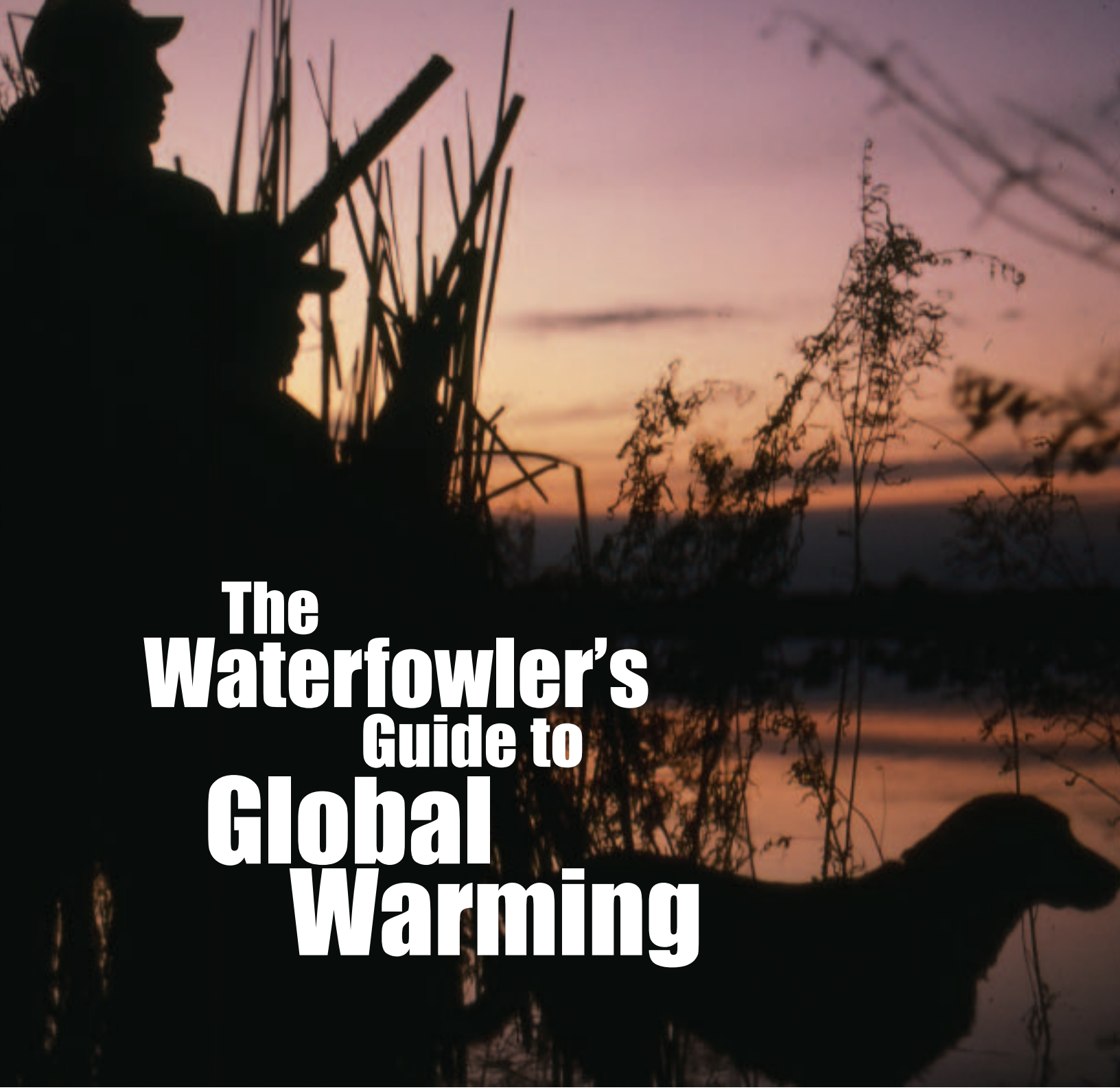
The Waterfowler's Guide to Global Warming



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The National Wildlife Federation is America's conservation organization protecting wildlife for our children's future.

The Waterfowler's Guide to Global Warming

June 2005

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Front and back cover photographs: By GLENN CHAMBERS

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GLENN CHAMBERS

CORBIS

Foreword

I have been afflicted with waterfowl fever since I was a young lad on a farm in the Prairie Pothole Region of North Dakota. Each spring day, I'd ride my bike from school to home, where I'd get down on my belly and crawl to the edge of a seasonal wetland a short downhill trek from our farmhouse. There, I'd hide in the grasses along the shoreline and view up close a fascinating array of ducks.

Much later in life, I witnessed the drainage of many similar areas, and the plowing of native prairie as farmers labored to make this part of the world safe for wheat, corn and soybeans. Even the large rocks strewn by advancing glaciers during the ice age were no longer obstacles to agriculture. The rocks, some the size of Volkswagens and refrigerators, were gathered and placed in huge piles which remain today, offering a stark reminder of a relentless push to farm the prairie. I have always wondered why a man would complain about plowing around a wetland, but be willing to farm around such an immovable obstacle. In spite of all of this, ducks have managed to survive, although sometimes at low population levels.

U.S. FISH AND WILDLIFE SERVICE

Now there's another threat to waterfowl, one that could greatly impact those wetlands that remain in this important waterfowl breeding area that currently produces more ducks than the Canadian prairies. The threat is global warming and while some reject the science that tells us it is happening, remember those in history who believed the world was flat.

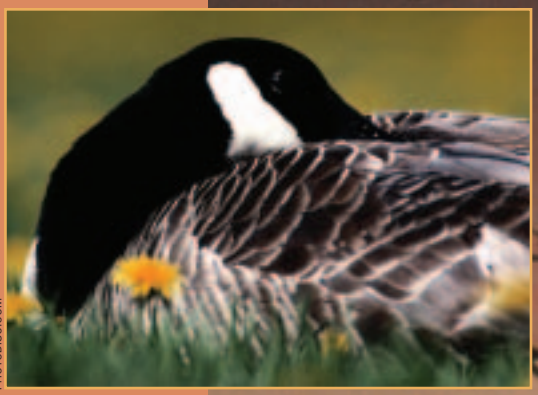
Global warming is real; a belief supported by reams of evidence produced by teams of the world's best scientists. And within that scientific community, there is near-unanimous agreement that it is happening, and that it carries serious consequences.

If you are a duck hunter, here is what you must know. Global warming has the potential to eliminate up to 91 percent of the wetlands in the Prairie Pothole Region. Carried to the worst potential scenario, it could surpass even agricultural drainage, and essentially end waterfowl hunting.

There is more to learn, and much information on the pages that follow. This report also examines some potential solutions. But the bottom line is this. If you wish for your children to carry on our rich waterfowl-hunting heritage, you must read this report, and be prepared to take action.

Tony Dean
Tony Dean Outdoors, Inc.
Pierre, SD

The potential consequences of global warming to waterfowl are significant because of the strong relationship between waterfowl and water conditions.



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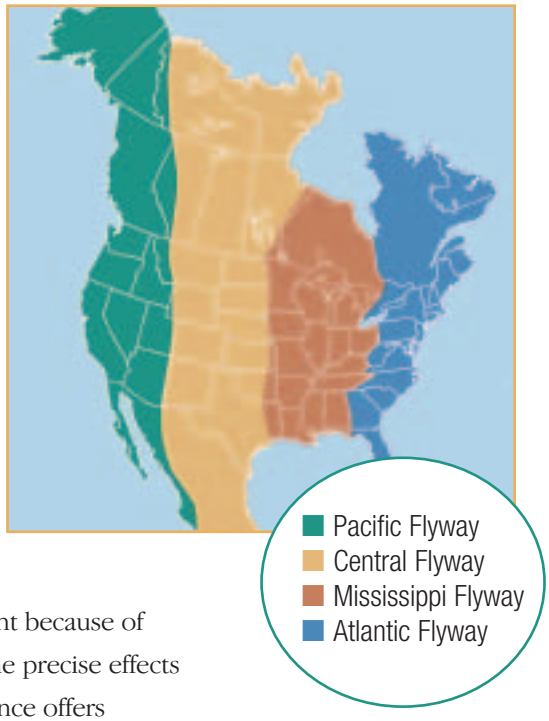
Executive Summary

Ducks, geese, and swans are important to waterfowl hunters, birders, and others. Annually in the United States, sportsmen and sportswomen spend some 12 million days hunting waterfowl. Waterfowl viewing is also popular among the more than 46 million birders in the United States. Moreover, waterfowl are integral components of natural ecosystems. For nearly a century, waterfowl conservation has been a priority for North America's citizens, leading to the development of numerous policies and programs to restore and protect waterfowl species and their habitats. But the job is far from complete.

In addition to the ongoing threat of habitat destruction due to development, agricultural conversion, and other activities, human-enhanced global warming has emerged as a significant challenge to conserving waterfowl populations for current and future generations. Fortunately, it is a challenge that can be met by seizing opportunities to better protect waterfowl habitat and curb global warming pollution.



The extensive burning of coal, oil, and natural gas has released large quantities of carbon dioxide and other gases into the atmosphere. In the last 200 years, use of these fuels has grown enormously. As a result, the carbon dioxide concentration in the earth's atmosphere has risen by more than 30 percent and is higher than at any time during the past 420,000 years. The released gases act like a blanket, trapping heat that would otherwise escape through the atmosphere and causing the earth's average surface temperature to rise. This global warming is disrupting the planet's climate system, affecting regional temperatures, precipitation, storm severity, and other climatic factors.

The potential consequences of global warming to waterfowl are significant because of the strong relationship between waterfowl and water conditions. Although the precise effects of global warming on waterfowl are difficult to project, the best available science offers significant insight into what is likely to happen if global warming continues unabated. While some localized effects may be positive, the overall impact on waterfowl populations is likely to be negative.

