

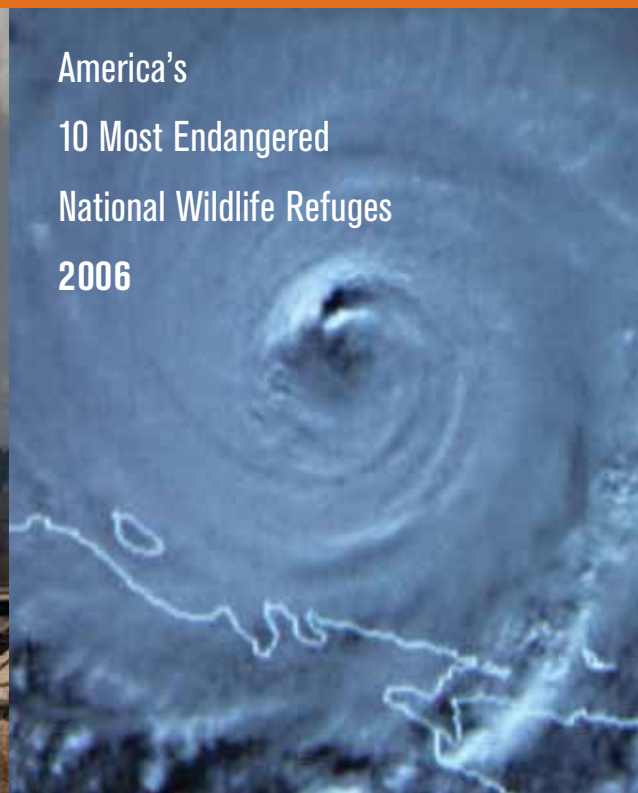


Refuges at Risk

THE THREAT OF GLOBAL WARMING



America's
10 Most Endangered
National Wildlife Refuges
2006





DEFENDERS OF WILDLIFE

Defenders of Wildlife is a national, nonprofit membership organization dedicated to the protection of all native animals and plants in their natural communities.

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“To those who say this problem is too difficult, I say we have accepted and met such challenges in the past.”

—Former Vice President Al Gore, on global warming

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Refuges and Global Warming

Refuge. The term encompasses many different meanings. For the whooping crane, it is a place free from power lines and near protected waters rich with blue crabs. For the grizzly bear, it is a place to forage and hunt without fear of reprisal or poaching. For all wildlife, it means a place of shelter from the struggle of being a wild thing in the modern world. And thanks to a century-long list of visionary people, in 545 quiet places around the country spanning nearly 100 million acres, there is a space that defines refuge for thousands of species of plants, mammals, birds, insects, fish, reptiles and amphibians. These natural havens sustain countless animals and plants and capture the imagination of people worldwide who yearn for a bit of nature's wild perfection.

A conservation concept unparalleled in the world, the National Wildlife Refuge System started by President Theodore Roosevelt in 1903 offers a network of places where the needs of wildlife must come first.

Many species would not survive without these places, yet these important areas are increasingly threatened by forces outside refuge boundaries. Since 2004, Defenders has published *Refuges at Risk* annually to raise public awareness of these forces and the dangers they pose to individual refuges in the system—from the oil exploration proposed for the pristine Arctic National Wildlife Refuge to illegal border traffic on the Cabeza Prieta National Wildlife Refuge in southern Arizona. This year *Refuges at Risk* focuses on the single greatest threat imperiling the National Wildlife Refuge System as a whole: global warming.

Through the ages the Earth has undergone climatic changes, but, for the most part, at a rate apace with wildlife's adaptability. Now changes are occurring rapidly, accelerated by humans (see page 6). These intensifying changes seriously threaten wildlife and habitat—including the network of lands that make up the refuge system. This report highlights 10 of our refuges that face the immediate and dire consequences of global warming.

Alaska's refuges, including the Arctic and the Kenai, are again on the forefront of concern in this year's report. Our northernmost state boasts more than three-quarters of the refuge system's total land, and is one of the first seeing serious alterations due to global warming—from melting glaciers and eroding shorelines to drowning polar bears. In other refuges profiled here, the effects of



warming are expected but uncertain. Hawaiian Islands National Wildlife Refuge faces the grave possibility of massive coral bleaching as sea temperatures continue to rise. Scientists predict a rise in sea level over the next century significant enough to drown refuges such as Chincoteague on the Virginia coast, Alligator River in North Carolina, Merritt Island in Florida and the Texas home of the whooping crane, Aransas National Wildlife Refuge. Anticipated changes in climate and rainfall could alter forest makeup and alpine habitats in Silvio O. Conte National Wildlife Refuge in the Northeast; interrupt seabird-nesting success in the Oregon Islands refuge; and dry the prairie potholes in Devils Lake Wetland Management District, a crucial migratory stopover and nesting ground for waterfowl.

While this report focuses on a handful of refuges, the entire refuge system faces an uncertain future given warming predictions. Action on the human causes of global warming must be swift to stem current change and lessen future effects from this worldwide threat. Along with reducing future greenhouse gas emissions, we must also address the impact of global warming already underway.

There is not a moment to lose if our children, grandchildren and future generations are to continue to enjoy Teddy Roosevelt's legacy.



Polar bear on ice floe | © Rinie Van Muers/Foto Natura/Minden Pictures

THE GLOBAL WARMING THREAT

The issue of global warming can seem overwhelming and complex, but the scientific explanation for the phenomenon is relatively simple.

