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Conserving Endangered Species in an Era of Global Warming

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Editors' Summary: While the ESA is lauded as one of the country's most powerful tools of environmental protection, the statute may not be strong enough to protect wildlife and habitat in the face of global warming. In this Article, John Kostyack and Dan Rohlf argue that legislative and administrative changes will be needed if the ESA is going to make a real difference in protecting biodiversity from the dangers of climate change. They describe the effects that climate change will have on wildlife and habitat, and relay a list of potential management responses to these effects. They then discuss implementation challenges that climate change will bring, such as difficulties in designating critical habitat for wildlife moving due to warming. Finally, the authors conclude with some policy recommendations, including how to tackle climate change legislation, update the ESA, and institute adaptive management practices.

I. Introduction

Global warming is the single most urgent threat to the future of wildlife and wildlife habitat. The 2007 reports of the Intergovernmental Panel on Climate Change (IPCC) conclude that human activity is "very likely" causing the world to warm. These reports also note that the average surface temperature of the earth increased 0.76 degrees Celcius (°C) (1.4 degrees Fahrenheit (°F)) in the 20th century and predict that this temperature will likely increase by another 1.8 to 4.0°C (3.2 to 7.2°F) in the 21st century, depending on pollution levels.[1] The IPCC also finds that 20-30% of species worldwide are likely to be at increased risk of extinction if increases in average global temperatures exceed 2 to 3°C (3.6 to 5.4°F) above pre-industrial levels.[2]

Our children and grandchildren will inevitably ask if we sat up and took notice when the prospect of this massive wave of human-caused extinctions became apparent to us. Given the potential magnitude of the loss of the world's biological wealth, the only appropriate response is to act immediately to avert it. This Article discusses some of the actions necessary to avoid dire outcomes for wildlife, focusing on how the U.S. Congress and executive branch agencies can both strengthen and employ the Endangered Species Act (ESA) to make significant strides in addressing the threats to biodiversity posed by global warming.

II. The Challenge of a Changing Climate

Global warming has posed a serious threat to people and wildlife for decades. Atmospheric carbon dioxide (CO_2) and other greenhouse gases (GHGs) that trap heat and warm the planet have increased by more than 30% since the beginning of the Industrial Revolution. The standard measure of these gases, CO_2 equivalents (CO_2e), now stands at 383 parts per million (ppm) and is steadily increasing at a rate of 1.5 ppm per year. Until recently, however, policymakers in the United States have largely sat on their hands while various economic interests and advocacy groups raised doubts about whether global warming is real and whether observed changes in climate stemmed from human-caused emissions of GHGs. But over the past few years, a wealth of new empirical climate data—punctuated by dramatic images of collapsing glaciers and melting polar ice caps—have made it impossible for anyone to deny the existence of global warming. Further, work of the Nobel Peace Prize-winning IPCC, based on collaborative efforts of preeminent scientists from around the world, has virtually eliminated doubts about the central role of human activities in causing climatic change.

James Hansen, the National Aeronautics and Space Administration's (NASA's) premier climate researcher, warns that the planet is at risk of soon reaching a "tipping point," where levels of GHGs become so high and resulting warm-

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1. IPCC, Climate Change 2007: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Susan D. Solomon et al. eds., Cambridge Univ. Press) [hereinafter IPCC, The Physical Science Basis].

2. IPCC, Climate Change 2007: Impacts, Adaptation, and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Martin L. Parry et al. eds., Cambridge Univ. Press).

ing becomes so substantial as to trigger "positive feedback" loops that will further exacerbate the problem.[3] For example, as global warming melts Arctic permafrost, the resultant release of methane, a powerful GHG, will cause substantial additional warming. Similarly, as Arctic ice melts, the open ocean absorbs more of the sun's energy than the highly reflective ice, causing even more rapid warming.

Unless governments and people around the world take action quickly to curtail global warming pollution, we will face rapid warming and other climatic and physical changes, including disappearing polar ice caps, large rises in sea levels, and extreme floods and droughts. If this scenario unfolds, society would increasingly turn its focus to providing for the countless climate refugees fleeing sea-level rise and drought, developing new supplies of food and drinking water, and otherwise rebuilding the infrastructure of civilization. The ESA and most other traditional wildlife conservation programs would likely face drastic curtailments in the face of these competing priorities.

In the United States, Congress could make significant progress toward averting such worst-case climate change scenarios by enacting legislation capping GHG emissions, with a target of 2% annual reductions across the U.S. economy through the middle of the 21st century. Such action, combined with personal lifestyle changes, would enable the United States to achieve an 80% reduction in global warming pollution from current levels by 2050. Putting such a program in place would give the United States credibility to secure similar commitments from other nations. The challenges of achieving reductions of this magnitude are great, but society has met big challenges before. The goal of a safe climate is well within reach.

Even as work proceeds to reduce global warming pollution, we must recognize that reducing GHGs alone will not be enough to prevent widespread extinctions of species with which we share the planet. Even with significant reductions in global warming pollution from human sources, at least another 0.6°C (1.1°F) increase will inevitably occur (over and above the increase of 0.76°C (1.4°F) in the 20th century) in the coming decades due to GHGs already released into the atmosphere. Therefore, even if we immediately act to curb warming pollution, wildlife will still face threats from altered climates and major ecosystem disruptions.