Global Warming's Threat to North America's Duck Factory

One of the most important waterfowl breeding areas in North America is the Prairie Pothole Region on both sides of the U.S./Canadian border in the northern Great Plains. The region's productivity as waterfowl habitat has rightly earned it the designation as North America's "duck factory." The Prairie Pothole Region contains millions of shallow depressions that fill with water in spring, providing breeding habitat for millions of ducks and other migratory birds and many species of resident wildlife. As the climate warms and evaporation and

transpiration by plants increase, many of these ponds are likely to dry up or be wet for shorter periods, making them less suitable habitat for breeding pairs and duck broods.

Models of future drought conditions in the region due to global warming project significant declines in Prairie Pothole wetlands, from no change to a loss of 91 percent. This could lead to a 9 percent to 69 percent reduction in the abundance of ducks breeding in the region, affecting populations of mallards, gadwall, blue-winged teal, northern pintails, canvasbacks, redheads, and ruddy ducks throughout North America's flyways.

Threats to Northern Forest and Tundra Duck Habitat

Thawing permafrost and changes in the vegetation of northern forests and tundra regions of Alaska and Canada also could affect important breeding habitat for a number of North America's waterfowl species. In some areas and for some species, the changes could be beneficial to reproductive success. For example, thawing permafrost could lead to a conversion of parts of the tundra to wetlands, expanding nesting opportunities for arctic geese. On the other hand, problems such as higher temperatures and drought could reduce the productivity of North American scaup.

Even where changes associated with global warming alone might not cause problems, the combined effects from human activities such as oil and gas development, forestry, mining, and global warming could make it difficult for some waterfowl to adapt to a rapidly changing environment.

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Changes in Waterfowl Migration

Global warming also is expected to affect the timing and distance traveled during waterfowl migration. Warmer fall and winter temperatures in northern regions would make it unnecessary for waterfowl to fly as far south to find ice-free water and suitable food. For example, the unusually warm, late-arriving winter of 2001 increased hunting opportunities for waterfowl hunters in the Midwest and New England and reduced hunting opportunities in the Mid-Atlantic and South.

Recent research by the USDA Forest Service projects that changes in seasonal temperatures and precipitation due to global warming will contribute to a significant northward shift in the breeding range of mallards and blue-winged teal in the eastern half of North America before the end of this century.

Coastal Wetlands Habitat Loss

As the climate warms, a possible 3 to 34-inch rise in average sea level by 2100 could eliminate up to 45 percent of coastal wetlands in the contiguous United States. Especially vulnerable are the shallow wetlands of the Gulf and Atlantic coasts. These regions provide important wintering habitat for diving ducks such as canvasbacks, redheads, ruddy ducks, scaup, northern pintails, and lesser snow geese.

In addition to the inundation of low-lying areas due to sea-level rise, changes in inland precipitation patterns and a significant decline in average mountain snowpack are expected to affect the quality and quantity of water in many coastal marshes and estuaries along the Pacific Coast, which provide critical habitat for resident and migrating waterfowl in the Pacific Flyway.

River and Lake Waterfowl Habitat at Risk

Increased drought in the Great Plains and decreased snowpack in the Rocky Mountains could reduce water flow in the Platte River and associated streams, which many species of waterfowl, as well as sandhill cranes and endangered whooping cranes, use as they migrate north in the spring. Possible reductions in mountain snowpack could further limit water availability to rivers and lakes throughout the western United States, affecting key stopover and wintering habitat.

Global warming is also expected to affect shoreline wetlands of the Great Lakes and along the St. Lawrence River in the United States and Canada, which provide critical habitat for breeding and migrating waterfowl, especially diving and sea ducks. Research suggests that the combined effects of changes in breeding and migratory habitat could lead to a 19 percent to 39 percent decline in duck numbers throughout the Great Lakes region by the 2030s.

GLENN CHAMBERS

Changing the Forecast for Waterfowl: A Plan of Action

Fortunately, Americans can take action now to change the forecast for waterfowl and other wildlife. Addressing global warming's challenge to waterfowl should include upholding Clean Water Act and Farm Bill wetlands protections and expanding other programs that encourage protection and restoration of wetlands. In addition to reducing the impact of other non-climatic stressors on wetland ecosystems, wildlife managers should plan for the potential effects of global warming when developing wetland and waterfowl conservation strategies, including reforming floodplain and coastal-management practices to conserve these resources for the long term.

Finally, the most effective way to minimize the threat is to reduce emissions of carbon dioxide and other heat-trapping gases by enacting policies that set specific limits on the nation's global warming pollution; protecting and enhancing the ability of forests, grasslands, wetlands, and other natural systems to absorb and store carbon; strengthening programs to promote energy efficiency; and accelerate deployment of clean renewable energy sources. But policy makers must begin to take meaningful action today, because even 100 years after carbon dioxide is released, much of it remains in the atmosphere, trapping more and more heat. Delaying action will allow more carbon dioxide and other greenhouse gases to accumulate in the atmosphere, making worse case projections more likely to occur.

The solutions are at hand, and with the right investments, people can change the forecast for waterfowl and ensure that the economic opportunities, ecological benefits, and outdoor traditions they support will endure for generations to come.

PHOTOGRAPHS: GLENN CHAMBERS

November 5, 1805, Columbia County, Oregon (Heading to the Pacific):

"I slept but very little last night for the noise kept up during the whole of the night by swans, geese, white and gray brant, ducks, etc., on a small sand island close under the port side; they were immensely numerous…"

—William Clark, The Journals of Lewis and Clark[1]

Introduction

When the first European settlers arrived in North America and Meriwether Lewis and William Clark made their storied journey into the West, the landscape included wetlands and ponds teeming with ducks of all kinds, and scores of cranes and geese flying in formation in the skies above. Perhaps more than any other wildlife, waterfowl have epitomized America's great ecological richness; and for generations they have been a focus for writers, artists, birders, and hunters.

U.S. FISH AND WILDLIFE SERVICE

In every state of the nation, birding and waterfowl hunting are among the most revered outdoor pastimes. According to U.S. Fish & Wildlife Service, 3 million people hunted waterfowl and other birds in 2001.[2] That year, bird hunters alone spent $1.3 billion on equipment, travel costs, and other hunting-related goods and services, supporting tens of thousands of jobs. Also in 2001, more than 46 million people spent leisure time watching waterfowl and other migratory birds.

Beyond the recreational opportunities they provide, waterfowl play an important role in diverse ecosystems, from prairie grasslands to coastal marshes and estuaries. They help disburse seeds and contribute important nutrients into the food web. They are also prey for a number of other wildlife species, including bald eagles and peregrine falcons. Moreover, the sensitivity of waterfowl to environmental change makes them important indicators of the overall health of natural systems—particularly wetlands.

Historic declines in North American waterfowl populations can be tied directly to loss of wetland habitat. Since the mid-1700s, more than half of the wetlands in the contiguous United States have been converted to other uses.[3] Much of this wetland loss is caused by drainage for agriculture, although urban and suburban development, road building, and other factors have been increasingly a cause. By the mid-1980s, six states (California, Illinois, Indiana, Iowa, Missouri, and Ohio) and the District of Columbia had lost more than 85 percent of their original wetland acreage, and 22 states had lost 50 percent or more.[4] Today, birds that rely on wetlands and aquatic habitats represent 50 percent of the migratory bird species that are listed as threatened or endangered under the U.S. Endangered Species Act.[5]

Top 10 States for Trip and Equipment Expenditures on Migratory Bird Hunting in 2001

Texas	$219.1 million
Tennessee	$121.9 million
Arkansas	$118.3 million
California	$116.8 million
Minnesota	$99 million
Louisiana	$86.7 million
Illinois	$68.3 million
Wisconsin	$59 million
Washington	$46 million
Oregon	$41.5 million

SOURCE: U.S. Fish & Wildlife Service, 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Washington, DC: U.S. Department of the Interior, 2002)

Even by the early 1900s, concerns over the loss of wetland habitats and excess hunting led to considerable efforts to conserve waterfowl populations. Among the millions of Americans who care about protecting the nation's wildlife and wild places, sportsmen and -women have been true champions for conservation. Their leadership and financial support through the purchase of state and federal duck stamps, contributions to organizations such as

Ducks Unlimited, and other means have contributed to the creation of more than 540 national wildlife refuges and 3,000 small areas for waterfowl breeding and nesting across the United States.

In addition, the sporting community has helped spur some of the nation's most important habitat-protection policies and programs.[6] The Clean Water Act, for example, has been an invaluable tool for restricting wetland destruction and protecting water quality. Federal programs such as Swampbuster, the Conservation Reserve Program, and the Wetlands Reserve Program have encouraged farmers to set aside wetlands and other important habitat. And the North American Wetlands Conservation Act has been helping to protect existing wetlands and restore lost or degraded wetlands across the continent.

Yet, despite these and other relevant conservation successes, North American waterfowl still face considerable challenges. The long-term decline in populations of species such as the northern pintail, lesser scaup, and white-winged scoter continues to serve as an alarm bell. The northern pintail, for example, has dropped to about 20 percent of its peak population in the mid-1900s.[7] Continued habitat loss from residential, commercial, oil and gas, and other development, pollution, and expansion of invasive species are among the key factors still threatening the continent's waterfowl—and it is now clear that human-induced global warming can be added to the list.

Ignoring climate change is likely to increasingly result in failure to reach wildlife management objectives.