Earth has a built-in system for temperature control made up of gasses in the planet's atmosphere. When the sun's rays strike and warm the Earth, these gasses operate like a blanket, or a greenhouse, trapping some of the sun's warmth inside, and allowing some of the heat to be released into space. This greenhouse effect warms the Earth enough to make it hospitable for living organisms. Global temperatures have varied naturally over Earth's long history, but in the past 100 years, carbon dioxide (CO₂) and other heat-trapping gasses have accumulated in the atmosphere and caused rapid warming unprecedented in the known geologic record.¹

Human destruction of forests—which absorb CO₂—and our use of fossil fuels such as oil and coal—which release CO₂—have caused this unnatural accumulation of gasses in the atmosphere and the consequential rapid warming trend.² It is as if we have added a second blanket to the one present naturally. As our population grows and we continue to rely on fossil fuels, we add layer after layer. Since the beginning of the Industrial Revolution, average global temperatures have risen by 1 degree Fahrenheit, with the most accelerated warming occurring in the past two decades.³ In fact, nine of the 10 hottest years on record have occurred since 1995.⁴

Increasing concentrations of greenhouse gasses may raise global temperatures 2 to 10 degrees Fahrenheit over the next century, causing changes in rainfall and unpredictable and severe weather patterns, according to the U.S. Environmental Protection Agency.⁵ Scientists expect sea level to rise as polar ice and glaciers melt, and oceans physically expand. Based on varying models of greenhouse gas emissions, government and scientific estimates range from 4 inches to 3 feet of sea level rise over the next century, with a mean estimated level of 20 inches.⁶ If catastrophic melting of the Greenland or West Antarctic ice sheets occurs, sea levels could rise more than 20 feet.⁷

These temperature predictions are tied in part to future fossil fuel consumption. The only good news about global warming is that through personal action and wise government policy (see page 17), we can avoid the most dire predictions.



Freeway traffic | © Corbis



Virginia rail | © Wendy Shattil/Bob Rozinski



Black bears | © Mark Raycroft/Minden Pictures

Alligator River National Wildlife Refuge

Every Wednesday evening in summer, crowds gather at the Alligator River National Wildlife Refuge. They come to hear the howl of the red wolf, an eastern species declared extinct in the wild in 1980 but reintroduced from a captive population beginning in 1987. Once the group settles and is still, a refuge guide howls in a practiced voice good enough to fool most humans and hopefully at least one wolf. More often than not, a red wolf echoes a response, and the haunting wolf song that once was silenced floats again through the trees.

The newly restored red wolf—some 100 now roam free in North Carolina—is one piece of a larger community of wildlife that thrives in the refuge. The Albemarle Peninsula embraces one of the East Coast's largest and healthiest estuaries, part of which flows through the refuge's 150,000-plus acres. In addition to providing substantial habitat for the red wolf, the refuge's bogs, marshes and swamps mark the northernmost end of the American alligator's range and support a rare eastern stronghold of black bears. They are also resting place and home to the endangered red-cockaded woodpecker, peregrine falcon and bald eagle, and to hundreds of other bird species, including songbirds that flit about the vast, unbroken forested swamplands, and rails, herons, tundra swans, pintails and wood ducks that flock to ponds and brackish waters.

The Threat

The low-lying nature of the Alligator River refuge constitutes its greatest vulnerability to global warming. The rise in sea level that scientists expect in the next century would inundate



Red wolves | © Greg Koch/GKphotography.net

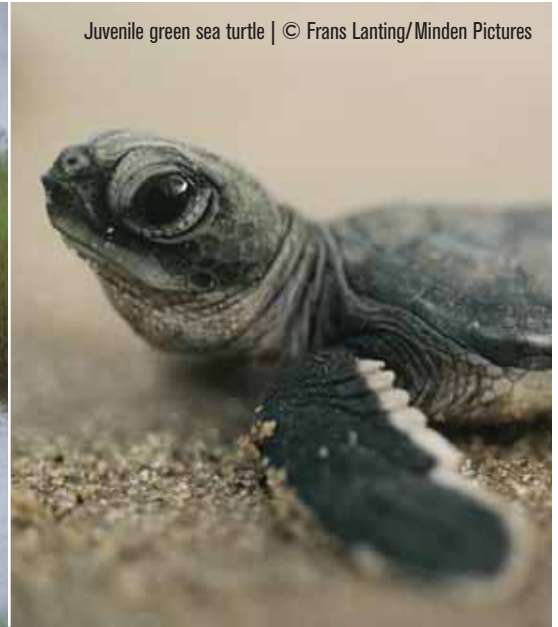
much of the refuge, turning low-lying acreage into open water, forest into marsh, and eliminating precious habitat for the red wolf, the refuge's most charismatic creature. With coastal waters on three sides and development to the west of its current range, the red wolf has limited options for shifting its habitat in response to changing conditions.

The repercussions of a large rise in sea level will be especially harsh for marsh specialists such as rails, birds that are not strong flyers. How habitat and wildlife respond depends on how much and how quickly sea level rises and the ability of species to adapt.

Whooping cranes, Aransas NWR | © Phyllis Greenberg/Animals Animals



Juvenile green sea turtle | © Frans Lanting/Minden Pictures



Aransas National Wildlife Refuge

In late October, they arrive in the marshes, a poetic chaos of oversized white wings and a tangle of gangly legs. Whooping cranes, the largest of the North American cranes, descend on southeastern Texas tired and eager to feast on the blue crabs that populate the waters of Aransas National Wildlife Refuge. Once nearly extinct, these big birds fought their way back from a low of 15 in 1941 to a total of 470 worldwide. Two hundred of these whooping cranes, the only wild, self-sustaining population, winter at Aransas.

While whooping cranes are the most renowned resident of Aransas, the refuge is alive with critters that thrive in its brackish tidal marshes, freshwater ponds, grasslands and oak woodlands. Five sea turtle species, all listed as threatened or endangered, paddle the refuge's waters or nest on its beach. More than 400 species of birds are on record here, including roseate spoonbills, wood storks, cormorants and colorful clouds of migratory songbirds that settle into the forest cover after their long spring migration across the Gulf of Mexico. Beneath them javelinas root in the understory, bobcats prowl and armadillos waddle.