To help wildlife survive inevitable global warming, we need to discuss actions that policymakers and resource managers can implement now. First, U.S. policymakers have an enormous obligation to help address the threat posed by global warming to people and wildlife in other countries. Although there are substantial limits to the ESA's ability to conserve wildlife abroad, the United States has a clear moral imperative to deliver technical and financial assistance to advance biodiversity conservation beyond its borders. Although making up only 5% of the world's population, the United States has contributed 25% of global warming pollution currently in the atmosphere. Meanwhile, global warming is harming wildlife and ecosystems around the world, even though people living in those areas often are not significant contributors to the problem—and often lack the resources needed to confront it. The United States thus must devote significant resources of its own toward assisting developing countries with protecting biodiversity in the face of climate change; such contributions could also enhance U.S. efforts to encourage these countries to adopt limitations on their GHG emissions.

At the domestic level, the ESA can play a significant role in conserving U.S. wildlife threatened by global warming. When Congress enacted the ESA in 1973 and amended the statute in the 1970s and 1980s, lawmakers did not see global warming as a significant threat to wildlife. However, policymakers designed the ESA to address all threats to wildlife, no matter what their origin. Thus, no radical changes to the law are needed to ensure that the ESA addresses the effects of global warming. On the other hand, climate change greatly increases extinction risks of species already imperiled for other reasons and thereby greatly reduces the margin for error in implementing the ESA's protections and recovery programs. Policymakers therefore will need to consider significantly strengthening ESA programs—as well as increasing ESA funding—to help fulfill the nation's commitment to conserve abundant wildlife and healthy ecosystems for future generations.

As discussed below, the fate of wildlife and ecosystems hinges on the willingness and ability of policymakers and natural resource managers to confront global warming-related threats. Natural resource managers will need to become much more conversant in integrating climate models and other considerations of climate change into ESA implementation, and policymakers will need to provide direction and funding to facilitate this integration. To maximize the chances that the ESA will meet its conservation goals, agencies implementing the law must confront global warming head-on.

III. Global Warming's Impacts on Wildlife and Wildlife Habitats

Global warming is exactly that: global. No ecosystem on earth is immune to its effects. Herein, we review the impacts of global warming by major habitat types. But it is important to note that across all habitat types, two serious problems have surfaced at the species level: (1) changes in phenology (timing of seasonal events); and (2) changes in distribution of wildlife (most notably, the disappearance of northern hemisphere wildlife species from the southern portions of their ranges and from lower elevations). An example of the former phenomenon is the shift in the time of springtime peak insect abundance, which affects the reproductive success of songbirds that depend on high insect levels during the critical nestling phase. The 90% decline of the northwestern Minnesota moose population in the past 20 years, which biologists have attributed to excessive heat, provides an example of the latter.[4] Another example is the decline of the American pika, a small rabbit-like mammal that inhabits talus fields in the mountains of the western United States. One study of Great Basin pikas finds that their range has shifted upslope by 900 feet and 36% of populations has been extirpated.[5]

3. James E. Hansen, *A Slippery Slope: How Much Global Warming Constitutes "Dangerous Anthropogenic Interference"?*, 68 Climate Change 269-79 (2005).

4. Dennis L. Murray et al., *Pathogens, Nutritional Deficiency, and Climate Influences on a Declining Moose Population*, 166 Wildlife Monographs 1-30 (2006).

5. Erik A. Beever et al., *Patterns of Apparent Extirpation Among Isolated Populations of Pikas in the Great Basin*, 84 J. Mammology 37-54 (2003).

A. Rivers, Streams, and Lakes

Even without taking global warming into account, threats such as dams, levees, channelization, polluted runoff, water withdrawals, and invasive species place much of the rich U.S. heritage of freshwater aquatic biodiversity at risk of extinction. Global warming adds a host of additional stressors to aquatic ecosystems. Warming of surface temperatures increasingly makes many rivers, streams, and lakes uninhabitable for cold water fish such as salmon and trout. For example, in summer 2006 and 2007, state officials shortened the trout fishing season in Montana because excessive water temperatures were placing too much stress on fish.

Snow pack across much of the West is declining due to warmer temperatures, which causes more precipitation to come in the form of rain rather than snow.[6] As a result, an increasing percentage of snow melts in the spring rather than summer. Summer stream flows drop precipitously, with serious consequences for both farmers and fish at the time both are in greatest need of water. These low flows, combined with elevated temperatures (which lowers the capacity of water to hold oxygen), renders habitat less suitable or even lethal for a host of species.

Warming also poses a serious threat to lake habitats (and the rivers flowing from these lakes) as increased evaporation rates causes lowered water levels. Hydrologists predict that water levels in the Great Lakes, the source of 90% of U.S. freshwater, will decline by up to eight feet by the end of the century if current global warming pollution trends continue.[7] Water levels for Lakes Erie, Huron, and Michigan have already declined 3.5 feet since 1997.[8] Continued drops in water levels would destroy or degrade hundreds of miles of delicate lakeshore habitats.