According to a recent report from The Wildlife Society (the 9,000-member association of wildlife biologists and habitat managers), "[C]limate change now underway has extensive potential to affect wildlife throughout North America, either directly or indirectly, through responses to changing habitat conditions." The report adds, "Ignoring climate change is likely to increasingly result in failure to reach wildlife management objectives." [8]

U.S. FISH AND WILDLIFE SERVICE

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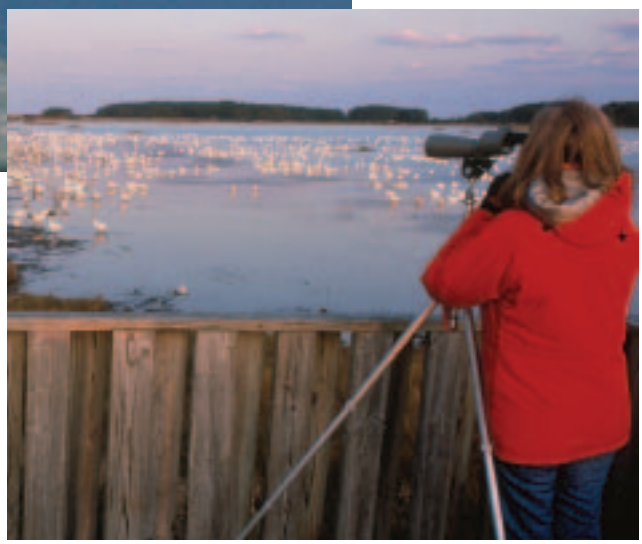


U.S. FISH AND WILDLIFE SERVICE

Left unchecked, global warming and associated climate change could affect North America's waterfowl and habitat in a number of ways. For example, more frequent and severe droughts in some areas could cause a significant decline in wetland habitat. A rapid rise in sea levels could lead to extensive coastal flooding, inundating marshes and causing a decline in food sources and resting areas. Changes in streamflows and timing of floods inland could alter important stopover and wintering habitat across the country. In addition, global warming could increasingly alter some birds' migratory patterns, migratory timing, and distribution.

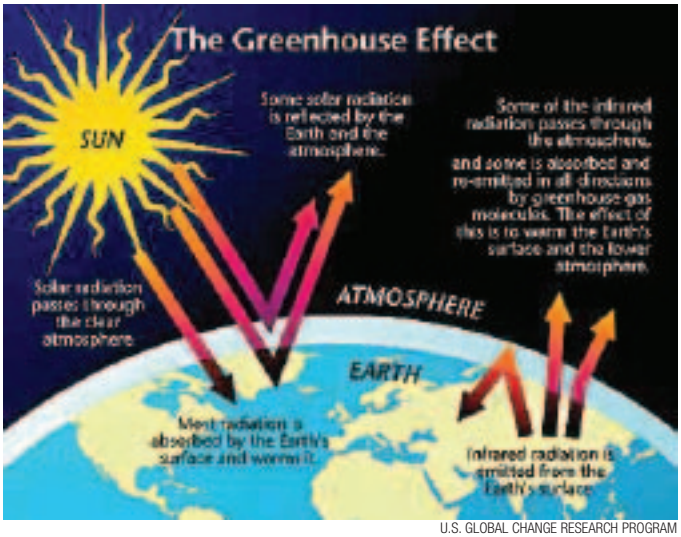
Wildlife and ecosystems provide the first warning signs that human activities may be disrupting the natural climate cycle. As conveyed by the Bush Administration to Congress in a 2004 update on global warming research, "Analyses based on a large number of studies of plants and animals across a wide range of natural systems worldwide have found that many species have shifted their own geographic ranges or changed temperature-sensitive behaviors—such as migration, flowering, or egg-laying, in ways consistent with reacting to global warming."[9] Scientists fear that, without a concerted strategy to address the problem, we could face even greater challenges in the coming decades. In particular, the combined effects of global warming and other human-induced problems (e.g., pollution, development, and natural resource extraction) pose the greatest threat to wildlife in the 21st century.[10]

NATURAL RESOURCES CONSERVATION SERVICE

U.S. FISH AND WILDLIFE SERVICE

The Threat of Global Warming

Global warming is real and is happening today. By burning fossil fuels such as coal, oil, and gas in power plants, factories, and cars, humans have been sending tremendous amounts of heat-trapping gases such as carbon dioxide, methane, and nitrous oxide into the air. Additionally, people have reduced the planet's ability to absorb excess carbon through photosynthesis by destroying vast areas of forests, wetlands, and other natural systems. As a result, carbon dioxide and other gases are rapidly building up in the atmosphere, overloading the natural blanket of gases that help maintain the earth's surface temperature.[11]



U.S. GLOBAL CHANGE RESEARCH PROGRAM

While there are a number of factors that affect the earth's climate, scientists know from looking back at long-term fluctuations in the planet's climate system that the level of carbon dioxide and other important trace gases in the atmosphere plays a significant role. When the atmospheric concentration of carbon dioxide has gone up, so has the average global temperature. When carbon dioxide has gone down, the temperature has gone down as well. Generally, though, the carbon dioxide level has remained in a somewhat stable equilibrium, fluctuating between 180 parts per million (ppm) and 280 ppm over periods of thousands of years.

What has scientists concerned today is the rapid rate at which carbon dioxide has increased over the past 200 years. The current concentration of carbon dioxide in our atmosphere of 379 ppm is higher than at any time during the past 420,000 years, and the increase can be directly linked to human activities.[12] Consequently, the average global temperature has risen more than 1 degree Fahrenheit during the past century—a rate of change that far exceeds anything the earth and the life it supports have experienced in at least the past 10,000 years.

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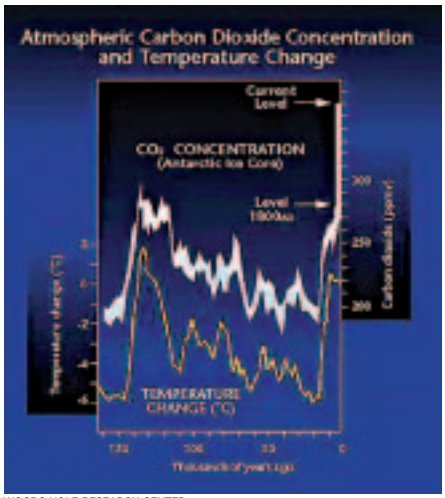

WOODS HOLE RESEARCH CENTER

Without significant action to reduce global warming pollution, scientists project that the temperature changes the planet will experience this century could be as much as ten times more severe, rising from 2.5 to 10.4 degrees F.[13] While this may not seem like much, the average global temperature difference between the peak of the last ice age more than 20,000 years ago and today's climate is only 9 degrees F. With global warming, we could see the global temperature change by a similar amount, but this time in just a matter of decades, not thousands of years. Already, the 20th century was the warmest in the last 1,000 years; and the World Meteorological Organization reports that the past 10 years (1995–2004), with the exception of 1996, are among the warmest years on record.[14]

Global warming means far more than hotter weather. As the atmosphere heats up, local climate systems are being altered in ways that directly affect forests, lakes, prairies, rivers, wetlands, and other habitats as well as the fish and wildlife that depend on them. Average water temperatures are becoming warmer, precipitation patterns are changing, and extreme weather emergencies such as droughts and floods are becoming more frequent and more severe. In addition, thermal expansion of the oceans combined with melting glaciers and polar ice caps are causing global sea levels to rise at an unprecedented pace.

There is growing concern that the accelerating pace of change may put alarming numbers of species on the path to extinction.[15] A study published in January 2004 in the prestigious scientific journal *Nature* concluded that as many as one-third of species in some regions are likely to be "committed to extinction" due to global warming within the next 50 years if we fail to act now to reduce the pollution that is causing it.[16] At a minimum, global warming threatens to vastly change the natural world if it is left unchecked.

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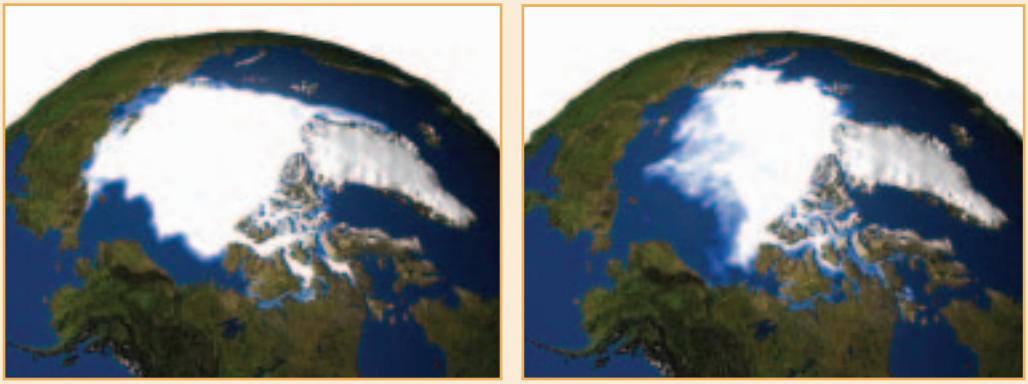


Rising Arctic winter temperatures have causes sea ice since the 1970s to lose an area the size of Texas and Arizona combined.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Weather vs. Climate

As the saying goes, "Everybody talks about the weather, but nobody does anything about it." From one day to the next, this is true. However, over the longer term, human activities are having an impact on the global climate—and it follows that weather patterns are changing as well. While no single hot spell or sequence of severe storms all by themselves signal global warming, the key is the long-term pattern of such weather events and, by extension, the likelihood of such patterns persisting or accelerating as the planet warms further.

The terms "weather" and "climate" are sometimes used interchangeably, but climate actually refers to average weather patterns or trends over a period of many years, rather than day-to-day or year-to-year variation.[17] The climate varies in different regions of the planet, based on factors such as the amount of sunlight, proximity to the oceans, and altitude. Within those climate regions, we have our weather patterns—our sunny days and rainy days, for example; and we adjust our behavior (and our wardrobes) accordingly. While weather extremes such as droughts, floods, heat waves, and blizzards can and do occur, we generally view them as aberrations.

