably contribute to invasions of woody shrubs into grasslands.

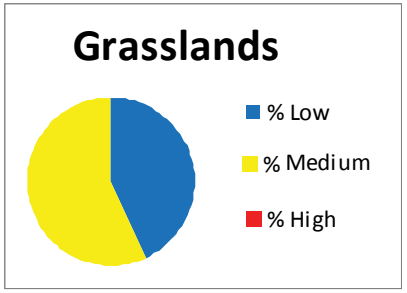
Bird Species Vulnerability

The vulnerability of birds in grasslands is not as high as in other habitat types; however, 25 (57%) grassland species have medium vulnerability to climate change, and grassland birds are at risk for many reasons other than climate change. Six species stand out as especially vulnerable. Sharp-tailed Grouse and Lesser and Greater prairie-chicken are less likely than other grassland birds to move in response to changing conditions because they are closely tied to their leks where males display to attract females. Wilson's Phalarope, Bobolink, and Dickcissel are long-distance migrants that may not be able to adapt quickly enough to changing conditions.

USFWS

Dickcissel

Species with a large proportion of the population wintering in the Chihuahuan Desert grasslands are also vulnerable because the habitat may dry out so much that it becomes uninhabitable.



57% of grassland species show medium vulnerability due to climate change.

Potential Impacts

Climate change is expected to exacerbate declines in grassland birds that already have declining populations, and several species that are common now will probably be added to conservation concern lists in the near future unless additional conservation measures are taken.

Although most grassland bird species appear able to move in response to environmental changes, Christmas Bird Count data show that grassland birds were the only group of birds that failed to shift north during the past 40 years in response to warmer winter weather. Perhaps they did not shift because the quality of remaining grasslands in the north is too poor to sustain additional birds.

As woody vegetation invades grasslands, birds that specialize in grassland may be replaced by birds of shrubby or woodland habitats. Grassland species have different thresholds of tolerance for woody invasion; some, like Loggerhead Shrike and Northern Bobwhite, do best in mixed areas, but disappear when the grass becomes rare. Others, like Chestnut-collared Longspur, are intolerant of even a low percentage of shrub cover.

Key Steps

Large patches of healthy grasslands will need to be restored and protected throughout the United States to allow grassland birds to move north as temperatures increase. Conservation of wet grasslands and grasslands adjacent to wetlands is critical to allow birds that require wet habitats to persist.

Active management will be needed to maintain enough grassland to support the full suite of grassland bird species. In addition to shrub invasion and climate-related drying, grasslands are threatened by intensification of agriculture, over-grazing, invasive species, and suburban and urban development. Energy projects often target grasslands, making proper siting decisions essential for grassland bird conservation. For example, Sharp-tailed Grouse and Lesser and Greater prairie-chickens will not breed near tall structures such as oil rigs, wind turbines, or power lines.

Collaborative efforts that consider grazing interests can allow grassland birds to coexist with cattle and other grazers in many grasslands. Moderate grazing may be required to maintain grasslands against woody invasion in some regions, especially in grasslands that coevoloved with native grazers.

Fire is essential for maintaining grasslands in most areas; in other regions, fire can favor nonnative invasive plants. Increased acreage of grasslands managed for wildlife is needed throughout the United States to stabilize grassland birds.

Brian Sullivan

Chestnut-collared Longspur

Conservation in Action

Wildlife conservationists have rallied around the plight of grassland birds in recent years. Increasingly, farm conservation programs have been designed to conserve birds and other wildlife, in addition to fighting erosion and supporting farm income. Many of the grassland conditions that benefit livestock production such as high grass cover and low shrub cover also benefit many of the most sensitive grassland birds. Farmers, ranchers, and conservationists are working together to combat invasive species and protect grasslands.

Loggerhead Shrike by Brian Sullivan

Climate change is expected to exacerbate declines in birds that already have declining populations, and several now-common birds will probably be added to concern lists in the near future unless additional conservation measures are taken.

FORESTS

Forest birds show greater resilience than birds in most habitats

Townsend's Warbler USFWS

Noteworthy

- Roughly one-third of the 312 forest breeding species in the United States show high or medium vulnerability to climate change; the most vulnerable species include aerial insectivores and high-elevation breeders.
- Changes in boreal forests are expected to be greater than those in temperate or tropical forests, driven primarily by increased frequency of fire and other disturbance.
- Increased frequency and severity of fire and outbreaks of insect pests, such as pine-bark beetles, are examples that climate change is already affecting our nation's forests.
- Forest degradation and deforestation are significant sources of atmospheric carbon; forest protection and management offer important opportunities to sequester existing stores of carbon while also providing bird habitat.