The Threat

The characteristics of the Aransas landscape that make it a haven for the whooping crane, sea turtle and many other species also make it vulnerable to the effects of global warming. The refuge is composed mostly of low-lying coastal land with shallow estuarine marshes that barely rise above sea level. The predicted rise in sea level would flood coastal marshes and other low-lying lands, erode beaches and

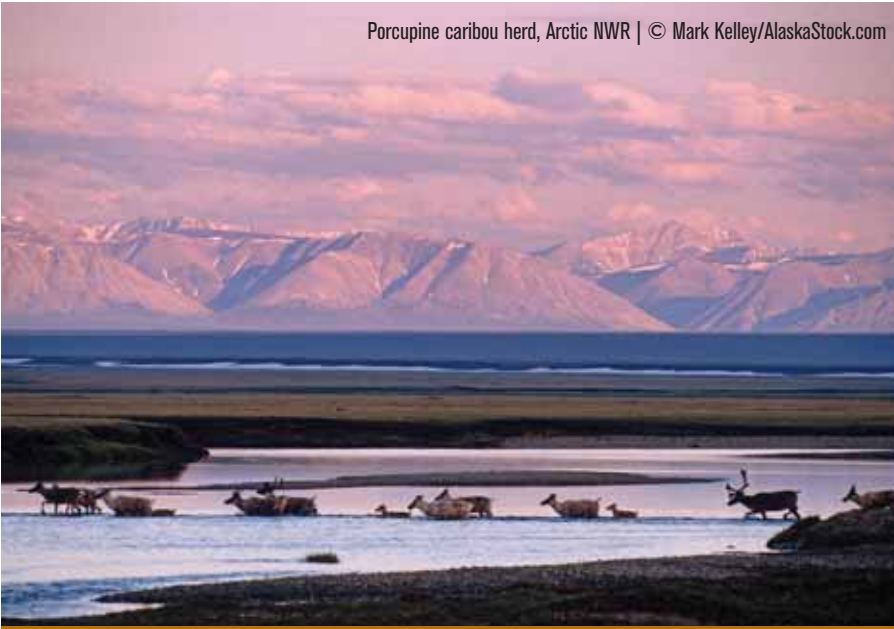
Bobcat | © Peter Weimann/Animals Animals



possibly increase the salinity of rivers and groundwater. The Environmental Protection Agency estimates that nationwide a two-foot rise could eliminate 17 percent to 43 percent of the wetlands in the United States.⁸

For sea turtles, this alteration of coastal nesting habitat may be beyond their already stressed powers of adaptation. Like many other species, they depend on sea temperatures and levels remaining relatively constant. Similarly, the drowning of wetlands, especially if other suitable habitat is not available, could devastate wetland-dependent birds such as the whooping crane.

Whooping cranes need shallow waters. If sea levels rise as expected, most of their current habitat in the refuge would be too deep. Development, including roads, will prevent higher ground from becoming new habitat. Additionally, warming threatens to alter rainfall patterns. Droughts in the crane's nesting grounds in Canada are of particular concern because breeding success is often tied to adequate rainfall. In dry years, whooping crane nests generally fail.



Arctic National Wildlife Refuge

The Arctic is a land of dizzying polarity. In winter, the shortest day sees no sun and lasts for months, settling a cold, contemplative darkness upon the land. When summer comes, a single day lasts almost three months. Over many millennia, the wildlife that thrives in the Arctic has evolved with the rhythm of the sun and seasons.

Animals have adapted to this cold, stark, snowy place. Some, such as the polar bear, arctic fox and ptarmigan, mirror winter's white to blend in, some sleep the season away. Caribou and others in tune with the seasons migrate nearly 1,000 miles south in the winter to the far side of the Brooks Range. In the spring, the caribou herd follows the spreading wildflowers to the coastal plain. There they will find nourishing forage on the tundra and safety from the predators of the foothills farther to the south.

In the isolation of the remote 20-million-acre Arctic refuge, many species have carved a hard-won niche. South of the Brooks Range, which bisects the refuge, the mountains slope into spruce forests where marten, mink and lynx make their homes. To the north of the range, rounded hills covered with thick moss give way to the vast unbroken plain that provides habitat and forage for many arctic species including caribou, musk ox and grizzly. More than 175 bird species nest on the refuge or stop through on their long migration south.

The Threat

Over the past century, the average temperature in the arctic region has increased by 4 to 7 degrees Fahrenheit, well above the global average temperature change. Evidence of the rapid

warming is everywhere. Sea ice is melting earlier, permafrost is thawing and wildlife is migrating.

The polar bear, an animal completely dependent on sea ice, has been the most visible victim of the rapid change in climate. Sea ice is melting an average of three weeks earlier, well before bears have finished their spring hunt for ringed seals, their primary food source. Consequently, the bear's overall health has declined in the past 30 years, and the situation appears to be escalating. Recently there have been incidents of polar bears drowning and turning to cannibalism when stressed by hunger.⁹ Scientists have predicted that if current trends continue and the sea ice disappears for long periods, this grand animal could be extinct by the end of the century.¹⁰

The polar bear is not alone. Arctic creatures great and small are responding to changes in the refuge landscape. Caribou are departing their wintering grounds a month earlier and still having trouble making it to the coastal plain in time for spring, when the most nutritious forage is available for their calves.¹¹ Arctic foxes are facing increased competition from the red foxes moving north as the climate warms.¹² If warming continues unabated, the melting of the permafrost and the transformation of much of the tundra into woodlands would dramatically affect the migratory birds that breed there and rely on tundra vegetation. That includes more than two-thirds of all geese and most sandpipers.

Proposals to drill for oil in the refuge further threaten this pristine place. Drilling would not only directly damage fragile habitat but would also ultimately contribute to the emissions that cause global warming.



Chincoteague National Wildlife Refuge

Dune-grazing wild ponies—descendants of horses that swam ashore from a wrecked Spanish galleon according to one legend—may be its most well-known residents, but Chincoteague National Wildlife Refuge has many other claims to fame. A choice parcel of more than 14,000 acres of beach, dunes, salt marshes, brackish wetlands and maritime forest on the Atlantic Flyway, Chincoteague is one of the top five resting and feeding spots for migratory birds east of the Rockies. Environmentalist and author Rachel Carson, who did research here early in her career, lobbied for the refuge's creation in the early 1940s. Today Chincoteague is also a designated International Shorebird Reserve and part of the United Nations' World Biosphere Preserve network.

Chincoteague is one of the National Wildlife Refuge System's most popular units, with more than 1.5 million visitors a year. Amid the traffic and crowds, more than 300 species of birds, myriad turtles, otters, muskrat, deer and the endangered Delmarva Peninsula fox squirrel go about their business. Bird song fills the air of Chincoteague, accompanied by the pounding of the Atlantic surf, the force that created this shifting barrier island. Black-crowned night herons huddle quietly in reeds at the water's edge, tree swallows dart and weave while filling their tiny bellies with the well-represented mosquito delegation, turtles slowly haul out on the mud flats. Along the soft-sand beach, fences protect key piping plover and least tern habitat from the careless footsteps of people, safekeeping the critical endeavors of wildlife.