DUANE HOVORKA

This is not to say that the climate itself has remained static throughout the earth's history. We know that the earth's climate has changed often, as evidenced by the modern ice ages. Scientists have determined that climate changes have often been associated with changing concentrations of atmospheric carbon dioxide. Generally, though, these changes have occurred over long periods of time—and people and wildlife have been able to adapt.

What concerns today's scientists is that we are forcing climate to change at a far faster pace than what nature has historically experienced. Rapid climate change associated with a large meteor impact is believed to have led to a massive extinction of wildlife, including dinosaurs. Scientists are concerned about the ability of wildlife to adapt to the rapid global warming underway. The challenge wildlife face in coping with climate change is compounded by the fact that humans have already destroyed much of their habitats and affected their health in so many other ways.

EYEWIRE

U.S. FISH AND WILDLIFE SERVICE

Global Warming and Waterfowl: Species and Habitats at Risk

Migratory waterfowl have thrived in North America for thousands of years. Over time, they have evolved and adapted to the continent's environment, including developing the ability to adjust to variability in their habitats. Extensive research and monitoring of waterfowl during the past 50 years has helped scientists better understand their habitat needs and behavior, including their sensitivity to factors such as weather extremes and changes in available food supplies.

U.S. FISH AND WILDLIFE SERVICE

Since widespread monitoring began in the mid-1950s, the estimated breeding population of North American ducks in the traditionally surveyed area has ranged from 26.5 to 42.8 million, with weather patterns among the factors contributing to these fluctuations. Seasonal changes in temperatures directly influence when and how far species will migrate. Waterfowl also respond indirectly to weather through its effects on their nesting and feeding habitat. This sensitivity is important to species' survival: it enables migratory wildlife to move to other places when conditions are unfavorable or to recognize and take advantage of more favorable conditions.

In general, most species of waterfowl have been able to bounce back from periodic declines in populations due to natural conditions. However, continued declines among some species may be a signal that we are pushing them beyond their limits. Ongoing loss of wetlands and other human-induced stressors have limited the options for waterfowl to find favorable habitat when they need it. On top of that, global warming is likely to alter weather patterns and habitats used throughout their life cycles, affecting breeding areas, migration, stopover sites, and over-wintering habitat. The 2004 Strategic Guidance for the North American Waterfowl Management Plan (an international action plan developed through thousands of partners representing diverse interests in Canada, the United States, and Mexico to conserve wetland and upland habitat) identifies global climate change as among the most serious threats to the future of North American waterfowl, along with human population growth, increasing demands for energy, water, food, and fiber, urban expansion, and invasive species.[18]

Ongoing loss of wetlands and other human-induced stressors have limited the options for waterfowl to find favorable habitat when they need it.

Potential Impacts of Global Warming on Waterfowl Breeding Habitat and Behavior

One of the most important factors in determining the overall population of migratory waterfowl species from one year to the next is breeding success. Scientists have determined that events occurring during the breeding season account for as much as 84 percent of the variability in population growth rate of mallards and other dabbling ducks.[19]

While a number of factors, including increased predation and contamination of food sources, can affect breeding success, the determining factor for most North American waterfowl is availability of adequate wetlands and grassland habitat.[20] Numerous studies have identified a strong correlation between availability of summer wetlands in important North American breeding areas and the reproductive rate of various waterfowl species.[21]

A decline in wetlands due to drought can affect breeding success of ducks in a number of ways, including reducing clutch sizes, shortening nesting seasons, lowering nesting success and brood survival, and even reducing the likelihood of breeding altogether.[22] If drought persists, these impacts can lead to declining populations. In fact, adequate water conditions are so important to reproduction that the number of late-spring wetlands in critical waterfowl breeding areas is monitored annually and used to help assess their annual reproductive success. These wetland counts also contribute to setting annual duck-hunting regulations.

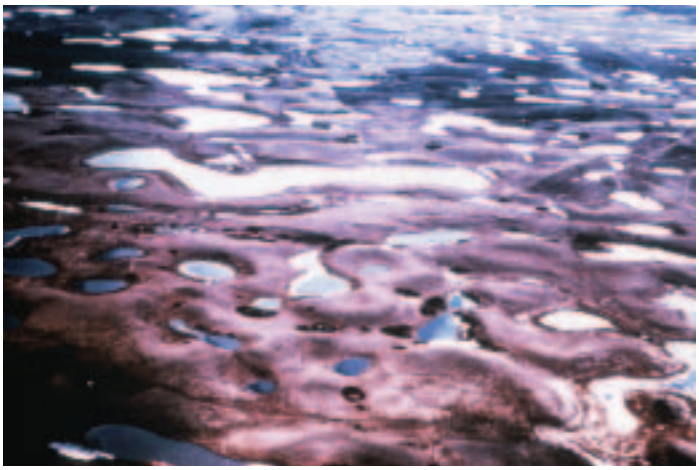
With global warming likely to affect wetland habitats across North America, managers will increasingly need to factor breeding conditions into their decision-making processes.

Prairie Pothole Region

The Prairie Pothole Region of south-central Canada and the north-central United States, so-called for its multiple, tiny, pothole-like wetlands, is the single most important breeding ground for North America's migratory ducks and other waterfowl, including popular game birds, such as mallards, gadwall, blue-winged teal, northern pintails, redheads, and canvasbacks.[23] The Prairie Pothole Region, often called North America's "duck factory," is a primary source for the waterfowl harvested in the contiguous United States—particularly in the Mississippi and Central flyways. For example, according to band recovery data compiled by the Ducks Unlimited Southern Regional Office, more than 75 percent of the ducks recovered in Arkansas, Louisiana, Mississippi, Tennessee, and Texas from 1990 to 2000 originated in the Prairie Pothole Region.[24]

U.S. FISH AND WILDLIFE SERVICE

Loss of prairie wetlands because of development has spurred numerous conservation activities in the region, including the setting aside of reserves, perpetual conservation easements on native grazing lands, and provision of incentives for more sustainable land-use practices. These efforts have no doubt helped maintain the health of many waterfowl populations. Whether these conservation successes will endure, however, depends on whether we can retain important policy protection for wetlands under the Clean Water Act and the U.S. Farm Bill, as well as prevent additional pressures on wetlands over the longer term from global warming.[25]


U.S. FISH AND WILDLIFE SERVICE

Left unchecked, global warming is projected to increase the likelihood of severe droughts across central North America, including the Prairie Pothole Region.[26] Mean annual March to May temperatures in the region already have increased in the latter half of the 20th century, and continued warming is expected to raise evaporation rates and reduce soil moisture by 25 percent by the middle to the end of this century, particularly in summer months.[27]

Continuing trends of higher regional temperatures and drier conditions would likely lead to fewer wetlands on average, with serious implications for breeding waterfowl. Models project that global warming could lead to significant declines in Prairie Pothole wetlands (from no change to a loss of 91 percent) by the 2080s. This could translate into a decline in the abundance of breeding ducks in the region by 9 percent to 69 percent, ultimately having a drastic effect on duck populations across the country.[28]

Boreal Forests, Tundra, and Other Arctic Habitat

U.S. FISH AND WILDLIFE SERVICE

The boreal forests, tundra, and coastal regions of Alaska and northern Canada are also important breeding areas for a number of North American waterfowl species. Alaska alone provides breeding habitat for 20 percent of America's waterfowl, including half of the species that winter in the Pacific Flyway states.[29]

This arctic region is also among the fastest-warming regions on the earth. Average temperatures in the northern region of North America have already risen four times faster than other parts of the globe, and this warming is significantly altering natural systems. According to the 2004 Arctic Climate Impact Assessment, spring is coming earlier in many areas. Since 1955, the average date of snow disappearance has moved from mid-June to late May. Permafrost is also thawing, tundra habitat is giving way to wetlands, trees, and shrubs, and loss of sea ice along the Alaskan coast has contributed to significant coastal erosion.[30]

U.S. FISH AND WILDLIFE SERVICE

With further warming, these trends are likely to continue. For example, scientists project that the arctic land area currently covered by tundra vegetation could decline by 40 percent to 57 percent by the middle to the end of the 21st century.[31] Freshwater habitats are also expected to change, as thawing permafrost could contribute to the formation of new wetlands in some areas by creating new depressions and reduce surface water in others by enabling water in lakes to drain into previously frozen ground.[32]

Scientists are uncertain exactly how these and other changes in habitat due to global warming will affect the waterfowl that nest and breed in the region, but they believe that the changes will likely be favorable for some species and unfavorable for others. For some species, earlier snowmelt and warmer springs could contribute to higher reproductive success. For example, several studies have found a positive correlation between increased productivity of lesser snow geese and other white geese species and a trend of earlier spring melt and warmer temperatures in the Hudson Bay region.[33] In addition, as average temperatures in Alaska have increased since 1950, arctic geese there have experienced a consistent trend toward earlier nest initiation and hatching. By early 1990, young arctic geese were hatching about 30 days earlier.[34]

Although scientists have not determined a direct causation between recent warming in the arctic region and the significant declines in populations of North American scaup and scoters since the mid-1900s, it is possible that changes in habitat associated with global warming could be among the contributing factors.[35] Population declines among surf scoters, white-winged scoters, and other waterfowl and seabirds in Alaska's Prince William Sound, for example, have been associated with a trend of higher average sea surface temperatures since the 1970s, which has reduced the availability of the fish they need for food.[36] Research also suggests that higher temperatures and prolonged drought conditions in the northern prairie and boreal forest regions could be reducing the productivity of lesser scaup.[37]

Potential Effects of Global Warming on Waterfowl Migration and Range

Like many plants and animals, birds' life cycles and behavior are closely linked with the changing seasons. For ducks, geese, and other migratory waterfowl, changes in weather as well as changes in day length help signal when they should begin their long flights southward in the fall and back northward in the spring. Variables such as temperature and precipitation also affect the timing and availability of insects and other food sources for the birds when they reach their destination.