Redwood National Park by Steve Holmer

Observations and Predictions

Although changes in tree species distributions may occur slowly, changes to regimes in forests are already being observed. This includes an increase in tree mortality from insect outbreaks and increases in the length and severity of fire seasons, exacerbated by increases in spring and summer temperatures and earlier snowmelts.

Approximately half of southern tree species will expand northward. One of the most notable changes is the predicted expansion of oak-hickory and oak-pine forests. Other species will decrease in importance as forest types such as aspen-birch, white-red-jack pine, maple-beech, and birch forests decrease in the United States and move north into Canada.

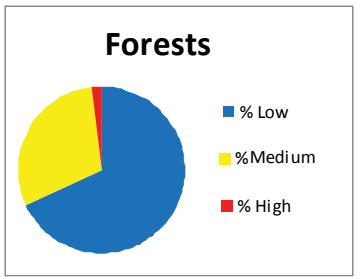
In the western United States, high-elevation chaparrals and grasslands are projected to increase at the expense of subalpine forests, alpine tundra, and Great Basin woodland communities. Plant and animal interactions may become uncertain as tree species shift in response to climate change potentially creating new combinations of species that do not resemble current plant communities or habitats.

Overall, the boreal forest is likely to decrease in area, with major changes occurring along the southern boundaries as ranges of tree species shift northward.

Bird Species Vulnerability

Although only 2% of forest bird species show high vulnerability to climate change, more than half of the species with medium or high vulnerability were not previously considered species of conservation concern. Among species that are restricted to a single forest type, a higher proportion of birds in eastern forests (75%) show medium or high vulnerability than birds in western (57%), boreal (49%), or subtropical (27%) forests.

Among the most vulnerable forest species are Bicknell's Thrush because of its restricted breeding range in high elevation forests in the northeast United States, the endangered Kirtland's Warbler because winter habitat on low-lying Caribbean islands is threatened, and specialized aerial insectivores such as Black Swift, Whip-poor-will, and Chuck-will's-widow. Forest birds



Overall, only 2% of forest bird species show high vulnerability to climate change, and another 30% show medium vulnerability.

The ranges of many forest birds will probably shift as ranges of tree species shift, generally northward or to higher elevations.

showing medium vulnerability include large flycatchers that feed on aerial insects and bird species in riparian or humid forests, mostly in the West, that are at risk from increased drought conditions and more frequent fires.

Pamela Hunt

Common Nighthawk

Potential Impacts to Birds

In general, because of their large ranges and high reproductive potential, forest birds are predicted to fare better in a changing climate than birds in other habitats. Important exceptions include species that are specialized on highly seasonal resources, such as aerial insects or nectar, or that are dependent on high-elevation, extremely humid, or riparian forests.

The ranges of many forest birds will proabably shift as ranges of tree species shift, generally northward or to higher elevations. Some species may become less common in the United States as their ranges increase in Canada. Conversely, species currently occurring primarily in Mexico may become more common in the United States. Increased drought and frequency of fire in western forests may also alter forest bird communities.

More than a third of forest birds are Neotropical migrants. These long-distance migrating birds may experience mismatches in the timing of breeding with the availability of seasonal food resources, causing ecological disruption of bird communities or reproductive failure.

Key Steps

Short-term actions should focus on managing forests to increase resistance to change and promote resilience. Managers can help forests resist climate change by protecting forests with high ecological integrity such as National Forest roadless areas and by improving forest health and reducing undesirable (or extreme) effects of fires, insects, and diseases. We can increase the resilience of forests to accommodate gradual changes by emphasizing process rather than structure and composition, such as restoring natural fire regimes where possible, and restoring natural hydrology to maintain fragile riparian forests.

Long-term management practices will enable forests to respond to change. Examples include forest management to assist tree species transitions and range shifts and connecting landscapes by protecting large forest blocks and creating corridors, especially along latitudinal and elevation gradients.

Preservation of forests with the highest carbon stores, such as the moist mature and old-growth forests of the Pacific Northwest would prevent vast amount of carbon from reaching the atmosphere if these forests were logged. Additionally, preservation of these forests provides habitat protection for the threatened and declining Northern Spotted Owl and Marbled Murrelet.

Better monitoring of aerial insect eating birds, especially swifts and nightjars, may provide a sensitive barometer to environmental change, especially close to urban areas.

Conservation in Action

Extensive forests have huge potential to lessen human impacts of climate change and are part of the solution to addressing climate change. Greenhouse gas reduction through carbon sequestration can be achieved by avoiding deforestation, promoting reforestation, managing forests to sequester and retain carbon, and sequestering carbon after harvest in wood products.