The Threat

Like other barrier islands, Assateague Island, the 37-mile-long strip of land on which the Chincoteague refuge sits, is the handiwork of ocean currents reconfiguring and relocating the sand over many years. This island has always been on the move, in slow geologic terms, and has always weathered changes brought about by the whim of the ocean. But changes in sea level and temperature generally occurred over many thousands of years. Now the pace has quickened due to global warming and scientists expect sea level to rise significantly in the next century.

If the rise happens somewhat gradually, some predict the island may narrow, losing some of its habitat for wildlife and impacting the roads, visitor facilities and other infrastructure of this top tourist attraction. However, if change comes too quickly, Chincoteague roads and facilities and the critical habitat that provides for resident wildlife and migrating birds would be overwhelmed.

For white-tailed deer, gray squirrels and other species that can thrive in a variety of habitats and conditions, adaptation comes easily. For animals that require certain niche habitats, any added stressor may be too much. For example, unlike its smaller and readily adaptable cousin, the gray squirrel, the endangered Delmarva Peninsula fox squirrel needs a mature forest with an open understory to survive. Piping plovers and least terns need beach habitat that is not vulnerable to erosion or flooding given sea level predictions. Further loss of habitat for these and other rare species would make their continued survival questionable.



Devils Lake Wetland Management District

Millennia ago glaciers scoured the midriff of North America, leaving behind gently rolling hills and millions of tiny glacial-melt lakes to reflect the endless sky. We know this land as the prairie potholes region, but for more than half the continent's waterfowl population, it is a place they cannot live without.

Mallards, gadwalls, teals, pintails, shovelers, snowgeese, wood ducks, bitterns, bluebirds and herons congregate here in impressive numbers. Some are migrants stopping only long enough to rest and refuel. Others have come to settle for a while with their mates around the nutrient-rich waters of the potholes, waters that nourish the fledgling generation of the majority of the nation's waterfowl, despite covering only 10 percent of the entire breeding area.

Devils Lake Wetland Management District in North Dakota was established to protect this land, vital to the survival of more than 300 bird species, including the threatened piping plover. The district protects about 45,000 acres in 200 important waterfowl areas.

Elk, white-tailed deer and bison also flourish in the Devils Lake district. All three species were reintroduced nearly a century ago in the nearby Sullys Hill refuge established by President Theodore Roosevelt in 1904, when the bison that once roamed the prairies in great thunderous herds were on the edge of extinction.

The Threat

When European settlers came upon the prairie potholes region it was a land brimming with wildlife. Bit by bit agriculture and industry plowed over and filled in more than half of the prairie ecosystem. Since the 1970s, the populations of gadwalls, teals and mallards have been at their lowest historical levels. And even today, although protection of the potholes is increasing, great swaths of grassland—which is as critical to ground-nesting birds as the potholes—continue to be degraded by agricultural development and roads.

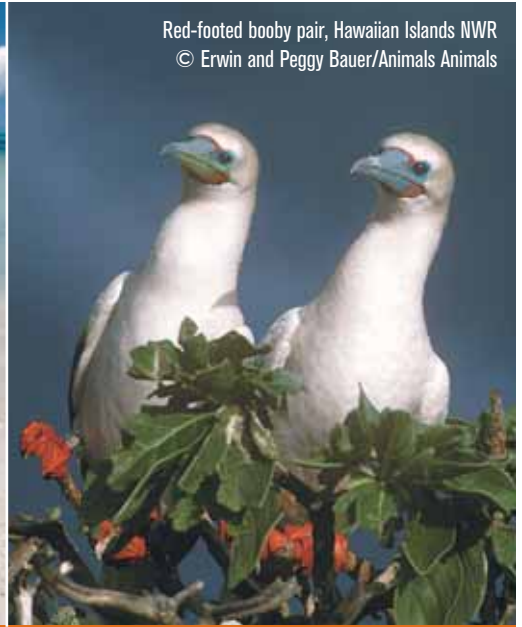
Perhaps the greatest threat to this most important waterfowl nursery is global warming caused by the combustion of fossil fuels. Average temperatures in North Dakota have increased by more than 1 degree Fahrenheit over the past century and may increase 3 to 4 degrees over the next century, according to the U.S. Environmental Protection Agency.¹³

Climate scientists have predicted that warmer climates in the northern prairie wetlands region will increase the frequency and severity of droughts, which could reduce the number of pothole ponds from 1.3 million to 800,000 by the middle of this century,¹⁴ a 38 percent reduction. Moreover, with waterfowl breeding habitat so concentrated in the potholes region, the effects of global warming could cut the number of breeding ducks in half¹⁵ and increase the likelihood of outbreaks of avian flu and other diseases.

Hawaiian monk seal | © Frans Lanting/Minden Pictures



Red-footed booby pair, Hawaiian Islands NWR
© Erwin and Peggy Bauer/Animals Animals



Hawaiian Islands National Wildlife Refuge

The submerged world of coral spreads in a colorful weave of delicate calcified meadows over more than 3 million acres around the northwestern Hawaiian Islands. Parrotfish nibble on the brittle undersea tapestry while green sea turtles coast past fluttering lavender fans. This marine menagerie is home to 7,000 species of coral, algae, mollusks, fish and crustaceans. In this vibrant underwater world, the endangered Hawaiian monk seal fishes for lobster and eel, repairing to sandy beaches to rest and give birth to the next generation of one of the world's most imperiled seals.