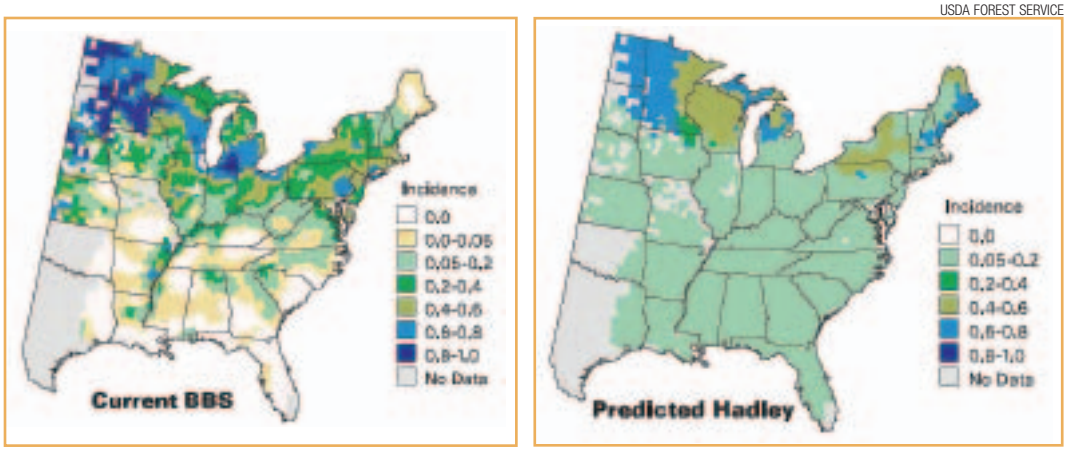
U.S. FISH AND WILDLIFE SERVICE

On the whole, most birds tend to follow relatively consistent patterns in their habitat ranges and migration timing. Some birds, however, may be more flexible in their migratory behavior in response to short-term environmental changes than others. As long as there is open water and plenty of available food, a number of waterfowl species will stay in northern areas rather than migrate south in winter months.[38] Mallards and Canada geese, for example, can show considerable variation in their wintering ground locations.[39] Their distributions tend to be farther to the north in years when the northern part of their wintering range is warmer than normal and water remains open rather than freezing over. They also can take advantage of available waste grain in fields when snowfall is low.

Wood ducks also are sensitive to temperatures and precipitation when migrating south each winter.[40] Young wood ducks, in particular, have shown a tendency to spend the winter farther north when temperatures in the region are warmer than average. Similarly, wetter-than-normal summer seasons in their northern range often leads to greater availability of forested wetlands, diminishing the need for the birds to fly farther south where such wetlands are more permanent.

It is for these reasons that waterfowl enthusiasts in the South may experience less-than-stellar hunting seasons in years when the winters in the North are warmer than normal, as occurred in the Mid-Atlantic region and southern United States in 2001. Conversely, such a phenomenon can bolster hunting opportunities in northern regions. If global warming continues unabated, a similar trend in waterfowl hunting opportunities is likely to continue in this century, although overall reductions in waterfowl populations due to other factors such as loss of breeding habitat could adversely affect hunting in northern regions as well.

USDA FOREST SERVICE



Modeled projections for contraction in habitat range of mallards in the eastern U.S. due to global warming.

Changes in climate due to global warming will also enable some waterfowl to expand their breeding ranges to more northern latitudes in the spring and summer months. Recent research by the USDA Forest Service suggests that changes in seasonal temperatures and precipitation associated with a doubling of carbon dioxide concentrations in the atmosphere from pre-industrial levels could contribute to a significant northward shift in the breeding range of mallards and blue-winged teal in the eastern half of North America before the end of this century.[41]

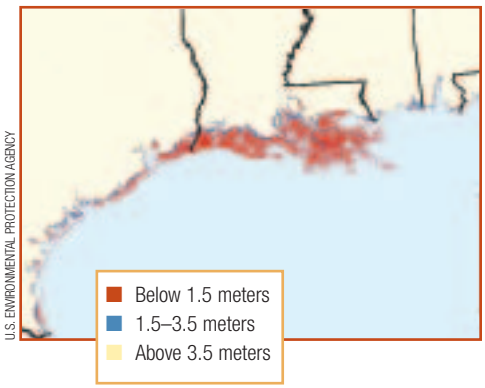
Some waterfowl may already be shifting their distributions in response to global warming. For example, in the increasingly warmer Northwest Territories of Canada, the mallard, green-winged teal, American wigeon, surf scoter, and common merganser are among nine bird species that have expanded their ranges north of the tree line in the Thelon River valley.[42] Also, milder winters and warmer springs since 1975 have contributed to a change in goose distributions in the Maritimes of eastern Canada, where spring staging geese have recently expanded to Prince Edward Island.[43]

U.S. FISH AND WILDLIFE SERVICE

Potential Effects of Global Warming on Stopover and Wintering Habitat

When North America's waterfowl do travel south for the winter, the majority of them seek out freshwater lakes, river basins, deltas, coastal marshes, and estuaries in the United States and Mexico as their stopover and wintering habitats of choice. Within the United States, many of the birds in the Atlantic Flyway travel through the eastern Great Lakes and New England to wintering areas along the Mid-Atlantic coast, including the Chesapeake Bay and Delaware Bay. Others move farther south into the Carolinas, Georgia, and Florida.

Depending on water conditions, mid-continental species that use the Mississippi and Central flyways largely winter in the Platte River basin, the Mississippi Alluvial Valley, the lower Mississippi River delta, the Playa Lakes region, and in flooded agricultural land and coastal marshes along the Gulf of Mexico. And in the Pacific, waterfowl that breed in Alaska and other northwestern regions of the continent opt for the lakes, river basins, bays, and estuaries of Washington, Oregon, California, the western Rocky Mountain states, and the Southwest. Once there, they feed on marsh grasses, invertebrates, and other prevalent foods and regroup for the next spring's return to the north to breed.



U.S. ENVIRONMENTAL PROTECTION AGENCY

Modeled projection of potential coastal inundation in Louisiana and Texas due to sea level rise.

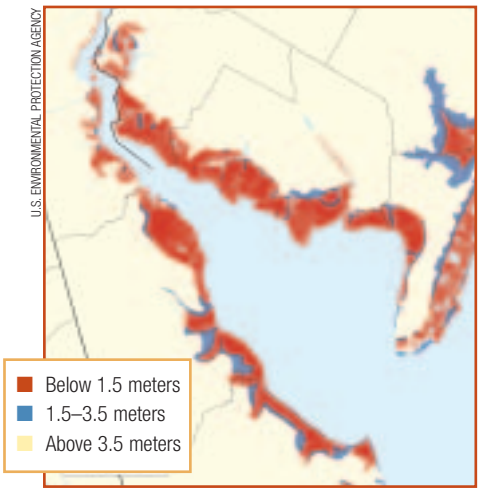
Throughout the regions, global warming–associated changes in sea level, river flows, precipitation patterns, and other factors may affect the availability of sufficient habitat and foods. Sea level rise, in particular, is likely to significantly reduce viable winter habitat for numerous waterfowl, especially where coastal wetlands and other natural systems are restricted by developments such as sea walls and dikes, which limit their ability to spread inland when coastal conditions change. Left unchecked, global warming is expected to cause global sea levels to rise by 3 to 34 inches by 2100—a rate up to five times faster than that of the past century.[44] The loss of coastal wetlands in the contiguous United States alone due to this amount of sea-level rise is estimated at 17 percent to 43 percent in areas without structural protection of dry land, and at 20 percent to 45 percent where structures such as sea walls are present.[45]

Exactly how much sea level will rise in any given area will depend on a range of factors, such as the relative slope of the coastline and changes in land elevation due to compaction of soils, deposition of sediments, groundwater withdrawals, and other natural and human-related factors. Scientists expect sea level rise in the United States to have the greatest impact along the Gulf of Mexico and Mid-Atlantic coasts, which have large areas of low-lying land.

Gulf Coast

The consequences of sea level rise for species that inhabit Louisiana and other states along the Gulf of Mexico could be devastating given the fact that much of the coastal wetland habitat in the region has already been damaged or destroyed by activities such as groundwater withdrawal, levee construction, and dredging projects. Over the past few decades, a combination of human activities, localized soil compaction, and sea-level rise has led to rates of coastal wetland loss in the region exceeding 25 square miles per year—roughly the amount of a football field every 30 minutes.[46]

Coastal Louisiana has seen some of the greatest losses, with nearly 1 million acres of coastal marshes having been converted to open water since 1940.[47] Species at greatest risk to continued losses include redheads, lesser scaup, and canvasbacks, which are less able to take advantage of alternative food sources and habitats such as shallow agricultural lands than most of the dabbling ducks (e.g., mallards, northern pintails, northern shovelers, and mottled ducks) and geese.[48]



U.S. ENVIRONMENTAL PROTECTION AGENCY

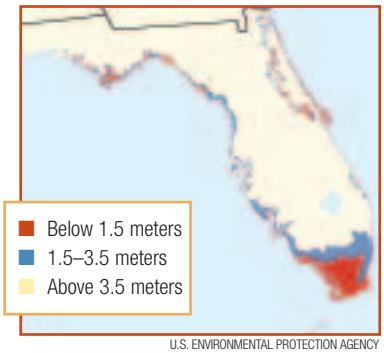
Modeled projection of potential coastal inundation in Delaware Bay due to sea level rise.