Hooded Warbler USFWS

A BIRD'S-EYE VIEW: ADDRESSING CLIMATE CHANGE AT A LARGE SCALE

Reducing the impacts of climate change on birds

Bryan Watts, Center for Conservation Biology

Conservation efforts will need to be integrated with social and economic initiatives to maximize the reduction of greenhouse gasses and to help ensure healthy habitats for birds and for people.

Maintaining healthy bird populations in the United States in the face of accelerated climate change is an unprecedented challenge. It will require managing natural resources in a way that responds rapidly and effectively to observed and anticipated changes in the condition and distribution of habitat, food supplies, competitors, and predators. Monitoring changes in bird populations and the resources upon which they depend is essential to provide the lead time necessary to put conservation actions in place. But, simply helping species adapt to a changing environment is unlikely to produce the intended results without concurrent adoption of mitigation strategies that slow climate change through reduction of greenhouse gases and sequestering of atmospheric carbon.

Innovative Strategies

The scientific sophistication and effectiveness of bird conservation in the past two decades has greatly increased. The innovation that has helped carry bird populations into the 21st century must now be once again upgraded to ensure that these species survive the 21st century. Innovative solutions are needed on three fronts: large-scale planning and implementation; new technological and scientific advancements for protection, enhancement, and restoration of habitats; and identifying and abating the negative consequences associated with development of alternative sources of energy.

Conservation Without Borders

The ranges of many bird species may shift and change in adaptation to climate change. Those changes will come about regardless of political boundaries. So, too, must our conservation strategies be designed with seamless boundaries. The new Department of Interior Landscape Conservation Cooperatives and the Regional Climate Change Impact Response Centers, for example, will serve as a base for innovative thinking and determining broad geographic priorities for wildlife in response to climate change.

These climate change "think tanks" will advance biological planning and design of large-scale conservation efforts and link with the proven delivery models laid down by the Migratory Bird Joint Ventures and the actions outlined in the State Wildlife Action Plans, which provide a comprehensive assessment of wildlife conservation needs in each state.

New and improving data management and habitat mapping capabilities, along with the ability to compile and disseminate large quantities of information, information management capacities, and expanding conservation networking and partnerships is needed to ensure that conservation is emphasized in those places and at those spatial scales most relevant to the

health of shifting bird populations. These tools are necessary to help make better decisions that lessen the impacts of climate change within biomes, and thus, the birds that depend on them. Strategies must change from a tradition that considers historic landscape conditions as the framework for protecting intact landscapes and restoring damaged ones, to one which must address dynamic future environmental conditions. These strategies must also work within social and economic constraints and consider on-the-ground actions that can be used to increase the chances that bird populations persist in landscapes shaped by climate change.

New Technologies and Innovative Science

Migrating forests. Rising seas. Dry, sun-baked playa lakes. Outbreaks of avian disease. All of these may seem like scenes from a science fiction movie, but all are potential consequences of changes in climate. Helping birds and other wildlife adapt to these rapid environmental changes will demand the attention of the world's best scientific minds. Initiatives have begun that are planting the seeds for innovative thinking and partnerships, setting priorities for wildlife response to climate change, and developing new technologies for assessing and compiling existing and newly acquired information. Landscape Conservation Cooperatives and the Regional Climate Change Impact Response Centers, in partnership with universities, technology-based institutions and businesses, and individual entrepreneurs, need to be charged with finding solutions to the perplexing challenge of keeping species from going extinct.

• Identify new, practical ways to manage dynamic ecosystems. For example, to manage habitats that are resilient to the effects of climate change, we must manage for intact natural ecological processes including disturbance associated with fire and flooding.

• Transfer knowledge to those charged with the day-to-day preservation of species. For example, new and improved data management and habitat mapping capabilities along with the ability to compile and disseminate large quantities of information, will provide land stewards with the tools to make decisions to lessen the impacts of climate change.

Minimizing the Impact of Renewable Energy Sources

Generating energy from renewable sources holds promise in reducing greenhouse gas emissions, while still meeting the world's energy demands. However, development of alternative sources of energy can represent new challenges to bird conservation:

• Habitat loss, degradation, and fragmentation from the development of new wind farms and associated transportation corridors and power lines can cause direct mortality and indirect impacts to birds. Development of new technologies for renewable energy must account for potential new stressors that will negatively impact bird populations.