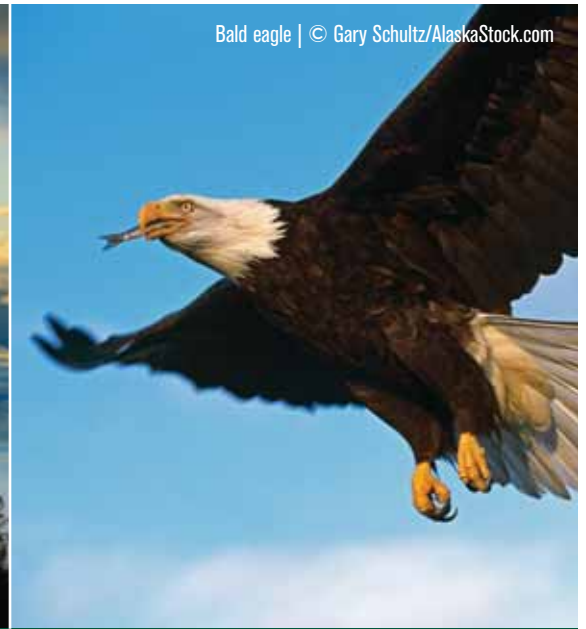
Nihoa, Necker and Laysan are among the islands that make up the 1,700-plus land-acres of the refuge, which also provides breeding and nesting space for endangered leatherback and threatened green sea turtles. Many millions of seabirds such as great and lesser frigatebirds, Laysan albatrosses, shearwaters, boobies and terns breed here, joined by wintering shorebirds, endangered songbirds and waterfowl. In recognition of this amazing biodiversity, President Bush recently declared the vast area of ocean in which the refuge is located a national monument, making it the largest protected patch of ocean on Earth.

The Threat

For monk seals, seabirds and coral the remote nature of their Hawaiian Islands habitat has never fully insulated them from threats of industry and pollution. However, previous threats look small in scale compared to the warmer sea temperatures, shifting currents, sea level rise and sunken habitat projected in future scenarios.

One island is already gone, claimed, researchers believe, by some combination of intense storms and shifting sea currents. Islands are crucial habitat for the monk seal, a marine mammal species reduced to only 1,500 individuals. Predictions of future sea level rise make further loss of habitat likely, another challenge to the seal's ability to reproduce. The situation is similar for the three sea turtle species that breed here, relying on the availability of suitable beach habitat to shelter their nests.

Coral species may be even more vulnerable to global warming because they require consistent ranges in water temperature. Prolonged periods of warmer water can cause bleaching in coral reefs, the loss of colorful algae that live in symbiosis with coral. Stripped of this algae, coral reefs around the world that were once an explosion of vivid colors are turning a pallid gray or ghostly white and are no longer able to survive. Complicating matters is the increasing acidity of the ocean as more CO₂ is pumped into the atmosphere and absorbed, creating carbonic acid and depleting seawater of the calcium carbonate corals need for growth and repair. With "temperature-induced bleaching" cited as one of the reasons, two species of coral in the Caribbean—the staghorn and the elkhorn—were recently added to the endangered species list, the first corals to receive that dubious distinction.¹⁶ Many scientists believe that if the warming trend continues, extinction is likely for many species of coral—along with the undersea communities that depend on them.



Kenai National Wildlife Refuge

Every summer near its confluence with the Russian River, the Kenai River charges in a flurry of milky glacial blue while grizzly bears, bald eagles and humans with fishing poles gear up for a singular and spectacular event in the Kenai National Wildlife Refuge. It is the season when five species of Pacific salmon begin their arduous upstream journey. Using cues from the Earth's magnetic field, their uncanny sense of smell or other unknown mechanisms, these fish navigate to the place of their birth, where they will create the next generation and die soon after.

Around this commotion, other wild inhabitants of this refuge go about the work of survival. Moose forage in the willow bogs and shrub lands of this nearly 2-million-acre refuge originally created for them. The numbers of these giants had declined precipitously in the early part of the 20th century from unregulated and aggressive trophy hunting. To prevent their utter extermination—a fate that befell the caribou on the Kenai Peninsula in 1910—President Franklin D. Roosevelt established the Kenai National Moose Range in 1941. Moose numbers rebounded, as did the reintroduced caribou, and today they reside along with Dall sheep, wolves, wolverines and 170 species of birds (including loons, ptarmigans, goshawks and harlequin ducks) on one of the system's most popular refuges. Kenai is known as “Little Alaska” because it contains nearly every kind of geologic feature and wildlife habitat found in the immense state, from icefields to alpine tundra, rolling hills, meadows, forests and wetlands.

The Threat

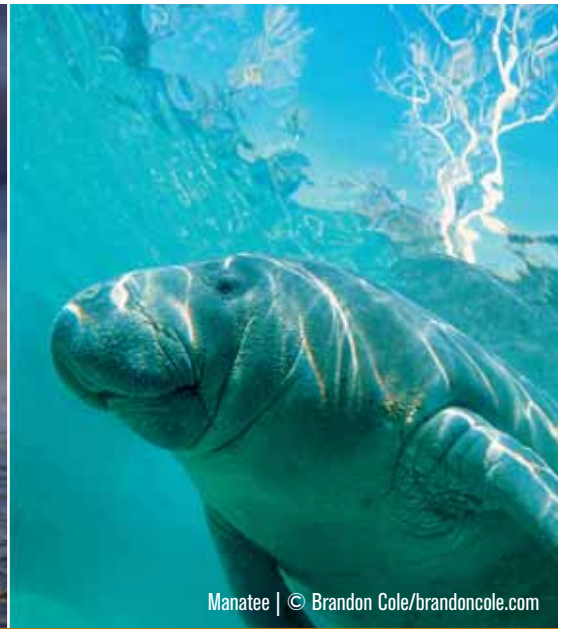
From the air, the Kenai Peninsula displays many scars of rapid warming. Retreating glaciers expose churned-up rocky debris. Frequent forest fires transform the landscape to an ebony char. Insect infestations leave spruce forests toppled in gray defeated heaps. Yellowed rims encircle drying lakebeds.

While the global average temperature has risen 1 degree Fahrenheit, Alaska has warmed by an average of 4 degrees since the 1950s.¹⁷ Even on the ground, the effects of warming are obvious and everywhere. Spruce bark beetles, their life cycles accelerated by rising temperatures, have killed most of the mature white, Lutz and Sitka spruce on the peninsula—half of its forested land, leaving the dry skeletons of these trees to fuel fast and furious forest fires.¹⁸ This major loss of forest cover has markedly changed wildlife habitat, including habitat for fish that require submerged woody debris to survive. In some areas, competition with invasive grasses makes it difficult for forests to come back.