The Atlantic Coast and Florida

Scientists estimate that a 15-inch rise in sea level along parts of the Atlantic Coast by the end of this century would likely far outweigh the natural rate of accretion (deposition of sediments) in the region, leading to large-scale submergence of marshes.[49] Relative water levels in the Chesapeake Bay are already rising twice as fast as the global average rate of sea-level rise, and many of the Bay's small islands have been inundated. The impact of sea-level rise comes on top of other ongoing problems, including the degradation of water quality in the Chesapeake Bay due to nutrient enrichment, turbidity, and sedimentation, which has reduced the abundance of aquatic plant and animal foods most

important to canvasbacks, redheads, American black ducks, northern pintails, American wigeon, and tundra swans. Continued trends in wintering habitat loss would likely be particularly harmful to these species. Other species, such as Canada geese, will likely be less vulnerable because they can more easily switch to alternative food sources.[50]

Rising sea level is also likely to be an important factor affecting waterfowl that winter farther south. In Florida, for example, waterfowl have already lost significant habitat as vast areas of wetlands have given way to development. Florida's coastal wetlands are home to large numbers of wintering ducks, including scaup, ring-necked ducks, and green-winged teal, as well as resident mottled ducks, wood ducks, and fulvous whistling ducks. Continuing pressures on land for development combined with saltwater intrusion and inundation of coastal areas to sea-level rise could reduce available habitat for these and other waterfowl species in the coming decades.



U.S. ENVIRONMENTAL PROTECTION AGENCY

Modeled projection of potential coastal inundation in Florida due to sea level rise.

Pacific Coast

For the Pacific Coast, areas at risk include San Francisco Bay, San Diego Bay, the Puget Sound, and the Fraser River delta in Canada, which provide critical habitat for resident and migrating waterfowl in the Pacific Flyway.[51] In addition to inundation of low-lying areas due to a rise in sea level, changes in inland precipitation patterns and a significant decline in average mountain snowpack are expected to affect the quality and quantity of water in many of the region's coastal marshes and estuaries.

While weather conditions can and do vary from one year to the next, long-term data point to some startling trends. Throughout the West, the dates of peak snow accumulation and snowmelt-derived streamflow have shifted by 10 to 30 days earlier, and snowpack has decreased 11 percent over the same period.[52] Some locations in the Cascades, for example, have already seen a 30 percent to 60 percent decline in snow water equivalent since 1950, which has contributed to a significant loss of summer water availability in sensitive areas.

BOB GRESS

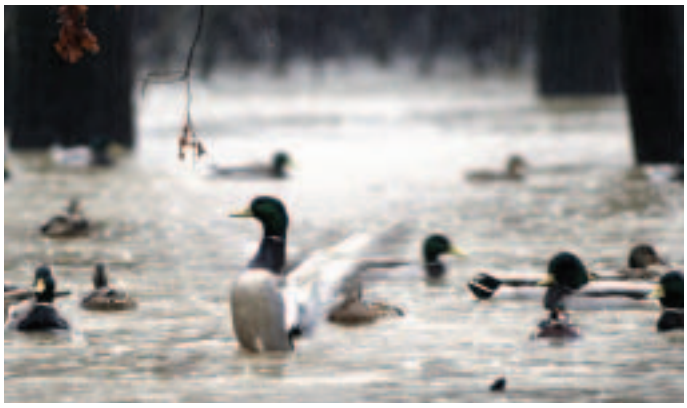
Scientists project that warmer temperatures and more winter rain due to global warming will continue to cause a substantial decline in snow accumulation across the western United States in the coming decades. As a result, earlier spring runoff and less water inflow in the summer months could contribute to higher salinity levels in estuaries, which are largely controlled by the influx of fresh water.[53] This could alter the distribution and availability of key food sources for resident and migrating waterfowl. Loss of estuary habitat is expected to be especially harmful to diving ducks such as canvasbacks and ruddy ducks in the Pacific Flyway because their habitat has already been limited in the region by dredging, construction of levees, and other development.[54]

NATURAL RESOURCES CONSERVATION SERVICE

Inland Regions: River Basins and Freshwater Lakes

Important stopover and wintering habitats inland may also be affected by global warming–induced changes in river flows, lake levels, and quantity and quality of wetlands. The Mississippi River corridor, for example, provides important stopover and wintering habitat for many duck species in the Mississippi Flyway, especially mid-continental mallards and wood ducks. The lower basin, in particular, is considered to be the most important wintering region in North America for mallards—accordingly, it is also among the most popular duck-hunting regions in the United States.[55] Both mallards and wood ducks prefer forested wetlands dominated by oak trees, which provide them with acorns and other preferred foods. Their over-winter survival also depends in large part on the extent of winter flooding.

Historically, forested wetlands were prevalent throughout the Mississippi River valley, but they have since been reduced to a mere fraction of their original area.[56] By the early 1900s, loss of wetland habitat due to flood control and agriculture, along with excess hunting, caused wood duck populations to nearly disappear. Subsequent conservation efforts have helped restore wood duck populations to healthy numbers, but how they and other waterfowl in the region fare in the future will depend on continued restoration and protection of their habitat from a broad range of threats—including global warming. While models vary in their projections for what global warming will mean for the south-central United States, most studies agree that the region will see greater weather extremes, including floods and drought.[57]

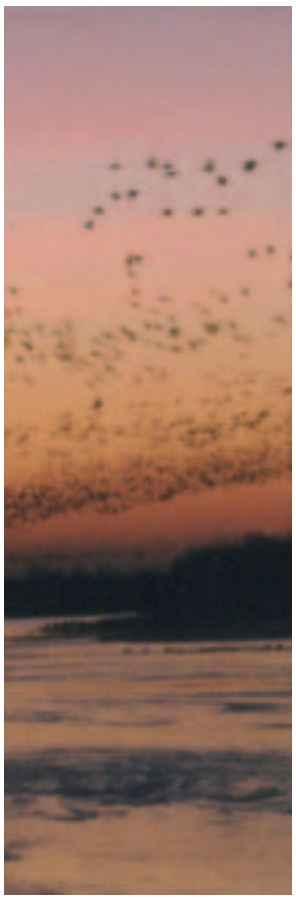


U.S. FISH AND WILDLIFE SERVICE

Global warming may also affect shoreline wetlands of the Great Lakes and along the St. Lawrence River corridor in the United States and Canada, which provide critical habitat for breeding and migrating waterfowl, especially diving and sea ducks.[58] Research suggests that the combined effects of changes in breeding and migratory habitat could lead to a 19 percent to 39 percent decline in duck numbers throughout the region by 2030.[59]

Several climate models project that higher average temperatures and increased evaporation in the region will contribute to a decline in average Great Lakes water levels in summer. Estimates for Lakes Michigan and Huron, for example, show a 0.7- to 2.4-foot reduction in lake level by 2030, with further reductions later on.[60] This could also contribute to a reduction in the amount of water flowing out of the St. Lawrence River.[61] While Great Lakes ecosystems have evolved to withstand the regular, natural variations in water levels, persistent low lake levels could reduce available food sources such as submerged vegetation important to canvasbacks and redheads.

Warmer lake temperatures and lower oxygen concentrations could also contribute to increased uptake of contaminants such as mercury through the food web.[62] On the other hand, low lake levels that expose mud flats could allow wetland areas to expand toward the new lakeshore, providing added habitat for some species. Low flows in the St. Lawrence River can also affect waterfowl habitat along its banks, particularly if more extensive dredging is required to support ship navigation.


DUANE HAVORKA

On the Platte River basin of Colorado, Nebraska, and Wyoming, regulation of streamflow due to construction of dams and other structures already have contributed to a reduction in open channels and marshes, which provide important roosting areas for whooping cranes, sandhill cranes, and other species as they migrate north in the spring.[63] Much of the upper Platte River depends on snowmelt and spring and summer rains as its primary sources of water. Higher average temperatures and reductions in average snowpack in the region due to global warming would limit water available for competing uses, including protecting fish and wildlife.

Increasing pressures on water farther south may also affect whooping cranes if it results in a lower influx of fresh water from the San Antonio and Guadalupe rivers into critical estuarine habitat on the Texas coast. Associated increases in the salinity of the water in the estuary can lead to a reduction in the availability of blue crabs, the primary food source for wintering whooping cranes.[64]

Western waterfowl habitat is also threatened by potential changes in snowpack and the availability of water. For example, the Klamath River basin in northern California and southern Oregon was once one of North America's most significant wetland areas, earning a reputation as the "Everglades of the West."[65] Although the majority of the region's wetlands have already been destroyed because of agricultural conversion, the Klamath River basin remains one of the most important habitats for staging and wintering waterfowl in the Pacific Flyway. The region hosts as many as 6 million geese and ducks in a season, including white-fronted geese, snow geese, Ross's geese, Canada geese, tundra swans, mallards, American wigeon, and northern pintails. However, continued demands for water for irrigation and other uses have plagued the Klamath in recent years, and pressures will likely grow if, as projected, global warming leads to a significant decline in the average snowpack that feeds the river system each year.

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NATURAL RESOURCES CONSERVATION SERVICE

Changing the Forecast for Waterfowl: A Plan of Action

Waterfowl are part of America's natural heritage, and they will no doubt continue to be a focus of conservation. Whether those efforts will be successful, however, will depend on how well we are able to tackle the growing pressures from human activities, including global warming. The challenge is great—*but there are solutions.*

Many of the strategies that help protect waterfowl today, such as protecting and restoring the quantity and quality of wetland habitat and regulating harvests, will also enable them to be more resilient to the global warming that is already occurring. Moreover, taking global warming and associated climate change into consideration in long-term resource management plans will improve the outlook for waterfowl in the future.

More importantly, it is possible to minimize the impact of global warming altogether by reducing the pollution that is causing it—but policy makers must begin to take meaningful action today. Delaying action will allow more and more carbon dioxide and other greenhouse gases to accumulate in the atmosphere, making worse case projections more likely to actually occur. Furthermore, delaying action will require even greater emission reductions later, which will be more difficult and costly to achieve. Numerous studies show that the nation can lower global warming pollution by using readily available technologies to improve energy efficiency and generate electricity with clean, environmentally sustainable resources, spurring innovation and promoting an emerging market of new alternatives in the process.