• Production of biofuels, the use of plants or other biomass to make fuels, can reduce greenhouse gasses by reducing use of oil and its byproducts. Yet, widespread conversion of native grasslands and other habitats to row crops or monocultures of fast-growing grasses to make ethanol poses a risk to birds because of habitat loss, degradation, and loss of plant diversity that benefits wildlife.

Reducing and Sequestering Greenhouse Gases

As a parallel strategy to adaptive ecosystem management, society is working on measures to slow climate change by reducing production of greenhouse gases and sequestering atmospheric carbon.

• Many mitigation strategies address improved energy efficiency or the reduction of emissions; these strategies are most effective in concert the removal of existing carbon from the atmosphere or conserving already stored carbon.

• Forests, grasslands, wetlands, and other ecosystems can be managed for birds and other wildlife, as well as for storing carbon and removing carbon dioxide from the atmosphere. Conservation strategies to reduce atmospheric carbon include avoiding deforestation (especially in tropical zones and temperate mature and old-growth forests), promoting afforestation and reforestation, and managing vegetation for accumulation of biomass on site.

• Active restoration of native vegetation and wildlife habitats can serve to sequester carbon. Cooperative partnerships between industries and land management agencies can restore important habitats. In the Lower Mississippi Valley, for example, more than two dozen industries, conservation organizations, and National Wildlife Refuges have restored over 120,000 acres of habitat. These efforts have resulted in the planting of more than 22 million trees that will capture over 33 trillion tons of carbon during the next 90 years. Ducks Unlimited and its partners developed a carbon credit program for private landowners, who in turn manage grasslands for waterfowl and many other species.

• There are great opportunities for ecosystem restoration and carbon sequestration through new farming practices that promote habitat diversity and integrate ecosystem processes, including living soils. Incentives within the Farm Bill could be used to promote broad scale mitigation that will result in healthier ecosystems, healthier farms and farm products, and healthier bird populations.

Conservation efforts will need to be integrated with social and economic initiatives to maximize the reduction of greenhouse gasses and to help ensure healthy habitats for birds and for people. Each of the above strategies and conservation considerations are incorporated in the sections on key steps for each habitat in this report.

Pelican Island USFWS

Joint Ventures

A Joint Venture is a self-directed partnership of agencies, organizations, corporations, tribes, or individuals that has formally accepted the responsibility of implementing national or international bird conservation plans within a specific geographic area or for a specific taxonomic group, and has received general acceptance in the bird conservation community for such responsibility. Working both collectively and independently, Joint Venture partners conduct activities in support of bird conservation goals cooperatively developed by the partnership such as biological planning, conservation design and prioritization, project development and implementation, and monitoring, evaluation, and applied research activities.

Nationwide, there are 18 habitat-based Joint Ventures, each addressing the bird habitat conservation issues found within their geographic area. Additionally, three species-based Joint Ventures, all with an international scope, work to further the scientific understanding needed to effectively manage specific bird species or groups of species.

State Wildlife Action Plans

Developed by every state and territory, State Wildlife Action Plans are congressionally required plans that outline the conservation actions needed to conserve declining wildlife and their habitats before they become rarer and more costly to protect. State Wildlife Action Plans are historic in that they represent the first nationally comprehensive conservation strategy for wildlife and identify what is needed to prevent more wildlife from becoming endangered. Completed in 2005, the plans were collaboratively developed by state fish and wildlife agencies and their partners and identified more than 10,000 species in greatest conservation need, their priority habitats, threats and stresses, needed conservation actions and monitoring and research priorities. The plans are updated every 10 years, although many states are opting to update sooner to better address climate change and new emerging threats. The State and Tribal Wildlife Grants program is the principal source of funding to implement the plans. More information is available at http://www.wildlifeactionplans.org/

CLIMATE CHANGE AND OTHER STRESSORS

Ecosystems are currently under pressure from a number of stressors in addition to climate change, including habitat loss and degradation, development, pollution, toxic chemicals, overfishing, invasive species, pests, disease outbreaks, habitat fragmentation, and wildfires.

Climate change may interact with and amplify many of these existing stressors. As a result, birds and habitats that are already stressed may be highly vulnerable to additional impacts due to climate change.

Climate change will add to other existing stressors by:

• Altering habitats, allowing for the increase of invasive species. As invasive species expand, they can outcompete native species, leading to the reduction or loss of native plants and wildlife.

• Spreading disease. Distribution of disease patterns and changes in wildlife occurrence will affect the transmission of diseases. It is also expected that infectious diseases will emerge more frequently and in new areas due to climate change.

• Exacerbating the impacts of storm-surge flooding and shoreline erosion. Increasingly developed coastal communities and rising sea level will limit potential habitat for coastal birds.

