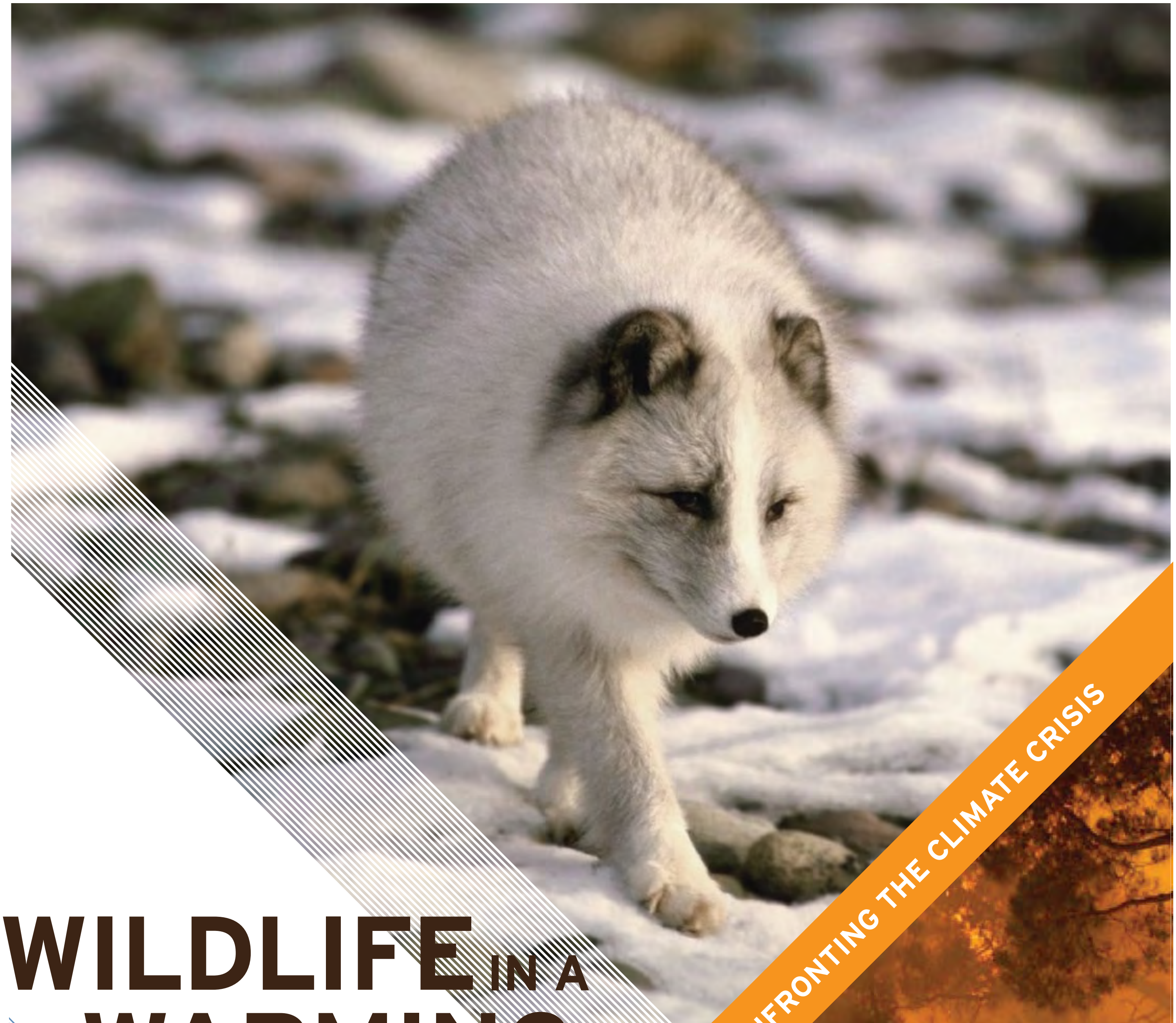
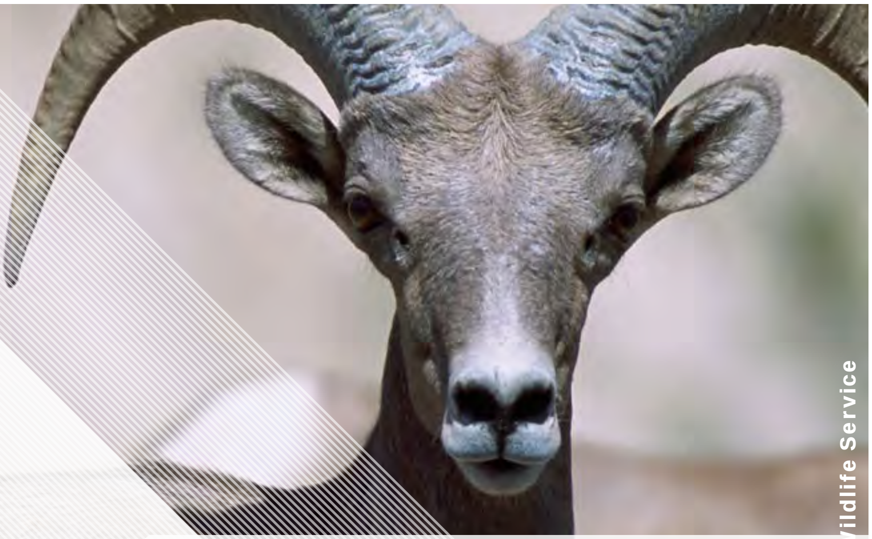


WILDLIFE IN A WARMING WORLD

CONFRONTING THE CLIMATE CRISIS

NATIONAL WILDLIFE FEDERATION®



Ryan Hagerty, U.S. Fish and Wildlife Service

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U.S. Forest Service

EXECUTIVE SUMMARY

Our nation's plants, fish, and wildlife are already facing a climate crisis.

Pine trees in the Rocky Mountains are being jeopardized by beetle infestations, while new forests are encroaching on the Alaskan tundra. East coast beaches and marshes are succumbing to rising seas, especially in places where development prevents their natural migration landward. Polar bears, seals, and walrus are struggling to survive in a world of dwindling sea ice, which is their required habitat. Birds and butterflies have had to shift their breeding season and the timing of their seasonal migrations. Fish are dying by the thousands during intense and lengthy droughts and heat waves. Many plant and wildlife species are shifting their entire ranges to colder locales, in many cases two- to three-times faster than scientists anticipated.

Now is the time to confront the causes of climate change.

Without significant new steps to reduce carbon pollution, our planet will warm by 7 to 11 degrees Fahrenheit by the end of the century, with devastating consequences for wildlife. America must be a leader in taking swift, significant action to reduce pollution and restore the ability of farms, forests, and other natural lands to absorb and store carbon. This means rapidly deploying clean, renewable energy sources, such as wind, solar, geothermal and sustainable bioenergy, while curbing the use of dirty energy reserves. And it means reducing the carbon pollution from smokestacks that is driving the climate change harming wildlife.

Wildlife conservation requires preparing for and managing climate change impacts.

Because of the warming already underway and the time it will take to transform our energy systems, we will be unable to avoid many of the impacts of climate change. Our approaches to wildlife conservation and natural resource management need to account for the new challenges posed by climate change. We must embrace forward-looking goals, take steps to make our ecosystems more resilient, and ensure that species are able to shift ranges in response to changing conditions. At the same time, we need to protect our communities from climate-fueled weather extremes by making smarter development investments, especially those that employ the natural benefits of resilient ecosystems.

Only by confronting the climate crisis can we sustain our conservation legacy.

The challenges that climate change poses for wildlife and people are daunting. Fortunately, we know what's causing these changes and we know what needs to be done to chart a better course for the future. As we begin to see whole ecosystems transform before our very eyes, it is clear that we have no time to waste.

A NEW PLAYING FIELD: HOW CLIMATE CHANGE AFFECTS NATURE

Climate change is the biggest threat wildlife will face this century. Wildlife species are already contending with numerous threats, such as major habitat losses, overharvesting of fish and timber, pollution, and invasive species. However, climate change has the potential to alter the playing field itself, leading to significant shifts in the species and habitats that we know today. The underlying climatic conditions to which species have been accustomed for thousands of years are rapidly changing, and we are already witnessing the impacts.

Species and Habitats Are Shifting Location

Climate change is already causing many species to shift to new locations, often at faster rates than scientists previously expected.[1] As temperatures have increased, land-based plants and animals have been moving further north and to higher elevations. For example, 177 of 305 species of birds tracked in North America have expanded their range northward by 35 miles on average during the past four decades.[2] Fourteen species of small mammals in the Sierra Nevada region extended their ranges up in elevation by about 1,640 feet during the past century.[3] Other terrestrial species have been shifting their ranges in response to changes in water availability, rather than temperature.[4] And marine species appear to be shifting ranges even faster.[5]

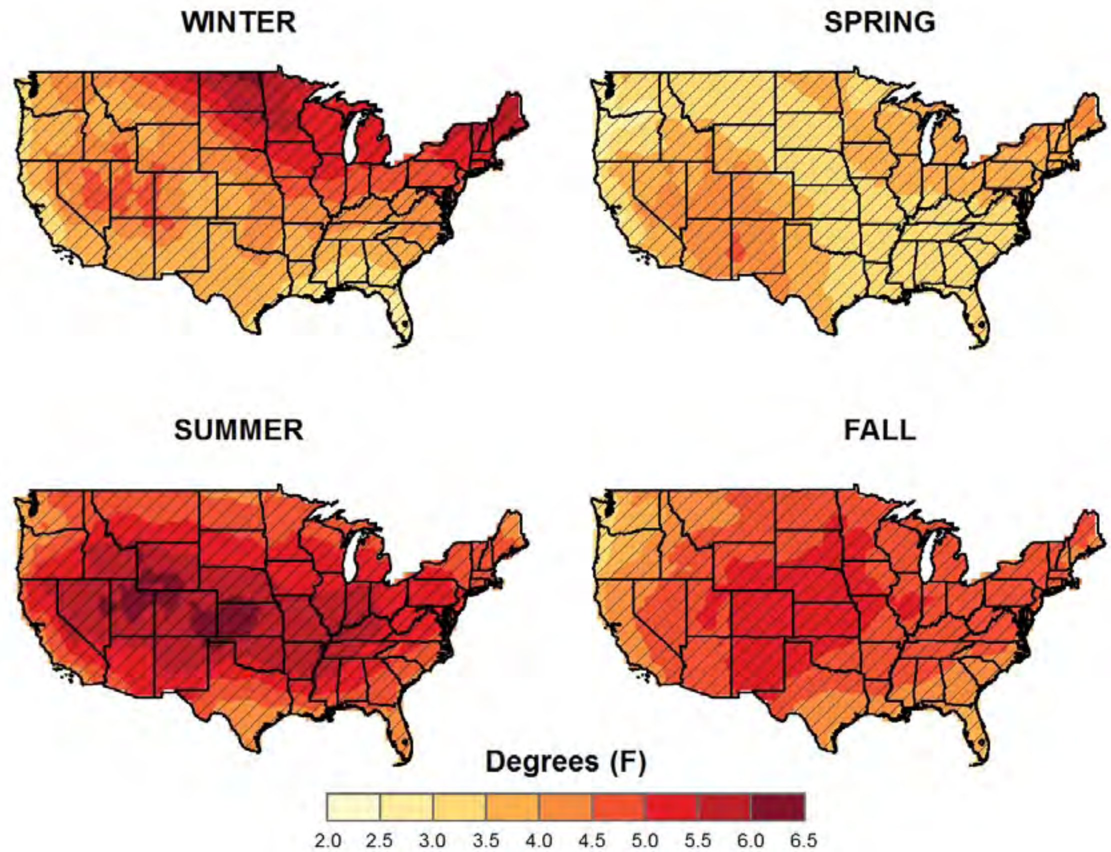
Not only are individual species relocating, but in some instances major ecological communities are shifting. Forests are moving northward into the Alaskan tundra[6] and upward into the alpine tundra of the Sierra Nevada in California.[7] Broadleaf forests are edging out conifers in Vermont's Green Mountains.[8] In other places, new climate conditions have favored colonization by a new suite of species after wildfires or storms.[9]

Climate change is the primary driving force of these transitions, which are occurring much faster than they did just a century ago. In parts of Alaska, California, the Midwest, and the Southwest, climate factors associated with species' ranges moved by an average of 12 miles per year since 1990,[10] much more than the average 20th century range shift of about 0.4 miles per year observed for terrestrial plants and animals in North America.[11] Continued climate change this century is projected to cause biome shifts for about 5 to 20 percent of North America.[12]

Missed Connections and New Species Interactions

As climate change alters the playing field, plants, fish, and wildlife face new situations, with sometimes surprising outcomes. Individual species respond differently to changes in the timing of seasons or the frequency of extremes, which can create mismatches between animals and their food sources. At the same time, the ranges of some species are shifting at different rates, creating interactions among species that previously did not coexist. All these shifts will create winners and losers, but ecologists expect that climate change will bring an overall decline in biodiversity.[13]

The earlier arrival of spring has many consequences for nature. For example, as springs in Alaska have become warmer, plants are emerging earlier. As a result, food sources are more limited at the times when caribou are breeding and caribou reproduction has suffered.[14] In Lake Washington near Seattle, warming has caused algal blooms to occur as much as 27 days earlier. However, the tiny water fleas that consume the algae have not responded to warming in the same way, and popula-



If carbon pollution emissions continue to increase rapidly, all areas of the United States will warm, with the biggest effect in the middle of the country during summer. These maps show the average temperature increases simulated by climate models for 2041-2070 compared to 1971-2000. The warming will mean fewer extremely cold days and more extremely hot days. Source: NOAA NESDIS (2013): Regional Climate Trends and Scenarios for the U.S. National Climate Assessment.