The tree line at higher altitudes has risen about a meter per year over the last 50 years, encroaching on the alpine tundra so critical to Dall sheep and many other animals. Wetlands and ponds are drying up and lake levels are dropping. Black spruce forests are colonizing wetlands, degrading habitat for waterfowl and other wetland-dependent creatures.



Wood stork, Merritt Island NWR | © Yva Momatiuk/John Eastcott/Minden Pictures



Manatee | © Brandon Cole/brandoncole.com

Merritt Island National Wildlife Refuge

An osprey perches in a high branch, clutching a recent catch. A great blue heron hovers motionless over a marshy channel, awaiting movement from its future lunch below. A mockingbird huddles in the brush, occasionally sending out a long-winded call to its mate. All the while the restless land beneath them is slowly shifting. At the capricious whip of water, wind and wave, the compliant sand tumbles, and this barrier island rolls on, at a pace nearly imperceptible to the sentient world.

Sharing the island with the wildlife refuge is Kennedy Space Center, a nexus of humanity's technological ambition. If the juxtaposition seems jarring to the sensibilities of people, it does not seem to have the same effect on wildlife. More than 300 species of birds make use of the refuge, including important populations of southern bald eagles, brown pelicans, wood storks and mottled ducks. Migrating warblers stop over in droves of fluttering yellow and blue, and winter concentrations of waterfowl can exceed 100,000 birds. A long list of rare and endangered wildlife also make their home here. West Indian manatees meander the Mosquito Lagoon in spring. Loggerhead turtles threatened by beach development, pollution and motorized boats safely nest on refuge beaches. And the imperiled Florida scrub jay finds a rare stretch of scrub habitat.

The Threat

As a barrier island and coastal ecosystem, Merritt Island National Wildlife Refuge exists at the pleasure of the sea. Historically the ocean has made gradual and reasonable



Osprey | © Dietmar Nill/Nature Picture Library

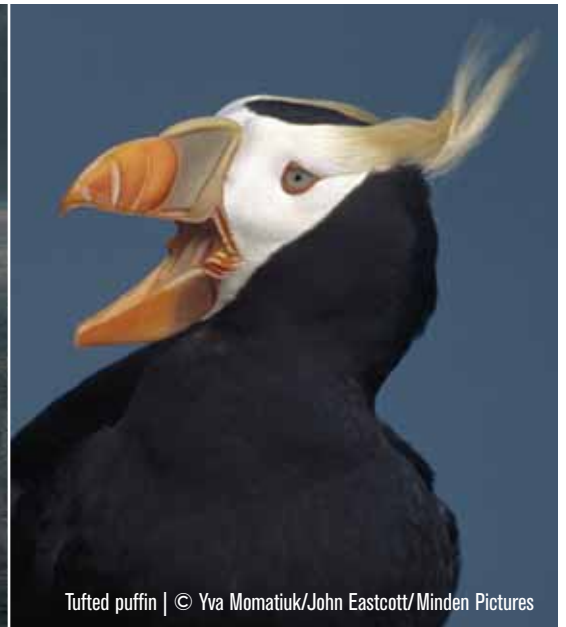
demands on the island's ability to adapt. But if expectations of a rise in sea level in the next century bear out, much of the refuge's marshlands and a portion of the uplands would be inundated. The future of the fragile island ecosystem depends on whether the change happens relatively quickly or gradually over a long period, and on the ability of the marsh to keep up.

Unfortunately, for Merritt Island wildlife the potentially enormous loss of habitat is not the only threat from global warming. Researchers believe higher water temperatures in Gulf Coast areas are behind the increase in toxic algal blooms such as the red tide that killed more than 150 manatees in 1996. If sea temperatures continue to escalate, Atlantic coastal sea life, including Merritt Island's, could suffer a similar fate.

Biologists have also linked rising air temperatures to the greater incidence of female hatchlings observed in loggerhead turtle populations in recent years, a dangerous reproductive trend for the threatened turtle.¹⁹



Bandon Beach, Oregon Islands NWR | © Terry Donnelly



Tufted puffin | © Yva Momatiuk/John Eastcott/Minden Pictures

Oregon Islands National Wildlife Refuge

At the mouth of the Coquille River, where sunset spreads in mercurial pastels across the Pacific Ocean to the Oregon coastline, the sentinel sea stacks of Oregon Islands National Wildlife Refuge keep watch. Tufted puffins bobble at their feet, Leach's storm-petrels soar at their ragged peaks, brilliant orange and maroon sea stars cling to their underbellies, and common murrelets nestle into their ragged wave-worn slopes. More than 1,800 rocks, reefs and islands with names such as Haystack Rock and Face Rock form the personality of the famed Oregon coast and the entirety of the refuge's habitat. These islands scattered along the coast provide a sanctuary of nesting grounds for 13 species of seabirds including rhinoceros auklets, cormorants, storm-petrels and puffins. About 700,000 common murrelets nest here, nearly two-thirds of the total nesting population south of Alaska.

On the protected islands, the threatened Steller sea lion congregates to give birth in the safety of refuge confines. An estimated 800 Steller pups are born here each year, more than any other site south of Alaska. They share these rocky islands with thousands of harbor seals and California sea lions and a small population of northern elephant seals.