• Changing the distribution and availability of surface and ground water. Climate change will constrain water resources, further increasing competition among agricultural, municipal, industrial, and wildlife uses.

White-tailed Tropicbird chick by Elena Babij

Photo by Erin Macchia

Spotlight on Waterfowl

• The Prairie Pothole Region is the most productive habitat for breeding ducks in the world. It produces 50–80% of the continent's ducks, even though it represents only 10% of the continent's total wetland area.

• Climate change models predict wetland numbers could decline dramatically, which would result in large declines in the fall flight of ducks. Researchers predict the number of ponds in the Prairie Pothole region could decline by two-thirds.

• The western boreal forest is the second most important waterfowl breeding area on the continent and supports 12–15 million breeding ducks. In some years, this amounts to about 40% of the continental duck population.

• Waterfowl conservation efforts in some currently protected areas may be undermined by climate change impacts

Observations and Predictions

A wetland simulation model applied to 95-year weather records suggested that the most productive habitat for breeding waterfowl would shift under a drier climate from the center of the Dakotas and southeastern Saskatchewan to the wetter eastern and northern fringes of the Prairie Pothole Region where areas are currently less productive or wetlands have been drained.

With a doubling of atmospheric carbon dioxide in the next century, average temperatures in the western boreal forest region may increase by as much as 8°F. This is expected to result in drier average conditions, greater annual climatic variation, melting permafrost, altered surface hydrology, and higher rates of wildfires.

Potential Impacts

Waterfowl are highly mobile, responsive to environmental variation, and have a relatively high reproductive potential. However, if model predictions are correct, the loss of shallow wetlands – their primary breeding habitat – may contribute to population declines. If pond numbers decline by two-thirds, duck numbers in north-central United States are expected to be reduced. Losing even a fraction of these habitats would impact continental duck populations.

Key Steps

Wetland managers will need to make decisions for allocating restoration dollars in an uncertain climatic future. For waterfowl, the potential impacts and uncertainties associated with climate change need to be taken into consideration in conservation efforts to help ensure conservation successes. This will involve cooperation and support of Joint Ventures, Flyways Councils, Land Conservation Cooperatives, conservation organizations, and others in the recognition of climate change in management plans and waterfowl conservation strategies. Existing funding sources must be enhanced significantly for these purposes.

Canvasback USFWS

Potential impacts and uncertainties associated with climate change may undermine current waterfowl conservation efforts.

Spotlight on Resident Game Birds

Greater Sage-Grouse USFWS

• The majority of resident game birds are unable to fly long distances and usually move by running or walking. Some species may not be able to shift their distributions in response to changing habitats.

• In a changing climate, White-tailed Ptarmigan in alpine areas may be unable to find appropriate habitats and may have nowhere else to go.

• A number of resident game birds perform elaborate courtship displays on lekking grounds and are disrupted when vegetation changes occur. Western grouse and prairie-chicken populations are already fragmented and isolated because of habitat loss, causing concern about the effects of inbreeding. Increased drought in aridlands and grasslands could further stress these species.

Observations and Predictions

Resident game birds in arctic and alpine habitats are likely to experience the greatest impacts due to their inability to shift their range. Ptarmigan depend upon arctic and alpine habitats that are already experiencing temperature increases. Continued change could result in vegetation shifts, leaving little or no habitat available in some locations. Loss of ptarmigan could cause a ripple effect among other wildlife by changing predator-prey relationships.