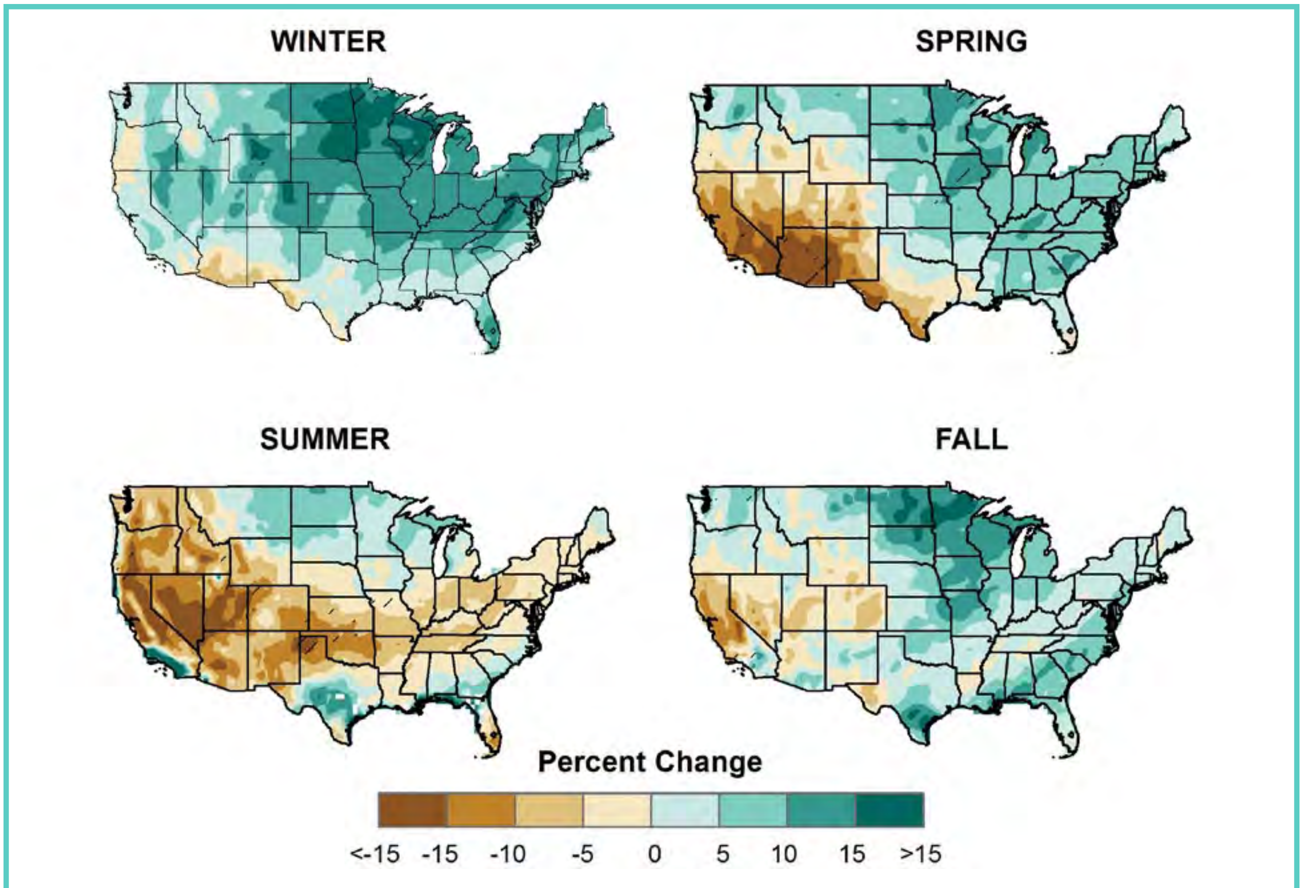
tions have declined due to limited food being available when they need it.[15] In some cases, the earlier spring can help certain wildlife species, as is the case for the yellow-bellied marmot in Colorado. Warmer springs have enabled these animals to emerge from hibernation and give birth earlier, allowing more time for the offspring to grow before hibernating, ultimately leading to increases in the marmot population.[16]

Shifting ranges for pests and disease-causing pathogens may have some of the most devastating impacts for wildlife and habitats. For example, warming ocean waters have enabled the outbreak of microbial disease in reef-building corals[17] and pathogens of the eastern oyster.[18] Mountain pine beetle outbreaks decimated trees on more than 26.8 million acres in western North America from 1997-2010.[19]

Species Are Being Pushed Toward Extinction

Unfortunately, some species have nowhere to go. For example, species found at high elevations or near the poles are already living at the edge of their climate tolerance, and thus are particularly vulnerable to increasing temperature. Other species may have no easy way to move to a more suitable location, perhaps because of natural geography or human-caused barriers, like cities, large agricultural areas, highways or dams.

Already there is evidence that climate change is causing declines in species populations and localized extinctions.[20] For example, local extinctions of desert bighorn sheep populations in California are strongly correlated with climate conditions, especially declines in



While climate change is expected to bring more precipitation on average to the northern and eastern parts of the nation, areas in the southwest are likely to get less precipitation, especially in spring and summer. These maps show the average change in precipitation projected for 2041-2070 compared to 1971-2000 if carbon pollution emissions continue to increase rapidly. Source: NOAA NESDIS (2013).

precipitation that reduce food availability.[21] Four species of amphibians in Yellowstone have experienced significant population declines due to pond drying.[22] The extinction of two populations of checkerspot butterfly, native to grasslands in the San Francisco Bay area, was hastened by increasing variability in precipitation.[23]

Overall, climate change is expected to cause widespread losses in global biodiversity.[24] Exactly how many species go extinct will depend on how much the planet warms during the coming decades, with much higher extinction rates projected for higher temperature increases.[25]

Changes in Winter Driving Year-Round Impacts

Even small changes in winter temperature or precipitation can have marked impacts on ecosystems. Most notably, pests and the pathogens that cause diseases are increasingly able to survive and thrive during the winter, which allows their populations to explode. Longer growing seasons and warmer winters are enhancing bark beetle outbreaks,[26] increasing tree mortality and the likelihood of intense and extensive fires.[27]

Declining snow cover is leaving soils without their normal insulation, leading to colder and more frozen soils. This has been shown to lead to increased root mortality, decreased decomposition, and significant losses of nutrients to runoff.[28] A question remains about how much warming of the atmosphere and reduced reflection of sunlight (due to less snow) might counteract these effects.[29]

Dwindling snowpack accumulation in mountain areas is creating greater risks of winter and springtime floods,

Lacking sea ice, walrus are forced to rest on beaches.

U.S. Fish and Wildlife Service

and depriving downstream areas of valuable snowmelt runoff during the summer and fall. These shifts in the seasonal cycle of stream flow present significant challenges for managing water supply for human consumption and agriculture, in addition to the stresses they put on fish and wildlife. For example, in California's Central Valley, strong winter floods can wash away the gravel beds used by salmon, trout, and steelhead for laying their eggs. Low summer flows when juveniles are growing and traveling downstream are associated with poor survival and return rates.[30] Furthermore, their development, migration timing, and navigation can be disrupted by changes in water flow.[31]

More Severe Droughts and Heavy Rainfall Events Are Stressing Wildlife

Extreme conditions are likely to have some of the biggest impacts on wildlife in the coming decades simply because floods, droughts, frosts, and winter thaws are the sorts of events that exceed normal tolerance levels, directly killing organisms or altering their competitive balance. At the same time, changes in disturbance regimes—often driven by floods, wildfires, and hurricanes—can strongly influence ecosystem functioning. For example, invasive species can take hold when extreme events degrade native habitats.[32] Ecosystems are adapted to historical patterns of disturbances, but changing the climate conditions will drive longer, more frequent and more severe disturbances, with expected major ripple effects on ecosystems.

Many streams and rivers in the Midwest, New England, Mid-Atlantic and south-central United States have experienced increases in stream flow since the 1990s, while some in the Northwest, Southwest, and Southeast have decreased. Changes in precipitation are the most important driver of these changes.[33] One major consequence of increases in heavy precipitation events is the excessive runoff of nutrients from agricultural lands and terrestrial ecosystems, exacerbating harmful algae blooms and dead zones in lakes and rivers. Terrestrial systems in the Northeast,[34] California,[35] and along the Mississippi River[36] have already experienced increased nutrient losses associated with increasing precipitation. Likewise, extreme precipitation events can transport large amounts of sediment downstream, significantly modifying riverbeds and coastal wetlands.[37]

Intensification of the hydrologic cycle is also linked to changes in the width, depth, and velocity of water in streams, as well as the seasonal and year-to-year patterns of high and low stream flow. These changes are altering food-webs and species composition in United States streams and rivers.[38] For example, after a period of extremely low flow in an Arizona desert stream, some small invertebrate species were completely lost while others became more abundant.[39]

What It All Means for Conservation

As the climate continues to change, plants, wildlife, and fish will attempt to do what they normally would under conditions that are far from normal. Whereas human populations can anticipate events and take steps to shield themselves from the impacts, wildlife cannot plan ahead for climate change. This makes our efforts to safeguard wildlife both crucial and much more challenging. We must reduce carbon pollution to limit the extent of impacts, and we must revise and intensify our conservation practices to minimize and avoid climate impacts when possible, and manage climate impacts when unavoidable.

In this report, we examine the challenges faced by wildlife in eight regions spanning the United States. From unprecedented pest outbreaks and catastrophic wildfires in Western pine forests to rapid loss of the sea ice that polar bears, walrus, and seals need to reach their food sources, nature is contending with new challenges.

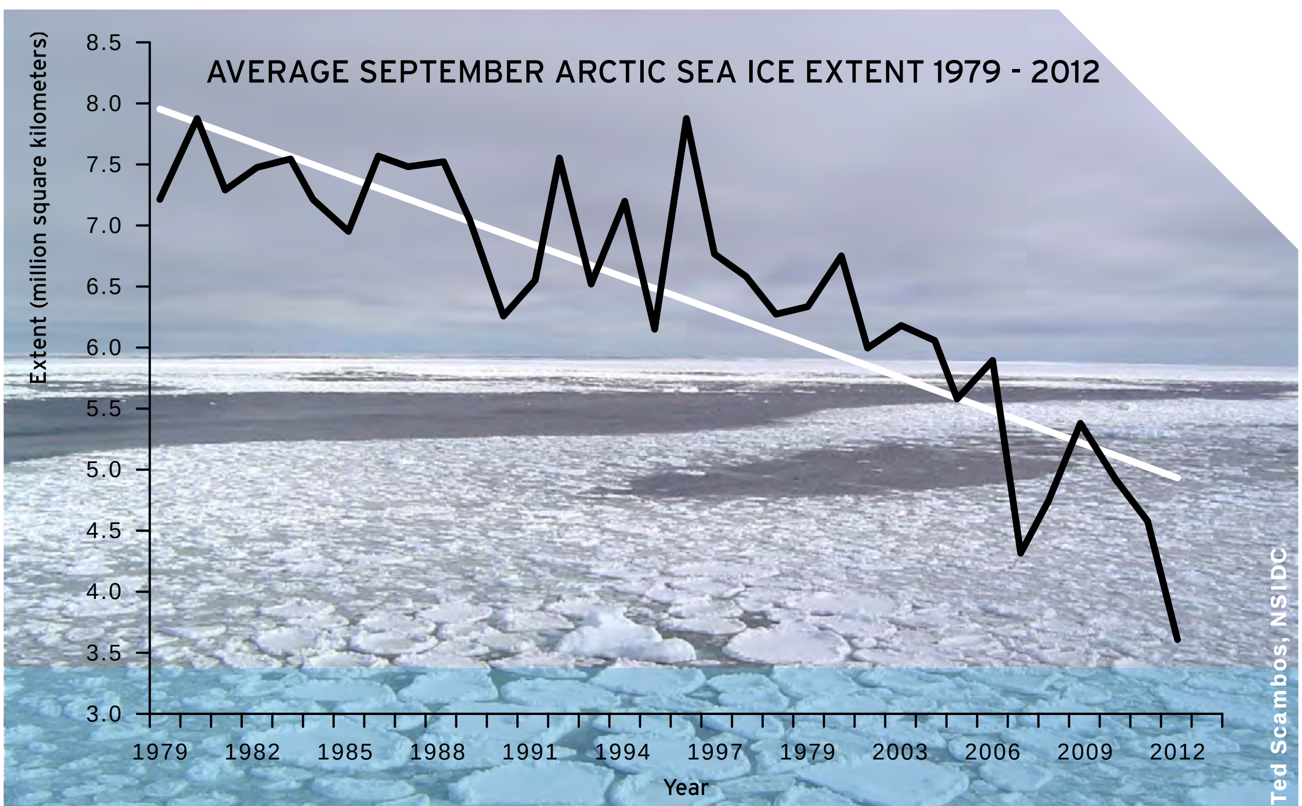
THE ARCTIC:
WILDLIFE FACING RAPID CHANGES

The climate is changing especially fast in the Arctic, and its species and ecosystems are scrambling to keep up. As predicted by climate models, Alaska has warmed about twice as much as the contiguous United States.[40] With so much of the Arctic landscape dominated by snow and ice, this warming is having a big effect on the landscape and seascape. More temperate habitats are encroaching northward, while uniquely polar habitats—like the sea ice that polar bears, seals, and walrus require to hunt—are shrinking fast.

Melting Sea Ice Means Lost Habitat

Perhaps the most dramatic indicator of the changing climate is the dwindling extent of Arctic sea ice, especially when sea ice reaches its annual minimum in September. In 2012, Arctic sea ice reached the smallest extent observed since satellite measurements began in 1979. The extent of sea ice observed in 2012 was 49 percent smaller than the average observed in the 1980s and 1990s.[41] This decline happened much faster than scientists anticipated.[42]

Not only is the sea-ice area much reduced, but its thickness and age have also markedly declined. The amount of sea ice that is at least 5 years old is only a fraction of what it was in the 1980s and 1990s.[43] The problem with this is that polar bears rely upon older, thicker nearshore ice as a platform for hunting seals. [44] Without it,



Arctic sea ice extent has been rapidly declining during the last three decades, reaching an all-time low in September 2012. Source: National Snow and Ice Data Center.

polar bears must resort to offshore sea ice. But, the increasing distance between land and the offshore sea ice creates a perilously long swim—some as long as 12 excruciating days—that can result in drowning of both adults and their cubs. Scientists are projecting that the Arctic Ocean will have late-summer stretches where it is ice free by the middle of the century, if not sooner.[45]

This sea-ice loss is having profound impacts on the ecosystems it supports, from the sea-ice algae at the base of the food chain to top-level predators such as polar bears, walrus, and seals. As the extent of sea ice has declined, most markedly in the southern portions of their range, so has polar bear body size, reproductive success, and survival of cubs.[46] The same pattern is beginning to be seen in more northern populations. Polar bears have more frequently been denning on land due to the lack of old, stable ice.[47] The grave threats posed by climate change to the critical ice habitat of polar bears led the U.S. Fish and Wildlife Service to designate the polar bear as a threatened species under the Endangered Species Act in 2008.[48]

During summer, walrus typically use the sea-ice platform as a place to raise their young with easy access to food sources. In recent years, however, walrus have been forced to haul out onto coastal beaches, creating dramatic scenes involving thousands of walrus huddled together. Their prey of clams quickly becomes depleted in the vicinity of their alternative haul-outs on shore. These haul-outs can turn deadly when walrus are spooked, causing a massive stampede for the safety of water. About 130 mostly young walrus were crushed to death in just this sort of situation in 2009 at Icy Cape in northwest Alaska.[49]

Rapid Changes on Land Too

Land-based plants and animals are also contending with rapid climate change in the Arctic. Trees and shrubs are shifting northward, modifying the ecosystem dynamics of the Arctic tundra and the species of wildlife than can survive there.[50] Meanwhile, spring is arriving 2 to 3 weeks earlier than it did just a decade ago.[51] The earlier flowering of plants and emergence of invertebrates can create mismatches with animals and their food sources, or plants and their pollinators.