[I]t is possible to minimize the impact of global warming altogether by reducing the pollution that is causing it—but policy makers must begin to take meaningful action today.

Recommendations

1. Enhance Current Waterfowl and Habitat Conservation Efforts.

The historic interest in waterfowl is the engine that has driven one of North America's most comprehensive conservation movements. Through local, national, and international policies and programs, and the unwavering efforts of thousands of private wetland managers and organizations such as Ducks Unlimited and Delta Waterfowl, conservationists have achieved considerable successes. The sight of hundreds of thousands of sandhill cranes on the Platte and the return of the wood duck to healthy populations across the country are welcome reminders of what can be accomplished.

Despite the progress, North America continues to lose ground every day as wetland and native grassland habitats are destroyed by development. Further losses in habitat area would mean greater challenges ahead for waterfowl as they face the added stressors from global warming. This underscores the importance of maintaining and enhancing protections provided under laws such as the Clean Water Act, Endangered Species Act, and the Farm Bill conservation title.

U.S. FISH AND WILDLIFE SERVICE

Unfortunately, many of the policies and programs that have helped to restore and protect the nation's waterfowl and wetland habitats are under threat. For example, a 2003 Bush administration policy directive designed to interpret a 2001 U.S. Supreme Court decision has opened up the possibility for developers and other industries to fill or degrade millions of acres of small streams, wetlands, lakes, and ponds they claim are "isolated," without seeking Clean Water Act Permits.[66] This policy is being implemented despite the fact that scientists find that very few waters are truly "isolated." Rather, these waters are often connected by water overflow or groundwater, and they frequently support the same species in different stages of their life cycles.[67] The prairie potholes, playa lakes, rainwater basins, and Texas coastal plains wetlands that are so vital to waterfowl are profound examples of the types of waters frequently being targeted.

The first line of defense must be to ensure that the nation does not lose ground in protecting its waterfowl and habitat. This should include the following actions:

- Stop efforts to weaken the nation's species and wetland protection laws and regulations, especially the Clean Water Act's wetlands-protection provisions;
- Expand existing programs, such as Swampbuster, Wetlands Reserve Program, and Wildlife Habitat Incentives in the Farm Bill;
- Increase funding for wetlands-conservation programs such as the North American Wetlands Conservation Act and acquisition of lands for National Wildlife Refuges; and
- Encourage greater support for state, tribal, and nongovernmental programs to restore wetlands and other key habitats.

2. Incorporate Global Warming and Associated Climate Change into Long-Term Resource Management and Planning.

While the most important strategy we can undertake to prevent broad-scale loss of wildlife and habitat due to global warming is to reduce greenhouse gas emissions, the nation must also begin to develop strategies to help species and ecosystems cope with some changes that are inevitable, as well as build in the flexibility to deal with those impacts that may be unforeseen. For waterfowl, taking the potential impacts and uncertainties associated with global warming into consideration in efforts such as the North American Waterfowl Management Plan and other relevant resource management activities will help ensure that our conservation successes will endure for generations to come. This should include the following actions:

- **Reform floodplain, coastal zone, and water resource management in critical areas.**

U.S. FISH AND WILDLIFE SERVICE

Historically, the United States has tended to manage its water resources and deal with weather events such as hurricanes and floods through structural mechanisms such as building dams, levees, and seawalls. Many of these costly projects, however, have dramatically altered America's landscape, affecting natural water flows, diminishing water quality, and destroying important wildlife habitat. Paradoxically, they have also increased the vulnerability of both human and natural systems to sea-level rise and extreme weather events that are expected with global warming. By continuing to use these outdated approaches to managing water resources instead of using wiser, more dynamic approaches, the nation will likely experience significantly greater weather and climate-related damages to buildings and crops, along with less and less viable habitat for wildlife, in the coming decades. The threat of global warming should provide added impetus for improvements.

Among other things, reforming the U.S. Army Corps of Engineers—the largest agency engaged in development and use of water resources—should be a priority to better serve environmental protection on rivers, coastal areas, wetlands, and floodplains. Two important issues in reforming the Corps are use of nonstructural approaches and increased attention to restoration.[68] In the 1990s, Congress added ecosystem restoration to flood-damage reduction and navigation as primary federal responsibilities. Restoring more natural hydrology and sediment transport through activities such as revised dam operation and improved water management, reopening access to natural floodplains, restoring riparian vegetation and habitat, and reestablishing natural dunes along coastlines and barrier islands will have an enormous positive impact in helping to revive these damaged ecosystems, including making them as resilient as possible to the impacts of global warming.

- **Address the potential for more catastrophic and unexpected events in long-term harvest and resource management plans.**

The recent advances in scientific understanding of the regional and localized consequences of global warming, as well as the vulnerability of species and ecosystems, will go far in helping resource managers and other relevant decision makers develop and promote appropriate solutions. The likelihood of drier conditions in the Prairie Pothole Region, for example, should persuade resource managers, conservation organizations, and other stakeholders in the region to develop contingency plans such as promoting development of less water-intensive agriculture or securing long-term rights for water use to ensure its availability for wetlands when water resources are scarce, and to implement watershed-based land-use planning.[69]

NATURAL RESOURCES CONSERVATION SERVICE

By its very nature, however, there will always be a degree of uncertainty about how, when, and where global warming will affect natural systems. Increased monitoring and research on known and potential impacts of global warming on species and habitats will help close the gap in knowledge, but that does not mean that we should wait until we can predict exactly when and where we will experience impacts in all cases before we act. Rather, the very fact that there is uncertainty—and the potential for global warming to lead to irreversible damages, such as the extinction of species—necessitates precautionary action.[70] Conservationists must develop strategies to better deal with uncertainty in long-term species-protection plans to ensure that resources will be available if and when extreme events occur.[71]

3. Curb global warming pollution.

Finally, America must be part of the solution to curb global warming altogether by reducing the pollution that is causing it. There are a number of actions at the national, state, and local levels—and even as individuals—that will make a difference. State and local governments have already been taking the initiative in addressing global warming, as have some major corporations. For example, at least 28 states and Puerto Rico have developed or are developing plans to reduce greenhouse gas emissions through activities under their jurisdiction, including land-use planning, transportation initiatives, building codes, and tax incentives.[72] Many cities across the country have also committed to reduce greenhouse gas emissions through community-based activities such as promoting car pooling and public transit and increasing recycling rates. All of these strategies are a clear indication of the groundswell of support for action to address global warming, and they are proving that it is possible to reduce global warming pollution and at the same time create economic opportunities and protect the environment in other ways.

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However, in the absence of a meaningful national plan to curb global warming pollution, these actions will likely fall short of the greenhouse gas emission reductions necessary to successfully reduce the nation's enormous contribution to global warming. A comprehensive and effective national strategy to curb global warming should include setting specific limits on the nation's global warming pollution; strengthening state and federal policies and programs to promote energy efficiency, renewable energy, and cleaner transportation options; encouraging protection and restoration of natural habitats (grasslands, wetlands, forests) that can help sequester carbon; and reengaging in international cooperation on global warming.

- **Set specific limits on the nation's global warming pollution.**

The United States has the technology and know-how to lead the world in environmental solutions while creating well-paying jobs here at home and strengthening America's economy. The best way to channel the ingenuity of America's industry into confronting global warming is to establish specific national limits on U.S. global warming pollution.

Despite the implementation of some voluntary actions to reduce emissions over the past decade, U.S. global warming pollution has continued to increase, rising 13 percent between 1990 and 2003. A sensible first step would require power plants, oil companies, and other major pollution sources to collectively stop their emissions of greenhouse gas emissions from increasing further. Using an emissions-trading system similar to that developed for acid rain pollution under the Clean Air Act would permit each business to make its own decisions on the best ways to meet the goals of the program. Companies that want to increase emissions can purchase emission credits from other companies that have reduced emissions beyond the program's goals. Although the initial goal of stabilizing pollution levels may be modest, it is important to get started now and put the nation on a path to a more sustainable future.

The United States has the technology and know-how to lead the world in environmental solutions while creating well-paying jobs here at home and strengthening America's economy.

A market-based emissions trading system that establishes concrete limits on pollution will provide needed incentives for American industry to innovate and respond to the challenges of global warming. It will spur manufacturing jobs by encouraging innovation that will help U.S. industry be a leader in the large global market for energy technologies. According to the President's Council of Advisors on Science and Technology in 1999, "U.S. firms would greatly benefit from investments in [clean energy technology], helping them capture much of the $10 trillion which will be spent worldwide for energy supply technologies over the next 20 years."[73] Moreover, researchers at the Tellus Institute estimate that a proposal to halt the growth in U.S. global warming pollution levels would lead to net consumer savings of $30 billion annually by the year 2020 by spurring innovation, energy conservation, and energy bill savings.[74]

Given the United States' role as the largest emitter of greenhouse gases, U.S. leadership on global warming is crucial to building international support for the deeper global reductions in emissions that will be needed in the coming decades.

- **Strengthen state and federal policies and programs to promote energy efficiency, renewable energy resources, and cleaner transportation options.**

While a national limit on carbon pollution will significantly spur innovation and promote an emerging market for alternative energy sources, there are a number of other strategies that the nation can undertake to help improve energy efficiency and increase the use of renewable energy resources.