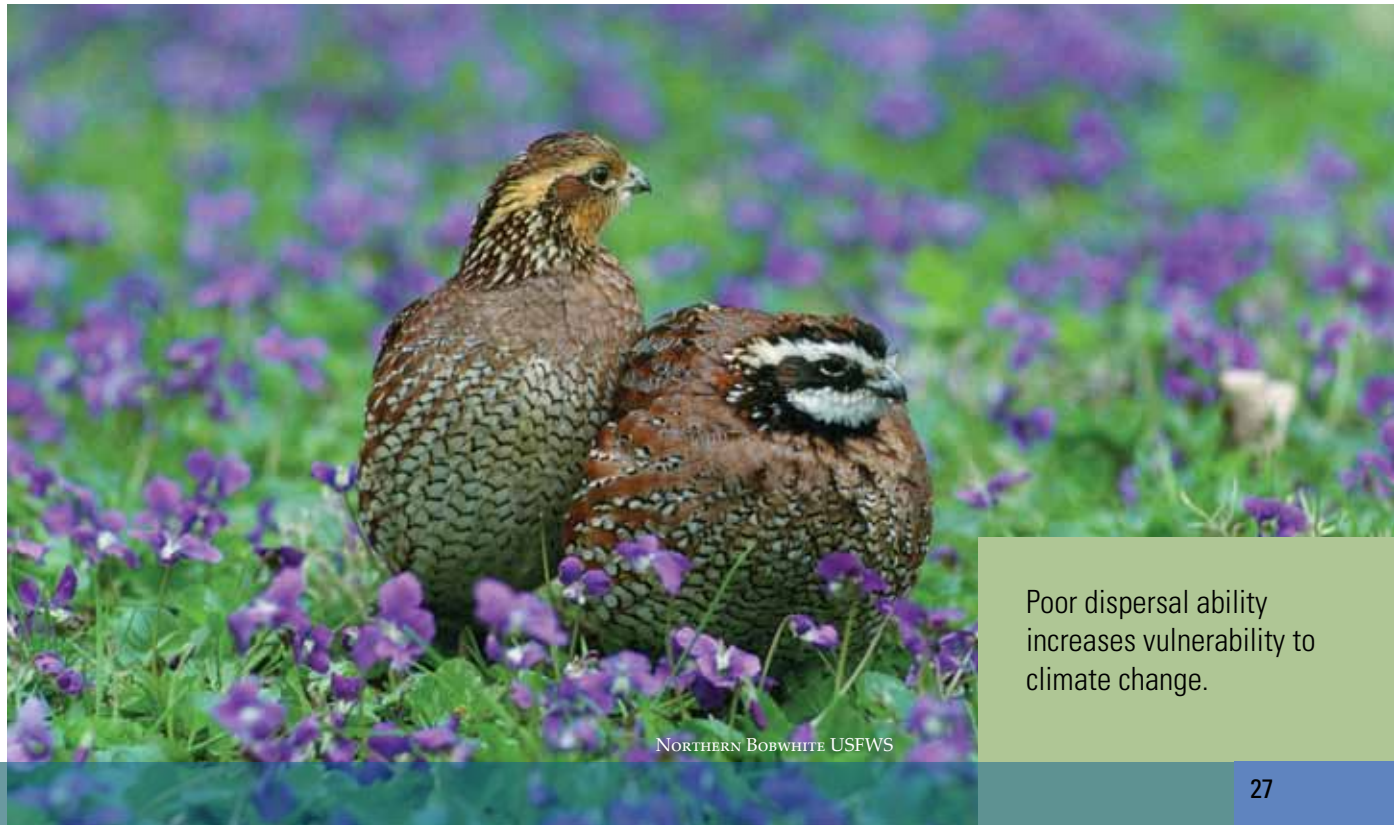
The inability to disperse is likely to negatively impact grouse in aridlands and grasslands. Changing fire management regimes and increasing invasion of nonnative vegetation (e.g. cheatgrass) in aridlands will negatively impact Gunnison and Greater sage-grouse. Because of their larger overall population sizes, forest grouse and western quail will experience range shifts, but may not experience large declines.

Key Steps

State agencies will need to adapt management strategies and increase coordination among states as bird populations shift. Monitoring programs that span entire ranges of game birds will be needed. Alternative energy projects will need to carefully consider the needs of grassland grouse and chickens.

Conservation in Action

Because resident game birds have large clutch sizes and many breed twice a year, populations may quickly rebuild if conditions are suitable. Existing management programs could be shifted as vegetative communities and land uses shift. For example, Farm Bill programs could expand acreage allocations of retirement programs and shift to new areas as agricultural production expands to new regions. Several resident game bird species currently benefit from single species regional initiatives where partnerships have been formed and are implementing conservation measures to reverse declines.



Northern Bobwhite USFWS

Poor dispersal ability increases vulnerability to climate change.

Our Approach

We evaluated all bird species on the basis of five independent characteristics of sensitivity to climate change, one measure of exposure, and three assessments of conservation status based on factors other than climate change.

We assessed sensitivity of birds to climate change based on five basic traits that demonstrate adaptability from temporal, spatial, ecological, and evolutionary perspectives. Each trait was scored as zero (low sensitivity) or one (high sensitivity). In addition, we scored the exposure of each species' habitat to climate change impacts on a scale of zero (low climate exposure), one (medium), or two (high). Scoring was based on the expert opinion of the science committee and outside experts.

Our approach provides a general picture of potential impacts to our nation's birds. Although we have a fairly good understanding of the inherent traits that make various species sensitive to climate change, the mechanisms are extremely complex and yet to be fully revealed. Despite uncertainty about how birds and their habitats will change, we provide this first assessment as a basis for future analyses and as a starting point for guiding bird conservation in response to a changing world.