More temperate species are moving northward, sometimes imperiling species adapted to the cold and snowy conditions typical of the past. For example, arctic fox live in the tundra, building underground

dens and feasting primarily on lemmings and voles. The habitat available for these animals is being lost as warming allows for trees and other plants to colonize the tundra. At the same time, red foxes are venturing further north.[52] With better hunting skills, red foxes can outcompete, and sometimes even kill arctic foxes.[53]

Caribou are struggling to adjust to new climate conditions as well. While warmer springs have caused plants to emerge earlier, caribou calving still happens at the same time. This mismatch with food sources has reduced reproductive success in some caribou populations.[54] Shifts from snow to rain have proved especially challenging for the Peary population of caribou that resides in the far northern parts of Alaska. Their numbers have declined by some 84 percent in the last 40 years, from about 50,000 to just 8,000.[55] As the region gets more freezing rain instead of snow, a hard ice can form over the lichen and other food sources below. One challenge in assessing impacts is that caribou populations are known to experience multi-decadal ebbs and flows, so scientists are still working to determine natural versus climate change impacts on the populations.

Warming in the Arctic Has Far-Ranging Impacts

Although the icescapes of the Arctic may seem far away, the changes underway there are already affecting coasts, habitats, and migratory species in places across the United States. The rapid melting of land-based glaciers and ice caps in Alaska, Greenland, and other places north of the Arctic Circle is already contributing to global sea level rise.[56] Coastal areas are being inundated, forcing refuge managers to consider options for relocating important marshes and other crucial coastal habitats.

The warming in the Arctic can also amplify future warming. The disappearance of sea ice converts large areas of highly reflective snow and ice to areas of dark ocean, which absorb much more energy from the sun. This ice-albedo feedback is self-reinforcing because as the oceans warm, less sea ice forms, which allows the oceans to absorb even more heat. Meanwhile, the changing ice cover is also affecting large-scale weather patterns, creating conditions that have exacerbated recent extreme weather events in the United States, including the severe Texas droughts in 2011 and Hurricane Sandy.[57]

The large reservoirs of carbon locked away in the permafrost also have the potential to create a powerful feedback cycle. With about twice the amount of carbon as is already in the atmosphere,[58] permafrost thawing would release massive amounts of methane—an especially potent greenhouse gas—to the atmosphere. This would create a feedback cycle in which warming leads to more carbon release, which leads to more warming, and so on. [59] Most current climate projections do not account for this possibility, even in their worst-case scenarios.

Sven Roeder

Ringed Seal: The Most Recent Species Listed as Threatened Due to Climate Change

Ringed seals are facing an increasingly dire outlook. Ringed seals seldom come ashore, depending almost exclusively on sea ice for their reproduction and livelihood.[60] Arctic sea ice has contracted dramatically over the last decade, and climate models predict that continuing sea ice decline may soon lead to conditions insufficient to support seals.

Ringed seals are also threatened by reduced snowfall. Their pups are born and spend the first few weeks of life in snow dens, which protect them from predators and freezing.[61] Diminishing snowfall, earlier snow melt, and winter rains are pushing more pups out of their shelters before they are able to survive in the open. An additional challenge is that ringed seals have only one pup per year, making them especially vulnerable to environmental changes.

In December 2012, the National Oceanic and Atmospheric Administration announced that the ringed seal, as well as the bearded seal, would be listed as a threatened species under the Endangered Species Act because of the risks posed by melting sea ice and reduced snowfall.[62] Fewer ringed seals could have dire consequences for the polar bear, as well. Polar bears hunt seal pups in their maternity dens. However, with pups spending less time in their maternity dens, polar bears are missing an easy and important springtime prey.

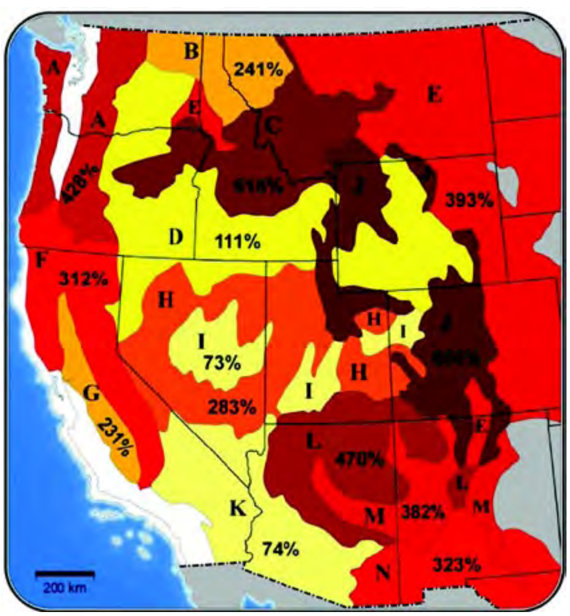
WESTERN FORESTS:
CONTENDING WITH MEGAFIRES

Many forest ecosystems in the American West have evolved so that episodic fires are part of their natural rhythms. However, climate change is creating conditions conducive to megafires with the potential to dramatically alter habitat for fish and wildlife. Throughout the American West, wildfires have become increasingly frequent and severe, and 2012 was the third worst wildfire season yet.[63] Hotter, longer-burning, and wider-ranging fires are the new norm and are likely to get worse in the future. Although past suppression of natural fires and the subsequent buildup of tinder have been a contributing factor to the megafires, researchers have shown that climate change is a now a major factor increasing the size and number of forest fires.[64]

The cost of wildfire suppression—about $3 billion a year—has tripled in the United States since the late 1990s.[65] The majority of these expenses are borne by the U.S. Forest Service, which now spends about half of its annual budget just fighting fires. Firefighters are adapting to the new wildfire realities.[66] They are struggling to keep up with these longer fire seasons, which in some places are now effectively year-round, leaving little time to regroup and prepare for the next incident. Moreover, they are finding it harder to control fires, in part because fires are less likely to quiet down at night like they used to. Nighttime conditions are hotter and drier, meaning that fires can stay active around the clock.

Climate Change Sets the Stage for Megafires

Longer, hotter, and drier fire seasons create conditions highly conducive to major fires. Western forests typically become combustible within a month of the snowpack melting, which is now happening 1 to 4 weeks earlier than it did 50 years ago. For example, the June 2012 Colorado snowpack was just 2 percent of its normal extent when the High Park and Waldo Canyon fires—the two most destructive fires in the state's history—occurred. At the same time, the region was in the grips of one of the worst droughts in U.S. history, leaving parched vegetation that was quick to burn.



A - Cascade Mixed Forest
B- Northern Rocky Mt. Forest
C - Middle Rocky Mt. Steppe-Forest
D - Intermountain Semi-Desert
E - Great Plains-Palouse Dry Steppe
F - Sierran Steppe-Mixed Forest
G - California Dry Steppe
H - Intermountain Semi-Desert / Desert
I - Nev.-Utah Mountains-Semi-Desert
J - South Rocky Mt. Steppe-Forest
K - American Semi-Desert and Desert
L - Colorado Plateau Semi-Desert
M - Ariz-New Mex. Mts. Semi-Desert
N - Chihuahuan Semi-Desert

Wildfire risk is expected to increase significantly across the West. This map shows the percent increase in burned areas for every 1.8 degree Fahrenheit increase in temperature, relative to the median area burned during 1950-2003. Source: National Research Council (2011): Climate Stabilization Targets: Emissions, Concentrations, and Impacts for Decades to Millennia.

Recent Record-Setting Wildfires in the West

Where	Record	Name	When	Area Burned	Losses
Arizona	Largest fire in state history	Wallow Fire	May-July 2011	538,049 acres	$109 million; 32 homes lost; 6,000 evacuated
California	Largest fire in state history	Cedar Fire	Oct-Dec 2003	280,278 acres	$40 million; 15 people killed; 2,232 homes lost
Colorado	Most destructive	Waldo Canyon Fire	June-July 2012	18,247 acres	Evacuation of over 32,000 residents; $352.6 million in insured losses; 346 homes lost
Idaho	Costliest fire season	2012 wildfire season	June-Oct 2012	1.718 million acres	Over $50 million; over 2000 evacuated
Montana	Worst fire season	2012 wildfire season	July-Nov 2012	1.209 million acres	$113 million; over 80 homes lost
New Mexico	Largest fire in state history	Whitewater-Baldy Complex Fire	May-Oct 2012	297,845 acres	Several towns evacuated; a dozen homes lost; severe damage to Gila National Park
Oregon	Largest fire in 150 years	Long Draw	July 2012	557,648 acres	Hundreds of cattle and farms lost
Texas	Worst fire season	2011 wildfire season	Nov 2010-Oct 2011	Almost 4 million acres in over 21,000 fires, including 6 of the 10 largest in the state's history	2,946 homes lost; 4 people killed; over 1.5 million trees killed
Wyoming	Worst fire season	2012 wildfire season; included over 1,400 fires	June-Oct 2012	560,000 acres	$100 million; 155 homes and buildings destroyed

Sources: http://www.inciweb.org; http://www.wikipedia.org

Widespread beetle infestations have left broad swaths of dead and highly combustible trees in their wake. Higher temperatures enhance winter survival of mountain pine beetles in the Rocky Mountains and allow the beetles to complete their lifecycle in one year, half of the previously recorded rate. Scientists are studying what sort of increased fire risk is posed by these millions of dead trees.

Our Western forests are already feeling the heat and going up in flames. The 2012 wildfire season was only the third time since 1960, when records began to be kept, that burned areas in the United States exceeded 9 million acres.[67] This is larger than the size of Massachusetts and Connecticut combined. The other two wildfire seasons exceeding 9 million acres were within the past decade: 2006 and 2007.

The future outlook isn't any better. The National Research Council projects that for every 1.8 degrees Fahrenheit warming across the West there will be a 2- to 6-fold increase in area burned by wildfire. With at least 3.6 degrees Fahrenheit of warming expected in even the best case scenarios, wildfire will be an increasing threat to wildlife.

More Stress on Wildlife

Most wildlife can escape the immediate effects of wildfires. However, for some animals, like newly hatched, downy chicks that are unable to fly or small mammals that are unable to outrun the blazes, there is simply no way to flee the fire. For others, escape routes can force wildlife across roads, putting them at greater risk of being hit by vehicles, or send them into urban areas.

Larger, more frequent, and more intense fires make it harder for wildlife to recover afterwards. Many animals must move longer distances to find habitat that can support them. The burned soils have lost important nutrients, and even more nutrients wash away in the erosion after the fires. As a result, there can be lower productivity of plants and wildlife for years, if not decades. In the 2012 Waldo Canyon fire nearly 20 percent of the affected area was burned so severely that all vegetation on the surface and the root systems to a depth of about 4 inches were completely killed.[68]

The massive amounts of ash produced by these fires can clog streams, with devastating effects on fish and other aquatic plants and animals, especially if fires are followed quickly by heavy rainfall events. Without trees and other vegetation to retain water and soil, burnt areas are subject to extensive erosion and sedimentation in streams, sometimes for years following a fire. After the 2011 Las Conchas fire in New Mexico, drinking water withdrawals from the Rio Grande were reduced for months because of the additional cost of treatment to remove excess sedimentation.[69] And the Poudre River was running black with ash following the High Park fire in Colorado, putting trout at risk.[70]

Ripple Effects of Losing Whitebark Pine

Mountain pine beetles and white pine blister rust are cutting a swath through the whitebark pine forests of the western United States and Canada, leading to a finding by the U.S. Fish and Wildlife Service that the species merits listing under the Endangered Species Act. As of 2009, aerial surveys showed that about 50 percent of whitebark pine stands in the Yellowstone area had high mortality in the overstory trees.[71] Fire frequency and severity are projected to increase in this area, further imperiling whitebark pine ecosystems. Annual area burned could exceed 247,000 acres by 2050.[72]

The species and ecosystem services supported by whitebark pine forests are feeling the effects. Healthy pine forests help maintain mountain snowpacks by shading the snow. As the tree canopy is lost, the snow is melting more quickly, leading to more flash floods in the spring and less water availability in summer and fall.[73] Many animals utilize whitebark pine nuts as an important food source. Grizzly bears, for example, use these extensively when available in the fall before hibernation. When pine nuts are scarce, bears have fewer cubs, fewer cubs survive, and there are more mortalities from conflicts with humans as bears seek alternative food sources in areas closer to humans. Nearly 300 human-bear conflicts were reported in the Greater Yellowstone Ecosystem during 2010, a year with low cone production.[74] That is more than double the average number reported during 1992-2009.[75]

Forest managers in the Greater Yellowstone area are already taking steps to limit the losses of whitebark pine and help other species adjust to new conditions. For example, trees are being genetically selected to increase their resistance to blister rust disease, forests are being managed to limit the damage from fires and pine bark beetles, and whitebark pine seedlings resistant to disease are being planted to replace lost trees.[76]

Efforts are underway to restore forests devastated by mountain pine beetles.

John Gale

Unprecedented Forest Die-Offs in the Rocky Mountains

Mountain pine beetle epidemics have impacted more than 4 million acres of pine forest in Colorado and Wyoming alone, drastically affecting the heart of the region's tourism industry. These beetles are native insects and outbreaks have occurred for millennia, but in recent years they have become extremely destructive in the Rocky Mountains and in high elevation pine forests. Dr. Barbara Bentz, who studies mountain pine beetles for the U.S. Forest Service Rocky Mountain Research Station, says that the changes are likely “caused by warming temperatures … because this increases their reproductive and development rate and fewer beetles are killed by cold.” Scientists worry, however, that high elevation pine forests may not be able to regenerate quickly enough to keep pace with the beetle.