Increasing the energy efficiency of homes, offices, motor vehicles, and factories is not only environmentally wise and technologically feasible; it also represents significant economic savings for households and businesses. Measures such as implementing stronger efficiency standards for air conditioners and appliances and improving energy efficiency in buildings can significantly reduce global warming pollution.[75]

Abundant, clean, and reliable energy sources such as the sun and wind also have tremendous potential to help reduce the nation's use of fossil fuels. Thanks in part to federal research programs and state clean energy standards, the cost of renewable energy has fallen dramatically, and use of these technologies continues to grow. With policies such as production tax credits and state and national renewable energy portfolio standards, the United States could achieve a goal of 20 percent renewable energy by 2020, creating hundreds of thousands of jobs in the process.[76]

Federal and state governments can also provide greater incentives to increase the use of cleaner fuels for transportation and energy-saving vehicles such as the new electric/gasoline hybrids, which are increasingly available to consumers. California has taken this a step further by enacting a law to limit the amount of global warming pollution from motor vehicles, beginning with the 2009 model year. Under the U.S. Clean Air Act, other states can elect to adopt California's standards.

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In addition, communities can decrease reliance on individual automobiles altogether by reining in suburban sprawl, reducing the distances between where people work, shop, and live. Curbing sprawl will not only save energy, but it will help save green space and habitat for fish and wildlife. According to the National Governors' Association, local and state governments can use a variety of strategies, such as creating incentives to increase public transit use, promoting bicycle- and pedestrian-friendly options, and linking transportation funding to effective growth-management strategies.[77]

- **Encourage carbon sequestration through sound management and restoration of wetlands, grasslands, forests, and agricultural lands.**

The primary emphasis of strategies to curb global warming must be on reducing emissions of carbon dioxide and other greenhouse gases from burning fossil fuels. However, strategies to protect and enhance the ability of natural systems to absorb and store carbon from the air can play a role in slowing the buildup of heat-trapping carbon dioxide in the

atmosphere. Some of the practices that increase the ability of forests, grasslands, wetlands, and other terrestrial systems to absorb and store carbon include preventing wetland loss, improving agricultural practices, or planting new trees and grasslands. Well-designed projects can also provide significant additional benefits such as habitat for wildlife, economic opportunities for landowners, and recreational outdoor opportunities for wildlife enthusiasts.

In addition to including carbon sequestration as part of an overall national climate policy, there are also opportunities to promote carbon-sequestration activities as part of the Farm Bill. Agricultural practices in the United States have historically been sources of carbon, but a recent study suggests that, by reforming certain farming practices, the nation has the potential to sequester 88 to 232 million metric tons of carbon per year.[78] Strategies could include providing greater incentives for soil erosion management, conservation tillage, and restoration and reclamation of wetlands.

While programs such as the Conservation Reserve Program have already contributed to a significant reduction in wind erosion and other factors that release carbon from agricultural soils, researchers estimate that if all cropland currently eligible for Conservation Reserve Program were enrolled, it would sequester an additional 8.1 million metric tons of carbon per year.[79] Similarly, restoration of 50 percent of the wetlands that have been lost to agriculture since the mid-1950s could help sequester close to 30 million metric tons of carbon per year—and provide waterfowl and other wildlife with additional habitat as well.[80]

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- **Reengage in international cooperation on global warming.** Ultimately, the U.S. government must reengage in the international process to implement a worldwide solution to global warming. At least 150 other nations have taken an important step forward by ratifying the Kyoto Protocol, which requires them to reduce their collective greenhouse gas emissions to 5.2 percent below 1990 levels by the year 2012. Although the United States abandoned its support for the treaty in 2001, there is still an important opportunity for the nation to participate in the development of further international commitments.

As the world's number one contributor to global warming, America has a responsibility to do its share in curbing the problem. Moreover, the United States has the technology and know-how to help other countries cut their own emissions, which places the nation in an excellent position to lead the international market for clean energy.[81]

10 Ten Steps You Can Take at Home to Combat Global Warming

1. Replace incandescent light bulbs with compact fluorescent bulbs.
2. Install a clock thermostat to save heating and cooling energy at night and when no one is home.
3. Change or clean furnace and air conditioner filters regularly to keep heating and cooling systems running efficiently.
4. Set your water heater to a lower setting or call a service person to adjust it for you.
5. Wash your laundry in warm or cold water instead of hot.
6. When shopping for home appliances and electronics, look for the Energy Star® label; when purchasing a car, buy the most fuel-efficient model that meets your needs.
7. Choose alternative transportation methods whenever possible, such as taking public transport, carpooling, biking, or walking.
8. Reduce gasoline consumption by keeping your tires properly inflated and your engine tuned up.
9. Recycle aluminum cans, glass bottles, plastic, cardboard, and newspapers to help reduce the energy needed to make new products.
10. Contact your representatives in Congress and encourage our government to enact policies to reduce global warming pollution.

Conclusion

Waterfowl have long symbolized North America's natural heritage. For generations, people have revered the beauty and reveled in the bounty of these birds, and concern for their protection has served as a foundation for the nation's profound conservation legacy. After more than a century of reckless destruction of wetlands and other habitat, the establishment of wetlands-conservation laws and the protection of millions of acres of habitat as wildlife refuges have helped to sustain healthy waterfowl populations across the country. Whether those conservation successes will endure depends on America's fortitude to rise to the challenge of global warming. The solutions are at hand, however, and with the right investments, people can change the forecast for waterfowl and ensure that their children and grandchildren will have the same opportunities to hunt, bird, and otherwise enjoy the natural world that they have grown to know and love.

The National Wildlife Federation's Long Fight for Waterfowl and Wetlands Conservation

The National Wildlife Federation's (NWF) commitment to wetlands and waterfowl conservation began in 1936 when Ding Darling, former Chief of the U.S. Biological Survey, founded NWF. The best friend ducks ever had, Ding Darling had two years earlier played a key role in establishing Federal Migratory Bird Hunting and Conservation Stamps, commonly known as "Duck Stamps," to fund wetlands conservation.

In the following seven decades, NWF has lobbied and litigated to protect wetlands and conserve waterfowl across the United States.

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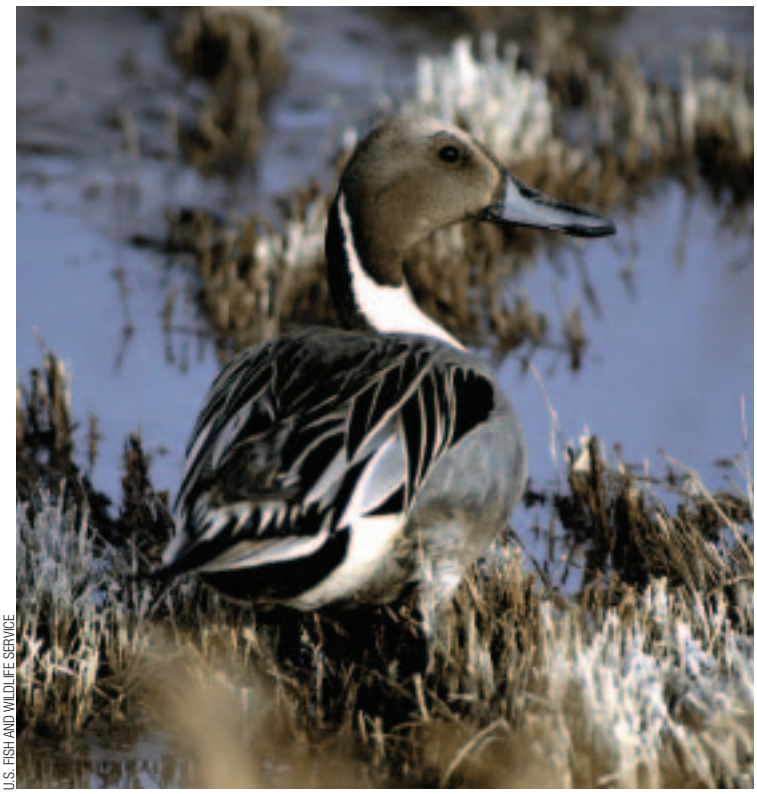
- **CLEAN WATER ACT**—NWF lobbied Congress to create section 404 in the Clean Water Act to protect wetlands, litigated to support its implementation, and defended its scope of protections, including weighing in with the Supreme Court to defend protection for so-called "isolated wetlands," such as prairie potholes, used by migratory birds. NWF is now helping to leading the battle in Congress to restore protection to these important wetlands upon which millions of waterfowl depend for breeding.

- **NON-TOXIC SHOT**—NWF, in conjunction with its affiliated organizations, led the battle to ban the use of lead in shotgun shells for hunting waterfowl. Millions of waterfowl and dozens of bald eagles were dying of lead poisoning from spent lead shot accidentally consumed. Regulations supported by NWF now require toxicity testing of shot used in shotgun shells for waterfowl hunting.
- **FARM PROGRAMS**—NWF was a leader in securing Congressional passage of farm programs such as Swampbuster to discourage wetlands destruction and the Wetlands and Conservation Reserve Programs to provide incentives for wetlands and associated upland habitat conservation. NWF continues to lobby for increased funding of these and other important farm programs that have protected and restored millions of acres of wetlands.
- **PLATTE RIVER**—NWF litigated to protect the Platte River and its wildlife from negative effects of construction of the Grayrocks Dam in Wyoming. In a negotiated settlement, the Platte River Whooping Crane Maintenance Trust of $7.5 million was established. This Trust works to conserve habitat for whooping cranes, sandhill cranes, and other migratory birds, including millions of ducks and geese, in and along the central Platte River.
- **NATIONAL WILDLIFE REFUGE SYSTEM**—NWF has long supported protection and expansion of the National Wildlife Refuge System which harbors some 93 million acres, including extensive wetlands acreage and Waterfowl Production Areas.
- **ARMY CORPS OF ENGINEERS**—NWF has been a leader in the long-term effort to stop Army Corps of Engineers projects harming wetlands, including important waterfowl wintering habitat in the Mississippi River delta and its tributaries, and to reform the entire Corps program.



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Today, confronting global warming is one of the National Wildlife Federation's top priorities because of the serious threat that global warming and associated climate changes could have on North American habitats and wildlife, including wetlands and waterfowl.

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