Five Basic Sensitivity Traits

Migration Status: A species was considered to have high sensitivity if it is a long-distance migrant that traverses many habitats during migration, using day length as a primary cue for timing its migrations. These species may experience a mismatch between food availability and the timing of arrival at critical stopover areas or on their breeding grounds.

Breeding Habitat Obligate: A species was considered to have high sensitivity if it was categorized in the 2009 State of the Birds report as an obligate of a single habitat type. This factor indicates species that are less likely to be able to adapt to a different habitat type. Seabird species received a high vulnerability score if they forage only in coastal or pelagic waters.

Dispersal Ability: We defined species with poor dispersal ability as those that lack the ability to shift when restricted by geographic barriers, narrow elevation requirements, or high site fidelity, whose specialized behaviors may make them unable to move in response to changing conditions, habitats, or resources. High sensitivity species include most island species, continental species such as lekking grouse, and species with island-like distributions, such as alpine, saltmarsh, and highly colonial breeders.

Niche Specificity: Species were scored as having high sensitivity if they are highly specialized on limited resources such as food, nest sites, or microhabitats that are likely to be disrupted or depleted due to climate change.

Reproductive Potential: We evaluated species whose life-history traits, including combinations of low annual reproductive effort and long generation time, may limit their ability to adapt to climate change events. A high sensitivity score was given to species that only raise one or fewer young per year.

Habitat Exposure: Species that are restricted to "sub-habitats"at highest risk of disappearance or severe degradation due to climate change were evaluated under this measure. Species restricted to habitats most susceptible to climate change were considered to have high exposure; those species restricted to habitats of medium susceptibility (especially due to increased drought conditions) were considered to have medium exposure; and species using the least susceptible habitats were considered to have low exposure.

Overall Vulnerability: The summed scores for the five sensitivity traits and the measure of habitat exposure give a composite score of vulnerability to climate change. We categorized species as showing High Vulnerability (Vulnerability score of four or more), Medium Vulnerability (vulnerability score of two or three), or Low Vulnerability (vulnerability score of zero or one).

Species of Conservation Concern

All of the birds of the United States have been assessed for conservation need, but climate change threats were rarely considered. These assessments were based on species protected by the Endangered Species Act, the USFWS list of Birds of Conservation Concern, and the American Bird Conservancy/Audubon Watchlist. If a species is on any of these lists, we included them as Species of Conservation Concern. We then compared the vulnerability scores of birds to the current assessment of their conservation status.

This report calls attention to how climate change may heighten threats for birds that are already of conservation concern. Additionally, many species that were not previously considered of conservation concern may now be of concern because of the threat of climate change to their populations.

Common Eider by Lilia D'Alba

Arctic Tern by Emily Pipher

Northward Shift in Wintering Ranges of Birds

Warmer winters in recent decades have played an important role in shifting winter bird ranges to the north.

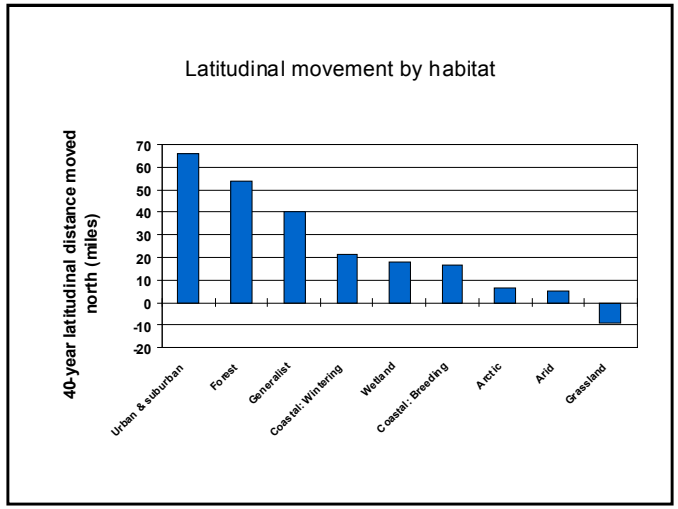
One of the most noticeable climate trends in recent decades is the increase in winter temperatures in the continental United States beginning in the 1970s. Since then, January has warmed the most (4.6˚F), and February the second most (3.6˚F). Government records indicate the two coldest Januarys occurred in the late 1970s and the warmest in 2006. Northern states warmed more than southern states, and inland states warmed more than coastal states.