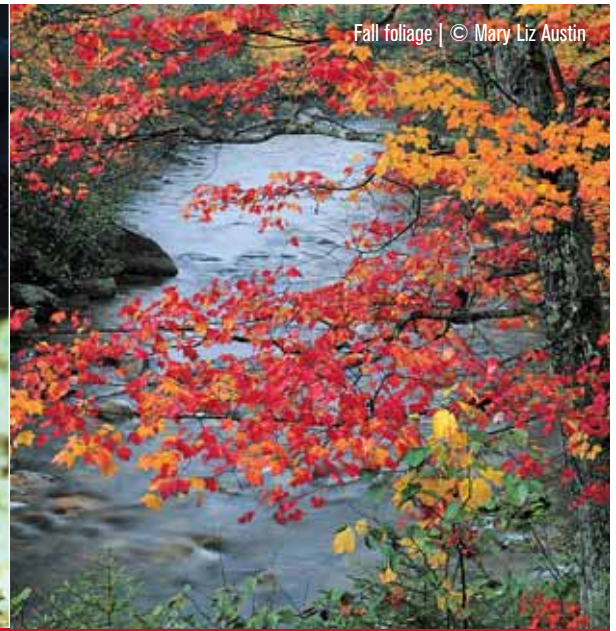
The Threat

From shore you can see them amassing at the nearby islands, jostling, debating, diving. An estimated 1.2 million seabirds nest on the Oregon Islands, more than on the Washington and California coasts combined. The rocky islands on which these birds breed and rest are protected from disturbance

and human footfall, but the global human footprint may be catching up with them. Last year a radically different weather pattern during the breeding season resulted in the largest ever die-off of the common murre, the refuge's most populous seabird resident.

The health of the murre and indeed an entire community of species along the coast can hinge on the tiniest of creatures. In this case, the minute but crucial player is oceanic phytoplankton. Populations of these microscopic plants boom when a seasonal upwelling thrusts colder, deeper waters toward the surface in a narrow band along the coastline. And everything from the tiny shrimp-like krill to the largest living creature—the blue whale—fattens with the resulting food-chain of events.

But the complex dance of wind and ocean currents that results in upwelling has been inconsistent in the past 10 years, a trend that some researchers have tied to global warming.²⁰ If so, the suppression of upwellings may be a long-term trend, and seabirds would not be the only victims. The refuge's population of seals and sea lions and an array of other marine species also depend on the food chain that begins with phytoplankton made plentiful by the vital infusion of cold, nutrient-rich waters from the deep.



Silvio O. Conte National Wildlife Refuge

In the mountains of northern New Hampshire, the Connecticut River begins its winding trek to Long Island Sound, carving its determined way through forested mountains and lush lowlands, feeding marsh, bog and wetland as it travels. Over the past few centuries the river has also increasingly encountered industry, dams and pollution.

By the mid-20th century, the Connecticut was so degraded some called it “the nation’s best-landscaped sewer.” Species that once thrived on the banks or in the flow of the river were gone, others were going. In 1972, the Clean Water Act set the Connecticut on a path to recovery. In 1991, the U.S. Fish and Wildlife Service committed to helping to restore the watershed by establishing Silvio O. Conte National Wildlife Refuge, 7.2 million acres spanning four populous Northeast states.

Today the refuge supports many rare and endangered species, including the shortnose sturgeon, bald eagle, American black duck, seaside sparrow, cerulean warbler, black rail and New England cottontail rabbit. Of the land acquired by the Conte refuge, one of the largest and most unusual parcels is Nulhegan Basin in Vermont, 26,000 acres of bogs and freshwater wetlands, spruce-fir forest and northern hardwood forest. The cold micro-climate and peat soils are more typical of ecosystems 200 miles north, and the remote landscape is home to moose, black bears, loons, hooded mergansers, wood ducks and spruce grouse.

The Threat

The Connecticut River flows through the heart of New England, known the world over for that moment in autumn when hardwood forests of sugar maple, red maple and birch blaze bright. Projected rises in global temperatures of 2 to 10 degrees Fahrenheit may change the very nature of the Conte refuge and the New England countryside. According to the U.S. Environmental Protection Agency, tree species are likely to shift north by about 200 miles. Some wildlife species may be able to adapt or migrate with the forest habitat, some will not. Alpine species such as Bicknell’s thrush may be the first affected because they depend so heavily on cooler habitats. Aquatic animals will also feel the heat, particularly the imperiled shortnose sturgeon, an estuarine dweller that swims upstream to spawn in cold, fresh waters.

Once plentiful in eastern coastal rivers, the shortnose sturgeon is now found in just 16 of them, thanks to overfishing, dredging, water pollution and the dams that impede its upstream migration. Although the Connecticut River population of this slow-to-reproduce bottom feeder is currently stable, a changing seasonal stream flow pattern linked to early melting of the mountain snowpack that feeds the river could change that. Earlier snow melt means that by late summer, stream flows are significantly reduced and dissolved oxygen levels are low, a condition to which juvenile sturgeon new to life in the river are especially susceptible.

Tackling the Global Warming Threat

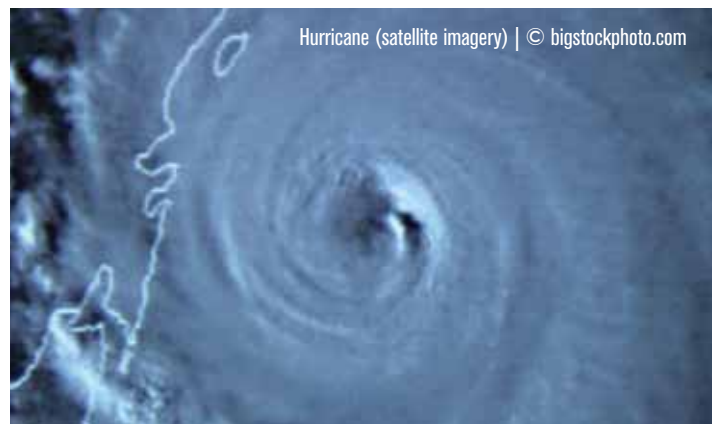
Among the many challenges facing America's wildlife refuges, none looms as large as a changing climate. Rising sea levels, drying wetlands, bleaching corals and many other changes caused by warming temperatures threaten the very fabric of the refuge system. Reducing the impacts of global warming on national wildlife refuges and all wild lands and natural systems requires a two-pronged approach: reducing greenhouse gas emissions and planning for a changing future.

Reducing emissions

Eighty-five percent of energy in the United States comes from the burning of coal, oil and natural gas. Emissions from these fossil fuels account for 25 percent of the world's CO₂ emissions. In addition to contributing to global warming, these energy sources cause other serious environmental and health problems.

Fortunately, many renewable-energy and energy-efficiency technologies are already available to wean the United States and

other countries off polluting fossil fuels. Moreover, with the proper call to action and government policies, we can develop new energy and transportation technologies that reduce the need to burn fossil fuels, creating thousands of high-paying jobs and placing the United States at the forefront of this fast-growing industry.