In addition to the unprecedented damage within their historic range, mountain pine beetles are expanding northward in British Columbia and into Alberta, Canada. Mountain pine beetle epidemics are particularly damaging because “they have to kill the tree in order to successfully reproduce,” says Bentz. And “once they get going, they are nearly impossible to stop.” Worryingly, the mountain pine beetle is now “attacking Jack pine trees, which were not previously known to be a host,” which may enable it to further expand its range into the Boreal forests of Canada.

Mountain pine beetle epidemics are a major threat to economic vitality and public safety. Dead trees left behind pose a serious danger to local communities. Not only do dead trees negatively impact home values, but trees have been known to fall on power lines, houses and people. As climate change increases the frequency of extended droughts and warm winters, the unprecedented mountain pine beetle activity is likely to continue, with potentially devastating effects to communities and some of our nation's most prized national parks (e.g., Yellowstone and Rocky Mountain National Parks), as well as numerous national forests.

“Seeing the beetles' impact on natural places they really care about has really brought this issue home for people,” says John Gale, the Rocky Mountain regional representative for National Wildlife Federation. “When people go fishing and hiking, they encounter parks and campgrounds that are closed because they are unsafe. The only thing currently making these places safe again is cutting all the trees down. It is really powerful to see – even something small like trying to take your family camping, you can't do anymore,” Gale says. He hopes that with better forest management practices we can prevent such widespread destruction in the future.

SOUTHWEST: NATURAL LANDSCAPES AND WILDLIFE IN TRANSITION

Climate change is already transforming natural landscapes in the Southwest, as the region experiences higher temperatures, more severe drought and wildfires, and more severe floods. Some plants and animals are moving northward and upward in elevation, while others are being replaced by non-native species that are better suited to the new climate conditions. Meanwhile, the increasing frequency and severity of wildfires is creating new conservation challenges.

Water Shortages

Increasing temperature is exacerbating droughts. As this trend continues, the impact on southwestern landscapes and wildlife will grow. Southwestern lands and rivers are particularly vulnerable to reductions in precipitation[77] because of their already arid nature. For example, native cottonwood-willow stands along streams continue to be replaced by extensive and dense stands of exotic tamarisk (salt cedar) and other non-native species that have a higher tolerance for drought.[78] This further reduces water availability and completely changes the ecology of these valuable wetlands habitats. To make matters worse, climate models project that the runoff in the region will decline by 20 to 40 percent by mid-century.[79]

Drought combined with increasing temperatures is not only reducing water supply, but also warming rivers and streams, placing fish and other aquatic species at risk. A recent analysis found that 70 percent of the watersheds in Arizona, New Mexico, Colorado, and Utah have experienced warming during the past 55 years.[80]

Invasive tamarisk plants in Utah's Canyonlands National Park

Kathryn Colestock-Burke

Iconic and Rare Species at Risk

From the well-known and elegant saguaro cactus to striking Joshua trees, the Southwest is home to iconic species found nowhere else. Climate change puts these and other treasured species at risk. For example, woody species from Mexico and invasive red brome and buffel grass species are already taking hold in the Sonoran Desert. These invasive grasses increase fire frequency and intensity, putting saguaro cactus at risk.

Droughts fueled by climate change have been linked to the die-off of more than 2.5 million acres of Piñon pine in the Southwest.[81] Piñon pine are adapted to withstand droughts; however, warmer temperatures and longer droughts are proving too much for them. The hotter it is during a drought, the more quickly the trees succumb. The upshot is that droughts are lasting longer, but trees are dying more quickly. In one experiment, trees exposed to temperatures just 7 degrees Fahrenheit more than their neighbors died 30 percent faster. This sort of sensitivity could lead to a 5-fold increase in regional tree die-off events.□

Todd M. Edgar/NPS

The Madrean Pine-Oak Woodlands ecosystem of Mexico and the Southwest is one of 34 biodiversity hot spots identified around the world. Confined to mountainous areas, about 80 percent of the original forest area in the U.S. part of its range has already been lost due to logging, agriculture, and urban development. Only fragments remain in the United States, though they once covered nearly 200 square miles in southern Arizona, New Mexico, and West Texas. These areas are home to at least 44 pine species, more than 150 species of oak, around 6,000 flowering plant species, more than 500 bird species, 384 species of reptile, 328 species of mammals, 84 fish species, and 200 species of butterfly.[83] Now, climate change is further constricting the few remaining areas suitable for this unique ecosystem.

Gary Kramer

Wildfire and Wildlife in the Southwest

The last few years have brought some of the largest wildfires ever witnessed in several southwestern states. The impacts on communities and property have been devastating, with thousands of homes lost and hundreds of millions of dollars in expenses. Such large and intense fires also have significant impacts on fish and wildlife. Although wildfire is a natural feature of many ecosystems in the Southwest, such catastrophic fires combined with other climate changes are setting the stage for wholesale ecosystem transitions and creating new challenges for conserving threatened and endangered species.

Wrecking wildlife-rich sagebrush habitats from Nevada to Montana, cheatgrass is a threat to the well-being of wildlife closely associated with sagebrush habitats, such as pronghorn and sage grouse. This pernicious invasive species is providing a ready source of tinder for wildfires already on the rise due to increasing drought and temperatures in the West. Cheatgrass has invaded wide expanses of sagebrush habitats, which historically burned infrequently, and are not adapted for surviving frequent fires. In 2007 alone, in the Great Basin where cheatgrass is pervasive, more than 2.7 million acres burned.[84] It is uncertain exactly how climate-driven changes in precipitation and temperature could affect cheatgrass, although one study indicates it could expand the amount of suitable land for cheatgrass by up to 45 percent in many areas.[85]

Species that already are confined to a small geographic area are especially vulnerable to extreme events like fires, especially if their entire habitat is affected. This is exactly what happened to the Mexican spotted owls that reside in the major canyon systems of the Bandelier National Monument in northern New Mexico. The 2011 Las Conchas fire burned more than 60 percent of the protected areas, causing near or complete mortality of trees and shrubs in the owl's nesting and roosting habitat. The following summer, the Whitewater-Baldy Complex fire in the southwestern part of the state forced fish biologists to manually relocate the threatened Gila trout, when ash from the fire entered important river habitat.


Ignacio Peralta

More Intense Wildfire 'Ups the Ante' for Gila Trout Conservation in New Mexico

On May 9, 2012 lightning struck Whitewater Baldy Mountain in the Gila National Forest of southwestern New Mexico. In two months the fire burned almost 300,000 acres of land, destroying numerous homes in addition to important wildlife habitat. For David Propst, a former fish biologist for the New Mexico Department of Game and Fish, the Whitewater Baldy fire put a special fish—the Gila trout—at risk.

Before the fire hit Langstroth Creek, "the stream was teeming with Gila trout – hundreds and hundreds were captured." But when the crew went back a few days later, "they found that ash-laden water had killed a mess of fish, just devastated them. Only about 65 fish were captured that day."

It was an indication of a larger, worrisome trend: "Climate change has really upped the ante for conservation," says Propst, who has worked on fish recovery efforts since 1984. Over the last decade, warming stream temperatures and a marked rise in severe wildfires have made it clear that climate change is a game changer for endangered species protection. "We were always aware of climate change, but it had not affected us so dramatically before. Climate scientists throughout the Southwest tell us that these big, intense fires are going to become the norm."

Gila trout, one of the first species listed under the Endangered Species Protection Act of 1966, has since been reclassified to "threatened" as a result of dedicated conservation efforts by Propst and others. But extreme fires now pose a big risk to Gila trout and the progress that has been made. When wildfire ash is washed into a stream it undergoes rapid denitrification, which is quite deadly to fish. Ash and sediment from wildfires clog fish gills, essentially suffocating them, while silt deposited on the riverbed kills aquatic invertebrates, the Gila trout's main source of food.

When a fire occurs, fish rescue teams jump into action to identify streams where imperiled populations are likely to be affected. During the Whitewater Baldy fire, rescue teams were able to evacuate and save around 1,000 Gila trout, which were taken to a national fish hatchery in New Mexico and relocated to a stream in Arizona. Returning the fish to streams after a fire can be somewhat problematic, Propst says. "It's kinda dicey, usually we like to wait 3 to 5 years before restoring fish to fire-affected streams; it takes about that long for the stream banks to recover."

In the past, Propst says, the biggest threats to Gila trout and other imperiled fish species were overfishing, poor management practices, and non-native species. Now, he says, fish recovery —and conservation more generally —need to incorporate climate change into management policies. Warmer stream temperatures endanger Gila trout, which typically inhabit cold waters at high elevations. With less snowmelt, "the flow regime will change and the thermal regime will change," says Propst. "We used to have all these things worked out. Now the paradigm has shifted."

GREAT PLAINS:
WILDLIFE IN THE GRIPS OF HEAT WAVES AND DROUGHT

In 2012 the Great Plains experienced blisteringly hot weather and extremely low rainfall, resulting in parched landscapes across America's 'bread basket'. More than two-thirds of the entire Lower 48 experienced drought conditions that summer, making it even worse than the infamous and devastating Dust Bowl of the 1930s.[86] But, climate scientists were not surprised. More intense heat waves and droughts are exactly what they have been projecting for the Great Plains.

The southern areas of the Great Plains are projected to get less rainfall while more northern regions of the Great Plains are likely to see more rainfall on average. That said, what rainfall there is, is more likely to come in heavy downpours in contrast to the historic more-frequent but less-intense rainfall. Thus, the whole region is at risk of more drought, especially when taking into account the enhanced evaporation associated with higher air temperatures.[87]

Habitat Drying Up for Waterfowl and Pheasants

The combination of drought and heat can dry up tens of thousands of playas and prairie potholes that harbor migrating and nesting waterfowl. Waterfowl populations are closely tied to the number of spring breeding ponds in the prairie pothole region of the Northern Great Plains. These seasonal and semi-permanent wetlands are important for breeding mallards and other ducks. During dry years, mallard ducklings have much lower survival rates.[88]

Carter Johnson, a professor of ecology at South Dakota State University, has studied wetlands of the pothole region for over two decades, but says he and his colleagues "were pretty shocked to see" how sensitive they are to increased temperatures of just a few degrees. His work shows that even a 3.6 degree Fahrenheit increase can drastically decrease the ability of a wetland to support waterfowl.[89] "You get a very different wetland and a very different habitat for wildlife," he says.

Severe drought can also affect pheasant populations in the Great Plains, particularly by reducing their food sources and access to vegetative cover, leading to reduced survival rates, especially for chicks.

U.S. Department of the Interior

Moreover, drought can force farmers to use land previously set aside in the Conservation Reserve Program for emergency haying and grazing, further reducing the birds' habitat. Indeed, a dry winter (2011-2012) followed by a dry, hot summer made for one of the worst pheasant hunting seasons on record in eastern Colorado.[90]

Heat Waves Bring Fish Die-Offs

The combination of heat and drought is particularly challenging for freshwater fish. When streams get too warm, fish growth rates decline and stressed fish become more susceptible to toxins, parasites, and disease. The lower water levels during drought cause the water temperatures to rise more rapidly and reach greater extremes. Warm water holds less oxygen and facilitates the rapid growth of harmful algae. When higher temperatures combined with oxygen depletion exceed tolerance limits, massive fish die-offs are the result.

During the summer 2012 drought, the stench of rotten fish was common across rural and urban areas alike as fish died by the thousands. Nearly 58,000 fish, including 37,000 sturgeon with a market value of nearly $10 million, died along 42 miles of the Des Moines River.[91] Severe fish kills also occurred along the Platte River in Nebraska,[92] where sustained drought caused over 100 miles of river to go completely dry.[93] Fish kills attributable to "hot" water were also reported in areas further east, including Michigan, Minnesota, Pennsylvania, Wisconsin, Ohio, Indiana, and Illinois.[94]

Mammals Feel the Heat Too

Terrestrial wildlife are no less susceptible to heat and drought. Drought can cause important wildlife food sources to produce less fruit or even kill the plant. Forced to range further in search of food, wildlife become more vulnerable to predation. Furthermore, deer and other wildlife have difficulty fattening up for winter and face starvation. Those that do survive are less likely to successfully produce strong and healthy offspring the following spring.[95]

Warming is particularly problematic for moose in northern Minnesota. The moose population in the northwestern part of the state plummeted from about 4,000 animals in the mid-1980s to less than 100 animals by the mid-2000s. Biologists attribute most of this decline to increasing temperatures: when it gets too warm moose typically seek shelter rather than foraging for nutritious

foods needed to keep them healthy. They become more vulnerable to tick infestations, which have proliferated as the region has warmed. Ticks leave moose weakened from blood loss and with hairless patches where they tried to rub off the ticks. Without protective hair, these animals can die from cold exposure in the winter. Individual moose infested with 50,000 to 70,000 ticks—ten to twenty times more than normal—have been documented.[96]

Uncertain Future for Sandhill Cranes in Nebraska

Each spring, half a million sandhill cranes visit the Central Platte in Nebraska en route to their summer nesting areas in Alaska, Northern Canada and even Siberia. "The cranes are an especially important species for Nebraska," says Duane Hovorka, director of the Nebraska Wildlife Federation and a lifelong Nebraskan. "The Platte River is really a key stopover" for the birds that spend 3 to 4 weeks feeding, resting and socializing before continuing on their long migration north. The birds are also an important game bird in the Great Plains and an economic asset for Nebraska, bringing in "tens of millions of dollars every year from tourism."

More than 80 percent of the North American sandhill crane population visits the Central Platte every year, but it is unclear how much longer the river will be able to sustain them. "About two-thirds of the water in the Platte River starts out in the Rocky Mountains," Hovorka explains, and the river is "very dependent on snowmelt into June and July." Climate models predict reduced snowpack in the Rocky Mountains in coming years, with more precipitation falling as rain instead. Bob Oglesby, a professor of Climate Modeling at the University of Nebraska-Lincoln, says, "In every scenario you could possibly imagine, there will be less water discharged into the Platte and Colorado Rivers over the summer months." Changes in water level and flow timing caused by climate change will make the Platte River a more volatile habitat for sandhill cranes and other species that depend on it for survival.