Although many factors are known to drive range changes, results from the Christmas Bird Count (CBC) show that the warmer winters in recent decades have played an important role in shifting winter bird ranges to the north. CBC data from the mid-1960s through 2006 show that 170 (56%) of the 305 most widespread, regularly occurring species have shifted their ranges to the north, whereas only 71 species (23%) have shifted to the south and 64 species (21%) have not shifted significantly north or south.

Species also shifted east or west, but an equal number of species moved east as moved west. Overall, the average shift over 40 years was 35 miles north. Many of the species that increased in northern states or provinces also decreased in southern states. Among states and provinces, rates of bird population change are correlated with rates of temperature change, independent of latitude.

During the 40 years of the study, birds were found farther north in winters that were relatively warm and father south in colder winters. Predictions of future temperature changes suggest that birds will continue to shift north and that more sedentary species may be vulnerable if they are unable to shift as temperatures increase.

Birds in most habitats showed the northern range shift (see graph). Urban and suburban birds shifted the most, and forest birds shifted the second most. Arctic and aridland birds did not show biologically important shifts, and grassland birds were the only group that shifted to the south more than to the north. Generalists (species with fewer specific habitat preferences) shifted their ranges north more than those with more specific habitat preferences except for forest birds. Each of the 305 species in the study showed a different amount of range shift. Some birds and many other species of wildlife are not able to shift rapidly in response to changing temperatures. If climate continues to change, future wildlife communities will look very different from those of today.



St. Paul Island USFWS

Addressing Uncertainty and Understanding How Birds Respond to Change

We live in a rapidly changing global environment. Because of differing emission scenarios, climate predictions, and ecosystem models, we may not be able to accurately predict the future, other than knowing we face an uncertain but certainly altered future climate. Successful conservation will require that solutions address the likelihood of our altered environment strategically and not be paralyzed by it.

Uncertainty can be reduced by developing and implementing effective programs to monitor how birds respond to climate change. Climate change in combination with numerous threats is creating environments not previously experienced by birds. Monitoring data are invaluable in making informed decisions in a changing world. We have limited information about many of the species that are most vulnerable to climate change -- birds that live in the oceans, in the arctic and alpine habitats, and along the coasts. Focusing monitoring on species that show the highest potential vulnerability will provide the most relevant indicator of how birds are adapting to environmental change.

Without additional information on how birds are responding to the effects of climate change, we will be unable to adjust our conservation and management strategies. Well-designed monitoring systems will also be needed to evaluate the effectiveness of the strategies used to counteract effects of climate change on bird populations.

Bird monitoring is usually a passive indicator of change, without providing knowledge regarding causes or possible responses to change. It is important, of course, to know when bird populations are declining and require conservation attention, but the designs of most existing monitoring programs have limited utility in interpreting system change and the response of birds, and must therefore be improved. We recommend that the nation's current monitoring programs be modified to:

- Improve the design of many monitoring programs to allow analysis separating the influence of climate change on population changes from impacts caused by other environmental factors, as well as synergistic interactions between climate and other factors affecting birds.
- Focus on the status of species most sensitive to climate change.
- Design and use monitoring systems and information to inform conservation and land management decisions.




Visit our website
www.stateofthebirds.org

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Contributors:

Project Leads: Brad Bortner, Paul Schmidt

Science Team: Brad Andres, Eleanora Babij, Laurel Barnhill, Bob Blohm, Greg Butcher, Jorge Coppen, Bob Ford, Charles Francis, Debbie Hahn, David Mehlman, David Pashley, Daniel Petit, Kenneth V. Rosenberg, John R. Sauer, Frank Thompson, George Wallace, Jennifer Wheeler

Communications Team: Miyoko Chu, Ashley Dayer, Steve Holmer, Alicia Frances King, Blythe Thomas, Nancy Severance

Editor: Alicia Frances King, with Steve Holmer

Designer: Susan Steiner Spear

Graphic Layout: Alicia Frances King

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Brant by Kristine Sowl

Global climate change is altering the natural
world in ways we are only beginning to understand.

One message emerges loud and clear:
only committed collective action can protect nature's resources.

It is up to us to safeguard birds, their habitat, and the environment
we all share and depend on, for our own lives and those of future generations.

Front cover photos from top, left to right: Laysan Albatross by Eric Vanderwerf; Hemlock Forest by Steve Holmer , Northern Pintail USFWS; Sonoran Desert USFWS, Midway Beach by Brad Bortner, Northern Bobwhite USFWS.

Back cover photos from top, left to right: Laysan Albatross USFWS; 'Akiapola'au by Jack Jeffrey; Bald Eagle Chicks USFWS: Allen's Hummingbird USFWS, American Woodcock USFWS, Laysan Duck by James H Breeden






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North American Waterfowl Management Plan
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