To pave the way, Congress must make bold investments in a new energy economy by shifting energy subsidies from coal, oil, and gas to renewable energy and energy-efficiency technology. The Energy Policy Act passed by Congress in 2005 handed billions of dollars to the fossil fuel industry, a sum that could have stimulated tremendous growth and development of clean energy products and markets. In addition to incentives for new energy technologies, Congress must also set new standards for greenhouse gas pollution from the two largest sources: power plants and vehicles. Significantly increasing the fuel economy of U.S. vehicles, for example, would be one of the most effective emissions-reducing steps the federal government could take.

The U.S. Fish and Wildlife Service, the agency that administers the National Wildlife Refuge System, must be true to its wildlife conservation mission and take immediate steps to reduce greenhouse gas concentrations and mitigate the effects of global warming. For example, the agency should consider expanding its partnerships with businesses seeking credits for carbon sequestration. Carbon sequestration projects that protect forests prevent the emissions of carbon dioxide caused by land conversion and those that restore forests remove some carbon dioxide from the atmosphere. For example, in the Southeast, the Fish and Wildlife Service is already working with businesses to acquire and restore bottomland hardwood forests for the benefit of wildlife.

Although the actual mechanisms for trading and accounting for carbon credits are still being developed, these partnerships have been successful in protecting and restoring forested habitat rich in biodiversity and important for water purification and flood control. These benefits, however, are at risk if ultimately global warming emissions from the burning of fossil fuels are not reduced.

In addition, refuge operations must conserve energy and reduce greenhouse gas pollution. Energy efficiency should guide agency policies and the procurement process for everything from replacing aging infrastructure to building new facilities to acquiring vehicles.

Planning for the future

Although strong and effective action to reduce greenhouse gas emissions is critical to minimize the potential impacts of global warming, the amount of CO₂ and other greenhouse gases spewed into the atmosphere over the past 100 years makes some degree of climate change inevitable. National wildlife refuges must develop strategies to protect wildlife populations and the ecosystems on which they depend from these changes to the fullest extent possible.

Perhaps the single-most important step the Fish and Wildlife Service can take is to begin considering the implications of global warming in its long-range planning, particularly the

WHAT EACH OF US CAN DO

Individual Actions Add Up



Compact fluorescent bulb
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USE COMPACT-FLUORESCENT BULBS. Replacing bulbs in frequently used lights with energy-efficient compact fluorescent reduces electricity demand and CO₂ emissions and lowers electricity bills. Replacing a regular light bulb with a compact fluorescent can cut yearly CO₂ emissions by 150 pounds.

SWITCH TO GREEN POWER FOR ELECTRICITY. Today, about 75 million people in 42 states have the opportunity to buy electricity from suppliers of alternative energy sources such as wind, solar and methane captured from landfills.

BUY ENERGY-EFFICIENT APPLIANCES. All major appliances come with energy-efficiency ratings. Energy-efficient appliances may cost more, but quickly pay for themselves, especially at today's high energy prices. Many energy-efficient choices are also now covered by state and federal sales and income tax incentives.

comprehensive conservation planning each refuge is required to do. The dramatic ecological changes already observed in response to global warming call for a new kind of conservation planning that carefully considers the effects of specific warming-related impacts such as rising sea levels, habitat shifts and the increasing intensity of hurricanes. For example:

- **Rising sea levels:** More than 160 refuges sit in coastal areas sensitive to increasing sea levels. As documented in this report, low-lying refuges are extremely important to wildlife conservation. In many areas, the natural processes that normally allow marshes and other habitats to adapt to changing sea levels are already constrained by human development or simply will not be able to keep up with the speed at which sea levels are rising. The Fish and Wildlife Service must begin planning to determine the feasibility of restoring and enhancing natural adaptive processes, to acquire land at higher ground and further inland to allow coastal systems to migrate, and to develop infrastructure to protect these areas. In particular, the agency must consider future sea-level rises before investing in new parcels of low-lying marsh.
- **Habitat shifts:** Plant species are moving to more northerly latitudes and higher altitudes, especially in Alaska and alpine areas. As the climate continues to warm, the habitat a refuge was

set aside to protect may shift outside of the refuge. Species will also migrate, each one shifting differently, creating new habitat mosaics and challenging the refuge to maintain the species for which it is responsible. The Fish and Wildlife Service must start planning now to cope with these changes on and off the refuges.

- **Hurricanes:** The devastating hurricane season of 2005 destroyed habitat and facilities on more than 60 national wildlife refuges—damage it will take more than \$260 million to repair. The Fish and Wildlife Service must do more than simply rebuild after each hurricane. The agency should form a task force, including experts outside the agency, to plan how to best manage refuges in hurricane-prone areas and how to minimize storm damage and allow habitats to withstand and recover from storms.

Besides incorporating these types of changes into comprehensive conservation planning for refuges, the Fish and Wildlife Service, as part of its wildlife education and interpretation responsibilities, should include information about global warming and its effects on wildlife in refuge interpretive programs and educational materials.

Taken alone the recommendations outlined above will not reverse global warming. That will require multigenerational, multinational commitment and leadership. But they will head us in the right direction—for our refuges, our wildlife, our children and our planet.



Solar power | © Corbis

CHOOSE A FUEL-EFFICIENT VEHICLE. U.S. cars and light trucks consume 10 percent of the world's oil and are some of the leading contributors of greenhouse gas pollution. Every gallon of gasoline saved keeps 20 pounds of CO₂ out of the atmosphere.

DEMAND BETTER FUEL ECONOMY STANDARDS. If all U.S. vehicles averaged 40 miles per gallon, emissions would drop by 600 million tons a year.

BUY SUSTAINABLY PRODUCED GOODS. Choosing certified wood produced in responsibly managed forests protects wildlife and leaves trees and less disturbed soils behind to store carbon. Purchasing locally grown organic food cuts down on the energy invested in cultivation and transportation.



Bike commuter | © Corbis

TAKE PUBLIC TRANSPORTATION OR RIDE A BIKE. Leaving the car home even two days a week can reduce your impact on the climate by 1,590 pounds of CO₂ a year.

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