High river flow, especially in the spring, is important for maintaining a wide channel with open areas containing little vegetation. When water levels are low "plants move in, and you get a narrowing of the river channel," Hovorka explains. The sandhill cranes depend on open areas of the river for protection from predators when roosting; "the river is what keeps them safe at night." In some areas, like Grand Island, "we've seen that the river channel has already shrunk. In many places it has gone from about a mile wide to one or two tenths of a mile." The narrowing of the stream is attributed to the construction of upstream reservoirs and past droughts reducing water flow.[97] Drought scientist Song Feng at the University of Nebraska, Lincoln predicts that "moderate to severe drought will become the norm by the end of the century."[98]

Maintenance of adequate water flow in the Platte River to sustain sandhill cranes has long been controversial and extensively litigated. A non-binding agreement among Nebraska, Colorado, and Wyoming to maintain adequate water flow and restore habitat for sandhill cranes and other wildlife was negotiated in 2007, but the work is not yet complete. With all of the water rights already appropriated, increasing severity of droughts threatens to further reduce flows as well as increase pressure for more water withdrawal for public water supply and irrigation.

Between drought, reduced snowfall and warming temperatures, sandhill cranes are being squeezed on all sides by climate change. As Hovorka says, "If what we're doing is drying up the river and drying up these wetlands, then we'll lose the population. It is a real serious concern for us in Nebraska."


Ryan Hagerty, U.S. Fish and Wildlife Service

MISSISSIPPI RIVER BASIN:

MORE ERRATIC FLOODING CREATES NEW IMPERATIVES FOR CONSERVATION

The Great Flood of 1993 devastated communities along the Mississippi River and its tributaries in nine Midwestern states. This 500-year flood displaced thousands of Americans, caused 48 deaths, and inflicted damages of an estimated $21 billion.[99] Federal response and recovery costs were $4.2 billion, part of which went to voluntary buyouts, relocations, and flood-proofing of thousands of damaged properties across the Midwest.[100] Yet, just 15 years later, many of these same places experienced another major flood. The Midwest received two to three times more rainfall than average and set more than 1,100 daily precipitation records during May-June 2008.[101] About 30 percent of the nation's corn and soybean crops were lost, damaged, or delayed by these floods.[102] And, just 3 years after that, the Mississippi experienced another 500-year flood in April and May 2011, which led to thousands of evacuations, 14 deaths, and the unusual step of blowing up the New Madrid levee to let water flow into the floodplain.[103]

These three catastrophes, as well as several other dramatic and costly floods across the Midwest in recent years, have cast a spotlight on the flooding risks posed by increasingly heavy rainfall events combined with the ways we have managed our agricultural lands, floodplains, and river channels. Meanwhile, river ecosystems have also been disrupted, even as robust wetland habitats could play a key role in managing our flood risk. To make matters even more challenging, the region is also experiencing severe droughts in some years. Indeed,

Barry Johnson

the severe 2012 drought, which caused extremely low flows to the Mississippi and major concerns for navigation, came just one year after catastrophic flooding.

Increasing Flood Risk for the Mississippi Basin

More heavy rainfall events caused by climate change is one important factor contributing to higher flood risk along the Mississippi.[104] The frequency of extremely heavy rainfall events has increased by up to 40 percent during the last 31 years for the central United States.[105] Climate projections for this century indicate that those big storms that historically only occurred once every 20 years are likely to happen as much as every 4 to 6 years.[106]

Inadequate floodplain management also contributes to the increasing flood risk. A particular problem is building right up to the river's edge combined with the overreliance on levees, which can give those who live behind them a false sense of security. In fact, about 28 percent of the new development in seven states affected by the 1993 Mississippi floods has been in areas within the flood extent.[107] Yet, natural riparian systems play an important role in absorbing excess flood waters and slowing its movement downstream. A single acre of wetland can store 1 to 1.5 million gallons of flood water,[108] and just a 1 percent loss of a watershed's wetlands can increase total flood volume by almost 7 percent.[109]

Modifications to the river channels have also reduced the rivers' capacity to convey floodwaters downstream. For example, on the Mississippi River, thousands of miles of levees placed near the river's banks create a narrower channel reducing the river's conveyance capacity, while 'river training structures' (rock jetties constructed in the river channel that make the river self-scour its bottom to reduce river navigation dredging costs) act as speed bumps during high water, further increasing flood heights.

Extreme Flooding and Wildlife

In a healthy, functioning river system, floods are vital to sustaining the health of human and natural communities. Floods deposit nutrients along floodplains creating fertile soil for bottomland hardwood forests. Sediment transported by floods form islands and back channels that are home to fish, birds, and other wildlife. By scour-

Bald cypress swamps are vulnerable to more precipitation extremes.

National Park Service

ing out river channels and riparian areas, floods prevent rivers from becoming overgrown with vegetation. Floods also facilitate breeding and migration for a host of fish species. In the deltas at the mouths of rivers, floods release freshwater and sediment, sustaining and renewing wetlands that protect coastal communities from storms and provide nurseries for multibillion dollar fisheries. Floods can also be helpful to fish and wildlife by temporarily restoring connectivity between habitat areas. This allows species from different areas to relocate, creating opportunities for species to find more suitable habitat.[110] The greater connectivity can also provide opportunities for enhancing genetic diversity.

The flip side, however, is the potential for heavy floods to spread pests, disease and invasive species like alligator weed that flourish in high water levels. Alligator weed crowds out native plants like smartweed and duckweed that waterfowl depend on for food in the wintertime. Wildlife refuges and hunters alike worry that a resurgence of alligator weed due to high water levels could lead to conditions that are insufficient to support important game like ducks and geese.[111]

Furthermore, the many plants and animals that depend on episodic flooding for lifecycle events will need to contend with new climate regimes. For example, bald cypress swamps in southern Illinois, Indiana, and Missouri rely on intermittent flooding for seed dispersal. Extreme floods, however, can deposit seeds too far upland, where conditions are not suitable for the trees to grow, or can kill seedlings that are not yet able to withstand flood waters.[112] Managers are particularly concerned about bald cypress regeneration in this northern part of its habitat range because areas further south are projected to become warmer and drier.[113]

Sediment, Nutrients, and Contaminants Washed Downstream

Heavier rainfall events mean that more soil, nutrients and contaminants are being washed into our waterways. Current estimates are that an additional flow equivalent to four Hudson Rivers is originating from farmlands in the Midwest and Great Plains each year.[114] Habitat for local fish and aquatic invertebrates can be drastically degraded following heavy downpours,[115] for example, by the deposit of massive sediment transported in these events or the restructuring of sediments in river-dominated shelves.[116] In addition, areas far downstream are put at higher risk for dead zones due to excessive runoff of fertilizer and other contaminants.

One particular concern is that farmers will aggravate the runoff problem in their efforts to address other impacts of climate change. For example, as heavy rainfall events become more common, farmers may add new drainage systems to quickly move water off the fields, thus promoting flooding problems elsewhere. Farmers may also apply additional fertilizer or pesticide treatments to take advantage of longer growing seasons or to combat new pests and diseases.[117] Thus, it will be even more important for farmers to work together with conservationists to identify ways to support natural floodplains that can protect people and property.[118]

When too many nutrients—especially nitrogen and phosphorus—are present in coastal waters, excessive algae and phytoplankton growth can occur, rapidly depleting oxygen from the local waters. Without oxygen, fish and aquatic invertebrates cannot survive. The Gulf of Mexico is home to the nation's largest dead zone, sometimes extending over 8,400 square miles.[119] Fertilizer washed off of agricultural lands into the Mississippi is the major cause of this dead zone. Past heavy precipitation events in the Mississippi basin have delivered more nitrogen to the Gulf of Mexico,[120] so the trend toward even heavier events is expected to further aggravate this problem. Indeed, one study found that climate change could increase river discharge by 20 percent, leading to higher nitrogen runoff, and decreasing dissolved oxygen in the Gulf of Mexico by 30 to 60 percent.[121]

Chase Fountain, Texas Parks & Wildlife

Jocelyn Augustino/FEMA

Floodplain Management and Agriculture in an Era of Extreme Floods

"I've been working all my life to protect natural habitats, especially along natural corridors like rivers," says Clark Bullard. As a native of Urbana, Illinois, a research professor at the University of Illinois and a board member of Prairie Rivers Network, Bullard is particularly worried that recent climatic changes pose a grave danger for wildlife and communities in the Mississippi River Basin.

Flooding has become more erratic and unpredictable, with devastating effects in a dozen states, including Nebraska, Iowa, Missouri, Illinois, Arkansas and Mississippi. Bullard says, "Rivers have been separated from their natural floodplains by levees, and they have also been channelized into straight canals, increasing water velocity and volume downstream. So now, spring rains that used to trickle out slowly are gushing quickly downstream, creating huge flooding problems for communities along the river." Tragically, historic and expensive efforts, funded largely by the U.S. Army Corps of Engineers to 'control' the river, have increased flooding in some areas.

"Now, climate change is exacerbating flooding due to growing extremes in heavy precipitation events," Bullard says. As a result, during the record-breaking Mississippi and Ohio River flood in 2011 the Army Corps of Engineers used the historic floodplain to reduce floodwater levels by breeching a levee, to save the town of Cairo, Illinois, and reduce pressure on miles of Mississippi River levees protecting communities and farmland. River management systems are in dire need of being updated to accommodate climate change. Levees, dams, and other structural solutions will continue to play a role in flood protection and navigation, but the time has come for a more balanced approach that recognizes and utilizes the natural defenses afforded by healthy wetlands, floodplains, and even farmland. "Unless there is a new system, towns and farms will be flooded more frequently and more severely," says Bullard. "That new system needs to recognize the importance of natural floodplains and restore them." Instead of plowed crops behind the levees, these historic floodplains can be allowed to periodically flood and grow water-tolerant trees like poplar or willow. This will allow agriculture to continue via the periodic harvesting of trees during dry seasons, to make biofuels. This has the added benefit of providing fantastic habitat for fish spawning during annual flooding. The lowest areas that are always flooded can become permanent wetlands, which are extremely rich in biodiversity, harboring many wildlife and plant species.

Bullard emphasizes that this is a positive picture for the future of our rivers, for more sustainable and less costly agriculture, and for our natural and human communities along the river. And the biofuel production will reduce our dependence on fossil fuels, which is the driving force of climate change. "It is entirely possible to achieve an appealing and sustainable future for the Mississippi River in a changing climate if we remember that the river owns the floodplain," Bullard says. "It all comes down to how you manage it, and how you reduce carbon pollution to minimize the impact of climate change."

GREAT LAKES:
NEW CONSERVATION CHALLENGES FOR AN AMERICAN TREASURE

The Great Lakes contain 21 percent of the world's surface fresh water, with more than 5,000 cubic miles of water.[122] Despite the enormity of the Great Lakes, they are far from immune to climate change. Of particular concern is the potential for climate change to make it even more difficult to address existing environmental problems in the lakes, such as excessive nutrients leading to harmful algal blooms, and invasive species like sea lamprey and common reed.

More Heavy Rainfall Events

Extreme precipitation events have already increased in the last decade for the Great Lakes region, with more increases projected for the future. Average precipitation in the Great Lakes region is projected to increase by about 10 percent in winter, and 30 percent in the spring with increases in both intensity and frequency of heavier precipitation events.[123] In contrast, summer precipitation is trending toward drought, such as experienced in recent years.[124]

Amanda Staudt / NWF

More heavy rainfall events are increasing runoff of nutrients from agricultural lands, contributing to harmful algae blooms in Lake Erie and causing oxygen-depleted dead zones.[125] Sadly, this reverses some of the cleanup progress made since the 1980s when Lake Erie was declared "dead."[126] In 2011, Ohio experienced its wettest spring on record. As a consequence of heavy rain and nutrient runoff, a harmful algal bloom covering 3,000 square miles plagued Lake Erie. The dead zones exclude oxygen for fish and other aquatic life, reducing lake productivity for sport and other fish.[127]

Declining Lake-Ice Cover

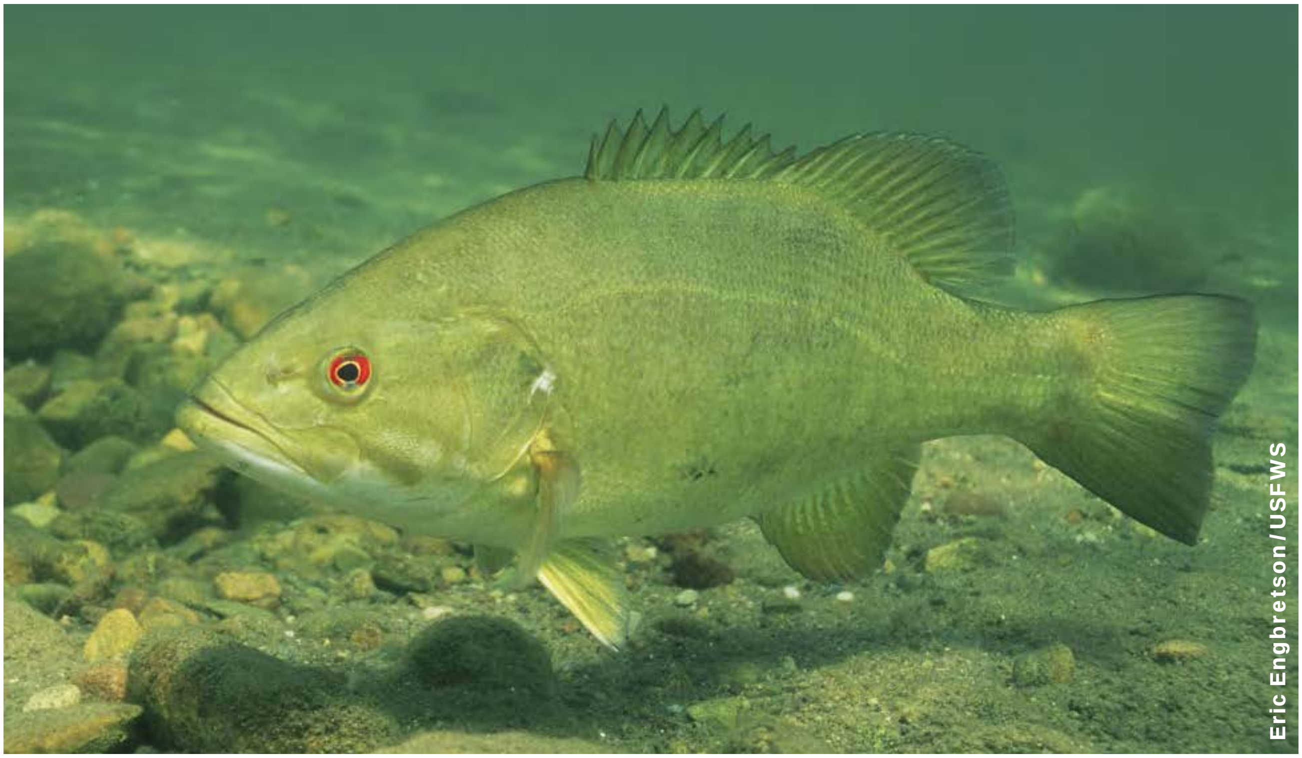
Climate change has already driven a huge decrease in winter ice cover throughout the Great Lakes from the period of 1973 to 2010.[128] Ice cover across the Great Lakes has declined by an average of 71 percent. Lake St. Clair ice cover has declined the least at 37 percent, while Lake Ontario has declined the most at 88 percent. Declining ice cover could benefit the shipping industry, but would leave coastal wetlands and shorelines more vulnerable to erosion.[129]

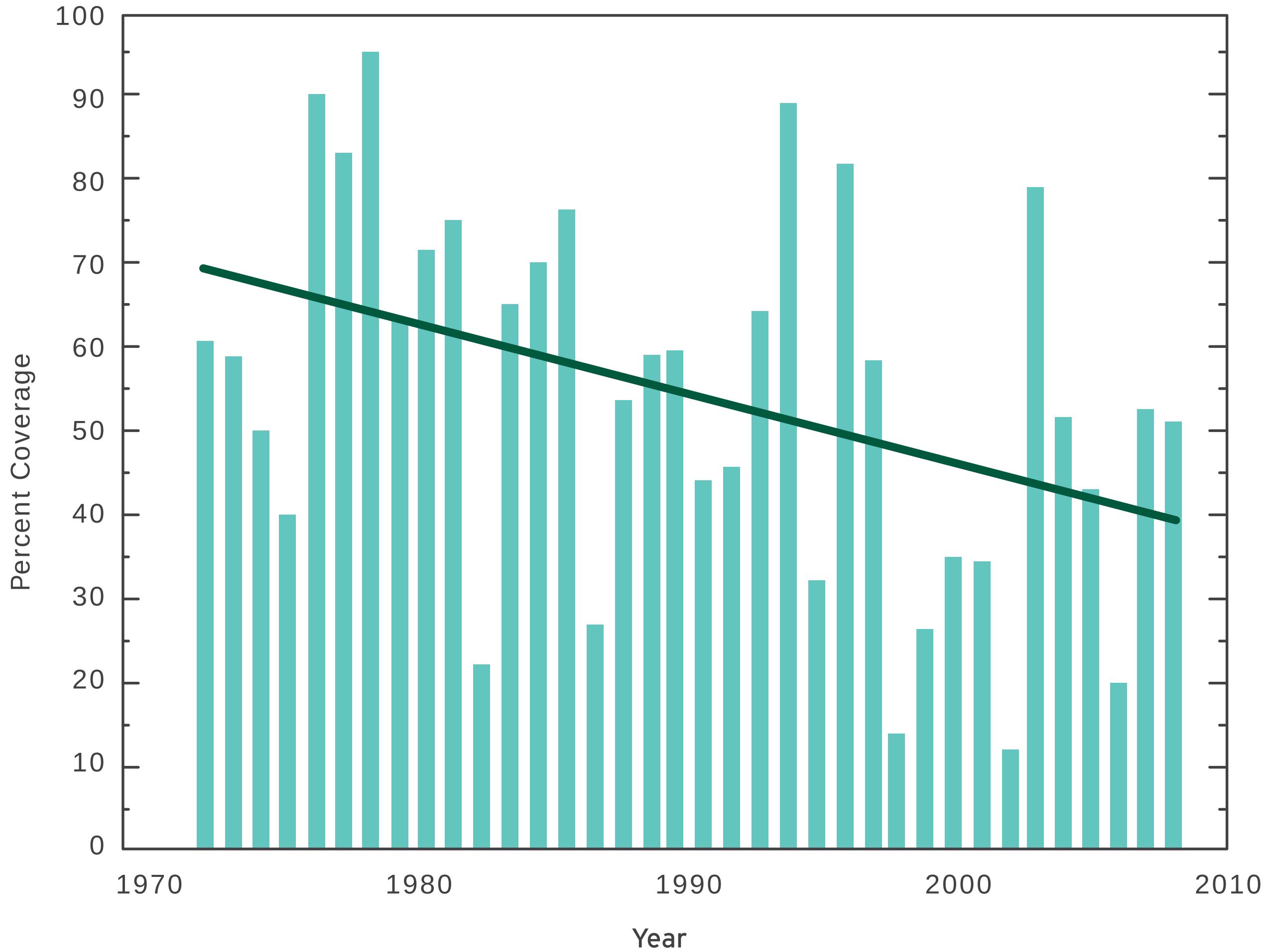
Reduced ice cover during winter and warmer temperatures in all seasons cause increases in evaporation. While several factors are at play, climate change is expected to cause declines in the Great Lakes water levels of anywhere from a few inches to several feet.[130] More evaporation during winter also pumps moisture into the atmosphere, creating conditions favorable for heavy lake-effect snow storms.[131]

The synergy between lake-level changes and invasive species has important implications for lakeshores. Fluctuating water levels facilitate establishment of the highly invasive common reed (commonly called phragmites, its genus name) in the coastal wetlands,[132] potentially forming a band of undesirable vegetation along the shoreline like a bathtub ring. The dense stands of phragmites are large and extremely difficult to control, have little wildlife value, and drive out native species such as cattails and the waterfowl and wildlife that use them.

Warming Lake Waters

Lake Superior is one of the fastest warming lakes in the world.[133] By mid-century the average air temperature in the Great Lakes region is projected to increase 5.4 (±1.8) degrees Fahrenheit with summer temperatures increasing more than winter.[134] A substantial increase in frequency and temperature of extreme heat events is also expected.[135] The summer heat wave in 2012, when historic high temperature records for Lake Superior water were shattered,[136] was a window into this future.

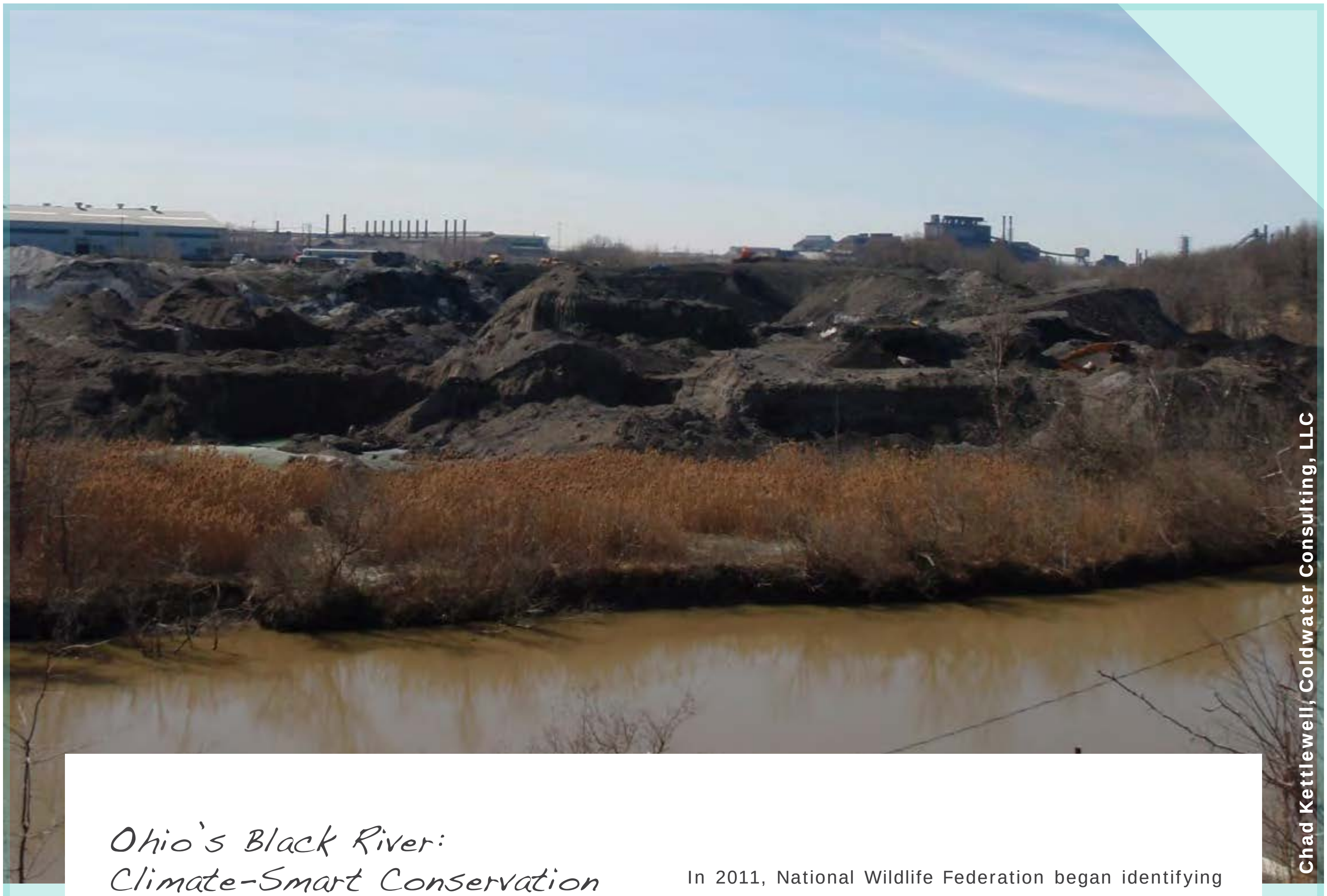

Eric Engbretson/USFWS



Great Lakes ice coverage has declined significantly since the 1970s. With more open water comes more evaporation, causing lake levels to drop more rapidly, providing more moisture for extreme lake-effect snow events, and leaving coasts more vulnerable to erosion. Source: USGCRP (2009).

Increasing water temperature in Lake Superior is expected to challenge fish populations by increasing sea lamprey populations.[137] This invasive species grows more rapidly in warmer water and also benefits from a longer warm season. The larger the sea lamprey, the more eggs it lays. The sea lamprey has already been enormously destructive to the once thriving fisheries in the Great Lakes.[138] Climate change will increase the difficulty of managing and controlling this destructive species.

As water temperatures increase, the Great Lakes will become more suitable for warm-water fish such as smallmouth bass and bluegill, but less suitable for cool-water and cold-water species such as northern pike and whitefish, respectively.[139] Streams flowing into the Great Lakes, such as the Black River in northern Ohio, could lose a third of their fish species by mid-century, including popular sport fish such as pumpkinseed, smallmouth bass and yellow perch, as increasing air temperatures cause water temperatures to exceed their thermal thresholds of reproduction and survival.[140] Streams throughout the Great Lakes watershed will face the challenge of rising temperatures.



Ohio's Black River: Climate-Smart Conservation

The Black River outside Lorain, Ohio is designated an Area of Concern (AOC) by the Environmental Protection Agency (EPA)[141] because of the severe degradation of its water quality and riparian habitats over the past century. Steel mills and other large industry were the dominant feature along the river since the late 1800s, leaching toxic heavy metals and polycyclic aromatic hydrocarbons (PAHs) into the water. In addition, millions of tons of steel by-products, especially slag, buried large areas of riparian habitat and even spilled into the river itself.

Once known as the "River of Fish Tumors,"[142] water quality in the Black River has been improving for the past couple of decades thanks to the Clean Water Act and extensive restoration efforts. Recently, the city of Lorain has been implementing on-the-ground restoration of the Black River, supported by the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) and others. Chad Kettlewell of Coldwater Consulting says, "Conditions have definitely improved" in areas that had been nearly devoid of in-stream fish habitat before. "Biologists are seeing very good reactions from fish communities," including popular sport fish like smallmouth bass, white crappie and yellow perch.

In 2011, National Wildlife Federation began identifying how restoration might be modified to account for climate change. These new "climate-smart" restoration projects are important because absent consideration of climate, the success and longevity of restoration could be compromised. "One of the most useful things," Chad says, "was a chart NWF gave us of current and projected tree species ranges," which led the City of Lorain to plant species that are likely to do well both now and in a warmer climate.

Water level in the river is projected to have more extreme fluctuations due to increasing incidence of both droughts and floods. Kettlewell reports that recommendations to account for climate change by "varying the height of fish habitat shelves will help ensure continued availability of good fish habitat even as the river level changes become more extreme." Furthermore, Lorain is now "using larger rocks, to withstand higher stream velocities" that will occur with increased rainfall and more extreme flooding.

Climate-smart recommendations, Kettlewell says, "were fairly easy to incorporate into the project and did not add a lot of cost." Preparing the river for climate change "definitely made the project better and more beneficial to the city and the river in the future."

APPALACHIAN MOUNTAINS:
FORESTS AND WILDLIFE ON THE MOVE

The vast Appalachian mountain range stretches some 1,500 miles from Newfoundland to Alabama, varies from 100 to 300 miles in width, and rises to nearly 7,000 feet above sea level.[143] Its diverse habitats include high elevation coniferous forests, mid-elevation deciduous forests, mountain balds devoid of trees, alpine tundra, cold-water streams, wetlands and many others. Nowhere will the Appalachian habitats and wildlife be left untouched by climate change.

Not surprisingly, climate change and its effects will vary considerably across the broad geographic range and ecological diversity of the Appalachian Mountains. While temperature increases are expected throughout the entire range, the degree and seasonality of temperature change will vary by latitude, altitude and local geography. Precipitation in the form of rain will increase at the expense of snow, due to rising temperatures.

Changing Forests

Changing climate will shift the locations of the suitable zones for many tree species. Extensive modeling for 134 tree species in the eastern United States, including many in the Appalachian Mountains, suggests that 66 of the species will experience a 10 percent or more increase in the area of suitable habitat, while approximately 54 species would see a 10 percent or more decline in area of suitable habitat.[144] The zones of suitable climate for these trees will generally move in a northeasterly direction and upslope.

Overall, suitable zones for spruce-fir and northern hardwood forests are projected to decline while zones for southern oaks and southern pines are likely to increase.[145] The projections are consistent with observed changes in the forests of New England. Already, deciduous forests are increasing at the expense of coniferous forests.[146] Iconic species such as the dogwood and sugar maple are at risk in their historical ranges.

Wildlife Responses

Wildlife in northeastern forests is already being affected by climate change.[147] Species dependent on mountaintops and their predominantly coniferous habitats will be particularly at risk, due to limited opportunity to move upward in elevation. Furthermore, they are inhibited from northward movement by low elevation areas of unsuitable habitat between mountaintops. These isolated mountaintops, often called 'sky islands,' are expected to experience greater loss of species than low elevation localities.

Among the high elevation wildlife at increased risk are snowshoe hare, Cheat Mount salamander, Shenandoah salamander, southern red-backed vole and northern flying squirrel. Brook trout that inhabit cold Appalachian streams are also at risk. As air and water temperatures rise, areas of suitable water temperatures are projected to recede from the lower elevations into the higher elevations, resulting in more isolated and smaller populations.

Finding Scarce Food

Wildlife cannot go into the pantry when their food crops fail. Increasing extremes in weather, especially drought, are likely to pose greater challenges for wildlife. Many wildlife food sources—vegetation, nuts and seeds—die or simply do not bear fruit due to extreme drought. Acorns, in particular, are an important food source for squirrels, mice, jays, woodpeckers, bears and deer.

Although warmer spring temperatures tend to increase acorn production, summer drought reduces acorn production.[148] In fact, acorn production can be 100 times greater in good years than poor years,[149] with weather being an important factor.[150] Climate change affects on acorn crops and production of other wildlife foods will be diverse, although difficult to project.

More Frequent Human Contact with Black Bears

"I was New Hampshire's first bear biologist, starting in 1978," says Eric Orff. "While I was there, for about the next two decades, we hardly ever had complaints about bears during the winter. But now they are getting bear complaints year-round. I know of people near Concord, near where I live, that have had their bird feeders taken down by bears in December and January, when they should be hibernating."

Warmer winters the last few years have changed black bear hibernation patterns. Orff notes that "last winter was very mild, and bears were much more active than we're used to." The usual black bear hibernation period in New Hampshire, Orff says, "goes from about the first or second week in November into mid-April. Most bears will continue to hibernate, but probably the males, who are less dormant, start to look for food in the middle of winter" if it is unusually mild.

Another potentially larger problem is warmer and drier summers. Orff says that "last summer, we had very dry, drought-like conditions here in New Hampshire," with devastating effects on wild bear foods. Andy Timmins, New Hampshire's current bear biologist, says that because of the drought in 2012 "soft-mass species, like strawberries and blackberries, didn't get the moisture they needed. The blackberries, which are an important source of food for the bears, ended up just drying up and falling off the vine."

"When food is scarce bears become very vulnerable," says Timmins. Bears must travel further to forage and will often supplement their diet with food sources common in more residential areas, which leads to an increase in bear-human conflicts.

With bears active longer and searching for food over wider areas, both humans and bears are at greater risk. 2012 set the record for bear conflicts with people. According to Timmins, in an average year New Hampshire has about 600 reports of bear conflicts with humans. Last year there were over 900. As current warming trends are expected to continue and even accelerate, the number of human/bear conflicts is likely to grow. That's bad news for bears.

ATLANTIC COASTS:
CLIMATE CHANGE SQUEEZING HABITATS

The U.S. Atlantic Coast is blessed with an amazing diversity of habitats, from the rocky coasts and barrier islands of New England to the extensive marshes and seagrass beds in the Chesapeake Bay and the sandy beaches and coral reefs of Florida. Together, these habitats support numerous species of fish and wildlife and are a linchpin for the economy, culture, and quality of life among the most populated and rapidly growing regions in America. Yet, the Atlantic coast will experience some of the most direct and costly impacts of climate change, including rising sea levels, warming ocean waters, enhanced coastal storms, and ocean acidification, all of which place both natural systems and coastal communities at risk.[151]

Sea Level Rise

Inundation of habitats and communities by rising seas and more exposure to intense storms are among the most immediate concerns for coastal areas. During the last century, sea level has increased by approximately 8 inches on average around the globe. Scientists project that the global mean sea level could increase by an additional 1 to 4 feet by the end of the century, and maybe by as much as 6.6 feet.[152]

Importantly, sea-level rise is not uniform across the globe; it can vary based on a range of factors, such as ocean circulation patterns, variations in temperature and salinity, and the earth's rotation and shape. New science suggests that the area off the Atlantic Coast is a "hot spot" for a relatively higher rate of sea-level rise than the global average.[153] In addition, because coastal lands in some areas, such as the Chesapeake Bay, are subsiding, relative sea-level rise will occur even faster.

Virginia Department of Emergency Management

Coastal inundation and erosion will surely increase as sea-level rise accelerates. However, communities and their natural habitats on America's coasts are ill-prepared to deal with sea level rise, putting these communities and their natural habitats at significant risk.

Marine Wildlife Sensitive to Warming

Tropical and subtropical sea surface temperatures increased by an average of 0.5 degrees Fahrenheit between the 1950s and 1990s, and this trend is projected to continue.[154] This warming is causing some fish species along the Atlantic Coast to shift their ranges northward by as much as 200 miles since 1968.[155] Several commercially important species now present off the New England coast, such as cod, haddock, winter flounder and yellowtail flounder, are particularly vulnerable to temperature increases because they are at the southern end of their ranges.[156] On the other hand, some subtropical species, such as croaker, are likely to shift northward and increase in abundance in the Northeast.[157]

Along the northern Atlantic Coast, there is considerable concern about lobster. In 2012, University of Maine marine researcher Rick Wahle said: "We have this surge in lobster population we've never seen before in the Gulf of Maine; as you go to southern New England, it's a collapsing fishery—and the causes may be the same."[158] Wahle noted that warming water temperature is impossible to ignore, but that many other factors are certainly involved as well. Warmer water in the cold Gulf of Maine may benefit lobsters, while more southerly lobster habitats become too warm. Although the Gulf of Maine 2012 harvest may exceed the 2011 record-breaking harvest,[159] the western Long Island lobster harvest has declined 99 percent since 1998.[160]

Sea turtle egg clutches face another challenge: rising temperatures. The gender of sea turtle hatchlings is highly sensitive to temperature.[161] Embryos incubating above about 88 degrees Fahrenheit are more likely to become females, while those incubating below about 82 degrees Fahrenheit are more likely to become males. Especially on our southern Atlantic coasts, studies suggest that populations of loggerhead sea turtles could become almost all female in some areas.[162] Unless nesting areas farther north continue to produce sufficient numbers of male sea turtle offspring, scientists worry that there could be a reduction in the reproductive success of loggerheads. In areas where average temperatures are already close to the upper threshold for incubation, including southern Florida, increased temperatures could also lead to higher rates of egg mortality.

Ocean Acidification Threatens Corals and Shells

Higher concentrations of carbon dioxide (CO_2) in the atmosphere are causing acidification of ocean waters. If CO_2 concentrations continue to increase at the current rate, the oceans will become more acidic (will have a lower pH) than they have been in millions of years.[163]

Acidification of ocean waters erodes the basic mineral building blocks for the shells and skeletons of calcareous and reef-building organisms such as shellfish and corals.[164] Although scientists are still in the early stages of understanding the consequences of ocean acidification for marine ecosystems, among the systems that appear at greatest risk are coral reefs. Coral reefs are already declining due to excessively high water temperatures causing coral bleaching events, from which they are often unable to recover.

Hurricane Sandy devastated coastal communities in New Jersey.

New Jersey Governor's Office/Tim Larsen

More Devastating Hurricanes

Atlantic hurricanes have increased in power since 1970, correlated with an increase in sea surface temperature in the region where hurricanes initiate.[165] Hurricanes are fueled by warm ocean waters, hence the intensity of hurricanes is likely to further increase during this century, bringing higher peak wind speeds, greater rainfall intensity, and higher storm surge heights and strength.[166] The increase in average summer wave heights along the U.S. Atlantic coastline since 1975 has been attributed to a progressive increase in hurricane power.[167]

Hurricane Sandy in October 2012 was a disastrous example of what climate change means for the future of America's coastlines. Coastal communities in New York and New Jersey experienced impacts never before seen, causing more than $60 billion in damages[168] and leaving an estimated 40,000 people in New York City still homeless nearly a week after the storm.[169]

Superstorm Sandy's powerful winds and storm surge reconfigured shorelines along much of the Mid-Atlantic coast, with particularly devastating effects from North Carolina to New York.[170] In many National Wildlife Refuges, the dikes of freshwater impoundments were breached by the storm surge and pounding waves. Of the 72 refuges in the region, thirty-five were temporarily closed.

Sea Turtle Habitat on Florida Beaches Threatened By Sea Level Rise

The southern Atlantic shores of the United States are highly vulnerable to sea level rise, which could be devastating for sea turtles. Gary Appelson, policy director at the Sea Turtle Conservancy in Florida, says that "sea level rise is one of the biggest threats" facing sea turtles. Along Florida's central Atlantic Coast, parts of the region could see a 49 to 80 percent decline in the area of ocean beach with just a 15-inch rise in sea level, which is well within the range projected during this century.[171]

Unhindered, beaches would naturally migrate inland. But "in Florida, the beachfront development line means that the beach cannot move inland as it would naturally," Appelson says. People try to protect ocean front properties by building sea walls, "but this only increases the erosion around them and has devastating impacts on turtles and their nesting habitat." Florida has "the most aggressive beach renourishment program in the country" and spends tens of millions of dollars every year adding sand to the beach. This is economically unsustainable because "the cost of doing this in perpetuity will be unbelievable."

Florida's beaches host 90 percent of all the sea turtle nesting in North America, as well as approximately 80 million tourists every year.[172] Sea level rise is already a problem. "The beaches are eroding, Appelson says. "They have been eroding for decades." Furthermore, sea turtles "depend on the in-shore marine environment" of barrier islands, bays and inlets. "Sea turtles use in-shore grass beds for extensive foraging habitat and depend on near-shore reefs for refuge. And they come from all over. Sea turtles leave their nesting areas far, far away to come to Florida's grass beds." These critical habitats will also be impacted by rising seas and increasing temperatures.

"Florida's beaches are ground zero for sea level rise," says Appelson, posing a huge threat not only to sea turtles but to Florida's coastal economy and residents. "One of the most important things we can do to protect sea turtles, and people, is to reform coastal management ... to incorporate climate change and sea level rise into planning, in addition to reducing carbon emissions."

CONCLUSION AND RECOMMENDATIONS

Confronting the climate crisis requires that we both address the underlying cause of climate change—by reducing our carbon pollution and transitioning to cleaner, more secure sources of energy—and that we consciously prepare for and adapt to current and future impacts of climate change and extreme weather events. Given the increasingly severe impacts of climate change, as documented in this report, aggressive action on both fronts is essential and must be a principle driver of U.S. energy policy and conservation practice.

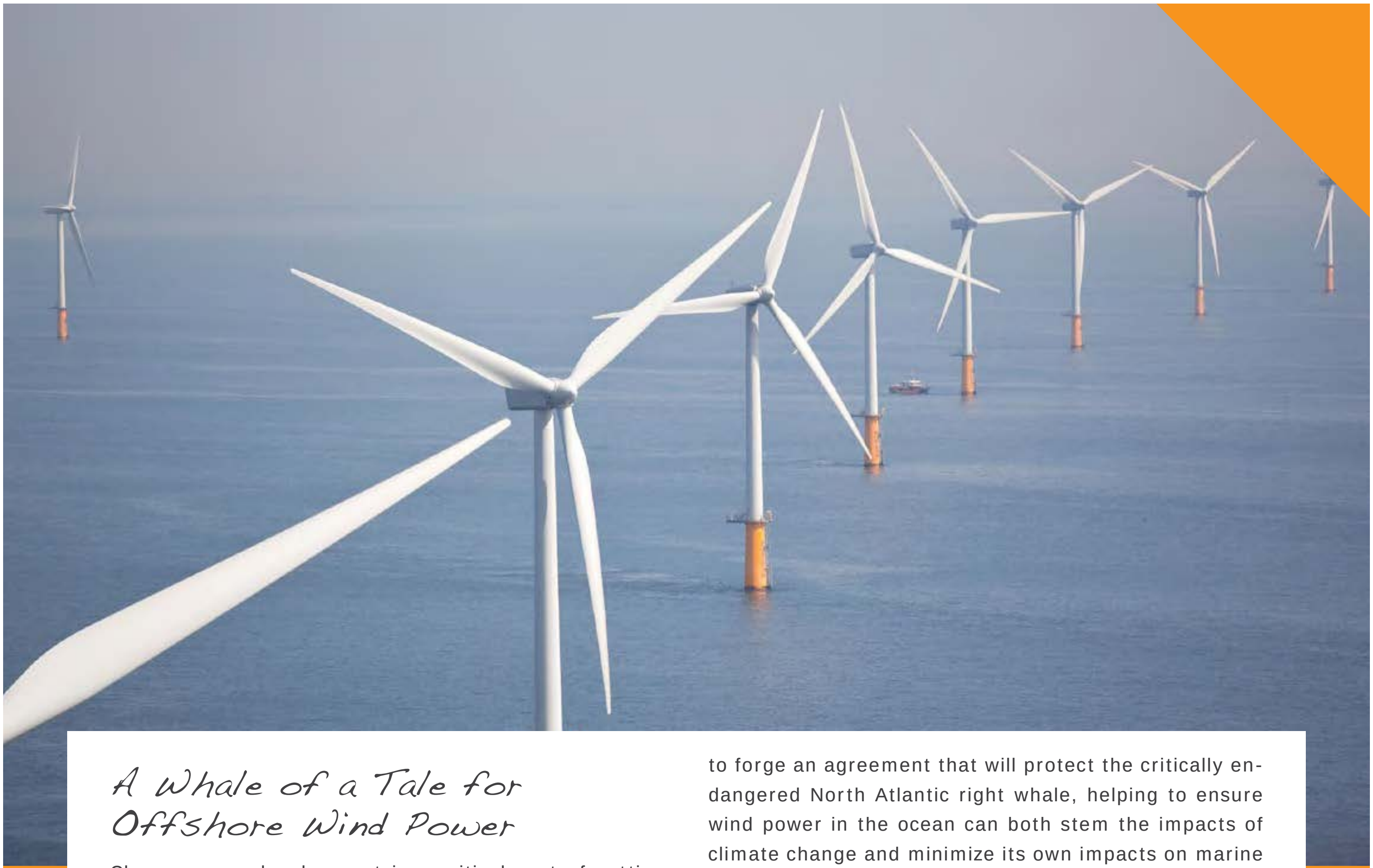
Protect People and Wildlife from the Worst-Case Climate Change Scenarios

U.S. Leadership on Reducing Carbon Pollution

The latest science on climate change is sobering news: Recent reports find that without significant new steps to reduce carbon pollution the world is on track for global temperature increases of at least 7 degrees Fahrenheit by the end of the century.[173] Such a scenario will guarantee that future generations will inherit a world fundamentally different than the one we know today, one in which scientists predict that almost half of wildlife species would suffer mass extinction. While the climate crisis is a problem that ultimately requires global action, America can be a leader in driving forward policies here at home that reduce the threat of catastrophic climate change. We can do this by taking swift, significant action to reduce carbon pollution and restore our natural systems that absorb carbon from the atmosphere.

We must:

- **Create a national climate change action plan** that establishes a clear path for the United States to reduce its carbon pollution 50 percent by the year 2030.
- **Put a price on carbon pollution** so that the fossil fuel industries responsible for the climate change impacts threatening our communities and wildlife pay the full cost of their pollution.
- **Use and protect the laws we have** on the books to limit carbon pollution from major air pollution sources like coal-fired power plants, oil refineries, and cars.
- **Prioritize energy policies** that support a rapid transition away from fossil fuels and advance the renewable energy sources needed to build a clean energy economy here at home.
- **Promote wise management** of grasslands, forests and agricultural lands as part of real-world strategies to remove excess carbon from the air and enhance wildlife habitat.



A Whale of a Tale for Offshore Wind Power

Clean energy development is a critical part of cutting carbon pollution and reducing the impact of climate change on wildlife. To protect wildlife from the dangers of a warming world, we must take appropriate, responsible action to replace as much of our dirty fossil fuel use with clean renewable energy sources as possible.

For example, ocean biodiversity is at risk from ocean acidification, rising water temperatures, and sea level rise caused by carbon pollution that fuels climate change. At the same time, the ocean offers a tremendous opportunity to reduce the carbon pollution threatening the ocean: offshore wind power..

Like any energy development—if done without proper planning, siting, risk assessment and design— there is a potential for clean energy to negatively affect wildlife. National Wildlife Federation (NWF) takes this issue seriously. That is why we are actively engaged with a number of stakeholders to ensure clean energy development—whether wind, solar, or bioenergy—first avoids, then minimizes and ultimately compensates for unavoidable impacts to wildlife.

With the long-awaited arrival of this massive source of clean energy comes the obligation to do it correctly for wildlife. NWF worked closely with major offshore wind industry leaders and marine conservation organizations to forge an agreement that will protect the critically endangered North Atlantic right whale, helping to ensure wind power in the ocean can both stem the impacts of climate change and minimize its own impacts on marine wildlife.

Scientists estimate that less than 500 North Atlantic right whales are currently roaming our Atlantic shorelines. The whales are sensitive to underwater noises, and there is concern that the early survey activities of offshore wind developers could disturb migrating whales and divert them off their typical course into areas where they may be more vulnerable to predation from sharks and orcas or collision with ocean vessels. With so few individuals left, scientists have suggested that the loss of even one female right whale poses a threat to the population as a whole.

We need rapid, responsible wind energy development in the Atlantic that avoids these types of unacceptable impacts. The exciting news is that the leaders in the U.S. offshore wind industry agree.

With colleagues at the Conservation Law Foundation, Natural Resources Defense Council, New England Aquarium, and companies like Deepwater Wind, NRG Bluewater, and Energy Management Inc., NWF helped forge a first-of-its kind agreement that balances the needs of industry, the conservation community and the right whale. For more details on this exciting work to protect wildlife while advancing critically needed clean energy, visit www.nwf.org/offshorewind

Invest in Smart Energy Choices that Protect Wildlife and Promote Economic Growth

A serious effort to reduce carbon pollution will require smart energy choices at every level—from our households to the national policy choices we make as a country—that reduce dependence on fossil fuels and move us quickly towards a future powered by clean energy. Rejecting dirty fuels and embracing responsible clean energy development are essential for protecting people and wildlife from the dangers of climate change while spurring economic development.

We must:

- **Promote a rapid transition to clean energy sources**, such as wind, solar, geothermal, and sustainable bioenergy, by establishing national and state energy standards that ensure America is getting at least 50 percent of our electricity from clean, responsibly-sited renewable energy.
- **Stop the expansion of new dirty energy reserves**—like the massive coal fields in North America and the tar sands oil fields in Canada—and end federal subsidies that support fossil fuels, so that America is not locked into more carbon pollution for decades to come.
- **Ensure that all federal and state permitting decisions on energy projects are informed** by a thorough assessment of the resulting wildlife, water, land, and climate impacts, guided by smarter upfront planning, and maximize opportunities to reinvest revenue to address impacts to communities and natural resources.
- **Advance currently untapped, underutilized, and wildlife-friendly clean energy sources** such as offshore wind, distributed renewable generation, energy efficient buildings, and sustainable transportation options.
- **Promote truly sustainable biofuels and biomass energy production**, here at home and abroad, that not only ensures long-term economic viability of the industry but also protects and enhances native habitats and ecosystems.

Safeguard Wildlife and Natural Systems from the Impacts of Climate Change


USFWS

Sustain Our Conservation Legacy through Safeguarding Wildlife and Their Habitats

The past century of conservation achievements are now at risk from the pervasive effects of climate change. Although climate change is global in nature, its effects are acutely local. Climatic shifts are amplifying the effect of a host of existing threats to our species and ecosystems, and undermining the ability of natural systems to provide for both people and wildlife. To sustain our rich legacy of conservation achievements, and ensure the survival of cherished wildlife species, policies and practices will have to embrace climate-smart approaches to conservation. Preparing for and managing these changes—climate adaptation—increasingly will need to serve as the basis for wildlife conservation and natural resource management.

Actions that can be taken now to prepare for and cope with the new conservation challenge include:

- Aggressively implement the forthcoming National Fish, Wildlife, and Plants Climate Adaptation Strategy, which represents a shared federal, state, and tribal vision for 21st century conservation.
- Promote the practice of "climate-smart conservation" by encouraging forward-looking conservation goals and by designing conservation actions to reduce climate vulnerabilities and enhance ecosystem resilience.
- Provide adequate space for wildlife to shift ranges in response to changing climatic conditions through strategic expansion of parks and refuges, enhancing connectivity among these protected habitats, and encouraging wildlife-friendly practices on lands and waters for agriculture, ranching, and other human uses.
- Provide adequate funding for federal and state programs critical to advancing climate science and adaptation, such as the Department of the Interior's Climate Science Centers and Landscape Conservation Cooperatives, and the U.S. Fish and Wildlife Service's State Wildlife Grants program.
- Ensure that actions taken to reduce carbon pollution are designed to minimize impacts on wildlife and their habitats, and encourage approaches for sequestering carbon in natural ecosystems that enhance habitat values.

Make Communities and Wildlife Safer from Extreme Weather

We live in a new era of extreme weather, driven in large part by climate change, and it is therefore critical to prepare people, property, and communities for a future of stronger, more damaging storms, flooding, heat waves, prolonged drought, and other extremes. We must make smarter development and infrastructure investments that reduce our risks from future extreme weather impacts, specifically by re-thinking where and how we build, and by increasing the resilience and adaptive capacities of ecological systems to help safeguard communities.

When natural disasters strike, rebuilding and recovery efforts should prioritize nature-based approaches, like restoring floodplains, to mitigate future risks.

Business as usual is no longer an option and we must work across sectors and scales of government to anticipate and prepare for extreme weather in the following ways:

- Promote climate readiness by supporting local, state, and federal agency efforts to develop climate adaptation plans that help communities understand their vulnerability to extreme weather and help them prepare for and cope with its impacts in ways that are beneficial for both people and wildlife.
- Prioritize and promote the use of non-structural, nature-based approaches, like living shorelines, to prepare for extreme weather; although hard armoring, like sea walls, may sometimes be necessary, climate adaptation planning should emphasize approaches that enhance ecosystems and habitats while providing natural protection against extreme weather.
- Require all federal, state, and local government agencies, service providers, and emergency responders to incorporate best-available climate change science into long-term disaster risk reduction and hazard mitigation activities and planning.
- Direct development and infrastructure away from environmentally sensitive and climate-vulnerable areas by using land-use planning tools, like zoning and comprehensive plans; by incentivizing development in less vulnerable areas; and by acquiring land in vulnerable areas better suited for wildlife habitat than for development.
- Build productive, sustainable urban landscapes through smarter planning and design choices that use green infrastructure, including landscape features (open space, parks, tree canopy) and low-impact development, to build resilience to climate impacts and reduce carbon pollution, while also providing wildlife habitat.

NOW IS THE TIME
TO CONFRONT THE CLIMATE CRISIS

Our nation's plants, fish, and wildlife are already facing a climate crisis with many changes happening faster than scientists anticipated, putting America's people and wildlife at risk. Extreme weather is devastating communities and habitats; species' range shifts are happening two to three times faster than previous estimates; and more and more wildlife species are on the brink of extinction due to human-caused climate change. Now is the time for America to take swift, bold action to reduce carbon pollution that is heating the planet and properly deal with the unavoidable impacts of an already changing climate.

The rest of the world has already begun to address the risks presented by the rapidly warming planet and are moving ahead with action to address the challenge. The clean energy sector is growing rapidly—global investments have increased by more than 600 percent in the past seven years[174]—and the United States is losing out.[175] For example, China and Germany have long-term, national, clean energy policies to attract investment and spur job creation, quickly leaving the United States behind. America needs to recognize that inaction is not a viable climate change policy and prevents us from taking advantage of the opportunities to create jobs and economic prosperity in concert with bold, swift action to reduce the carbon pollution that is heating our planet.

By harnessing America's spirit of ingenuity and leadership, we can confront the climate crisis and sustain our nation's conservation legacy. The challenges that climate change poses for wildlife and people are daunting. Fortunately, we know what's causing these changes, and we know what needs to be done to chart a better course for the future. As we begin to see whole ecosystems transform before our very eyes, we also know that we have no time to waste.

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Learn more & act!

www.nwf.org/climatecrisis

Shannon Smith/USFWS

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Front Cover: Arctic fox: Corel; Wildfire: U.S. Forest Service

Back Cover: Catherine Manley

Acknowledgments:

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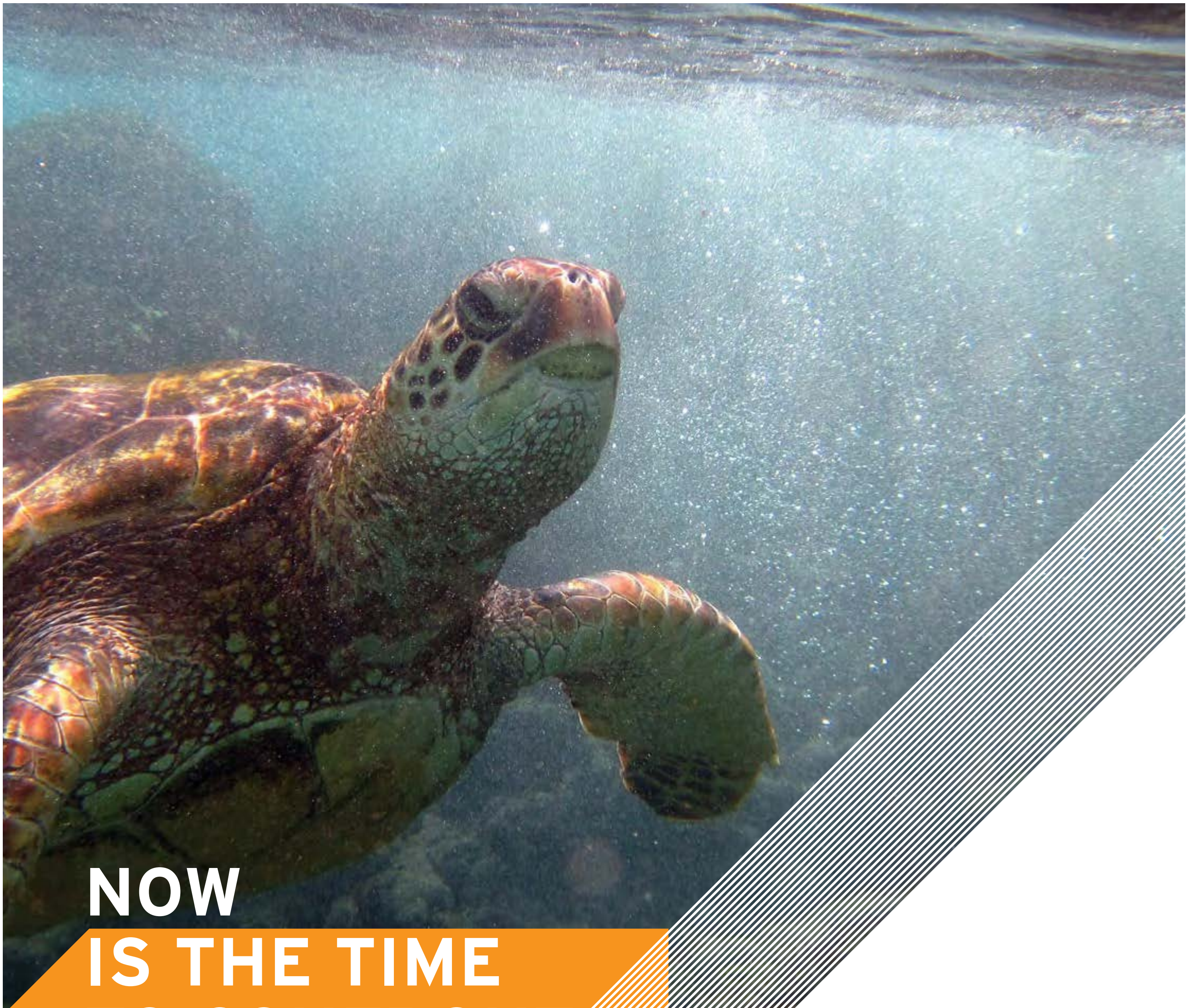

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