B. Wetlands

Increased temperatures and altered hydrologic cycles also stress and degrade wetland habitats. The prairie pothole region of the northern Great Plains, a major breeding ground for waterfowl, is especially vulnerable to increased evaporation caused by higher temperatures.[9] Even if precipitation increases in the prairie pothole region, experts predict that the increase in temperatures will increase evaporation, resulting in drier soils, earlier spring drying, and fewer potholes. By the end of this century prairie potholes could shrink by 38-54%, with accompanying declines in waterfowl populations.

C. Forests

Pests and disease, once kept in check by the cold of the winter, now thrive in many forests thanks to the warmer environment. In many regions, intensified droughts exacerbate this problem. As a result, a massive wave of forest die-offs around the globe is underway. In the northern latitudes of North America, epidemics of mountain pine beetles have killed entire forests because the increasingly warm winters have failed to provide the hard freezes which historically killed large proportions of overwintering mountain pine beetle larvae.[10] In the southern latitudes, southern pine beetles now complete more generations in a single growing season, resulting in rapid population expansions and subsequent pine die-offs.[11] Increased temperatures, drier conditions, and increases in dead trees have led to a fourfold and sixfold increase in the number and area, respectively, of catastrophic fires in western forests in the last two decades.[12] This loss poses serious problems for the wide array of wildlife species, such as the Canada lynx and pine marten, dependent on forests for food and cover.

D. Shrub Steppe and Desert Habitats

Shrub steppe and desert habitats will likely suffer a decline of rainfall in some regions and elevated CO_2 throughout these biomes. Invasive plant species already have become a serious threat to native wildlife in many thousands of acres in western North America. Studies show that elevated CO_2 levels may enhance these species. Moreover, these plant invaders are often more susceptible to fire, so their increased presence could exacerbate catastrophic fires.[13] Native wildlife in arid and semi-arid ecosystems, such as the sage grouse and the Wyoming toad, could suffer significant reductions as a result.

E. Coasts and Estuaries

The global average sea level rose about 6.7 inches (0.17 meters) in the past century. The latest IPCC reports project an additional 7- to 23-inch rise, due mostly to thermal expansion of the water, by the end of the century if current global warming pollution trends continue.[14] These projections likely understate actual threats because IPCC estimates do not account for recent observations showing significantly increased rates of melting of Greenland ice over the last several years.[15]

In many places, intensification of tropical storms that accompanies global warming exacerbates the threat posed by sea-level rise. Tropical sea-surface temperatures have risen by about 0.5ºC since 1970.[16] Although scientific consensus has not clearly linked the frequency of tropical storms to climate change, those storms that do occur have been more in-

6. Phillip W. Mote et al., *Declining Mountain Snowpack in Western North America*, 86 Bull. Am. Meteorological Soc'y 39-49 (2005).

7. Brent M. Lofgren et al., *Evaluation of Potential Impacts on Great Lakes Water Resources Based on Climate Scenarios of Two GCMs*, 28 J. Great Lakes Res. 537-54 (2002).

8. International Joint Commission, Climate Change and Water Quality in the Great Lakes Basin (2003).

9. W. Carter Johnson et al., *Vulnerability of Northern Prairie Wetlands to Climate Change*, 55 Bioscience 863-72 (2005).

10. David D. Breshears et al., *Regional Vegetation Die-Off in Response to Global-Change-Type Drought*, 102 Proceedings Nat'l Acad. Sci. 15147 (2005).

11. David W. Williams & Andrew M. Liebhold, *Climate Change and the Outbreak Ranges of Two North American Bark Beetles*, 4 Agric. & Forest Entomology 87-99 (2002).

12. Anthony L. Westerling, *Warming and Earlier Spring Increases Western U.S. Forest Wildfire Activity*, 313 Science 940-43 (2006).

13. Donald McKenzie et al., *Climate Change, Wildfire, and Conservation*, 18 Conservation Biology 1-13 (2004).

14. *See* IPCC, The Physical Science Basis, *supra* note 1.

15. Stefan Rahmstorf, *A Semi-Empirical Approach to Projecting Future Sea-Level Rise*, Science 315, 368-70 (2007).

16. Tim P. Barnett et al., *Detection of Anthropogenic Climate Change in the World's Oceans*, 292 Science 270-74 (2001).

tense (category 4 and 5) over the past 30 years, a trend directly linked to increases in sea-surface temperatures.[17]

Rising seawater harms coastal ecosystems in a variety of ways. Increasing seawater depth and loss of sunlight, oxygen, and nutrient flows overwhelms salt marshes and other shallow habitats adapted to shallow saltwater environments.[18] Seawater is toxic to brackish water species, and brackish water is toxic to freshwater species. Rising sea levels disturb the delicate balance between aquatic species and the sunlight, oxygen, nutrients, and salinity in their habitats, especially in areas where ecosystems are unable to migrate inland because of human development[19] and so-called armoring of the coasts to protect human infrastructure. Available projections indicate that sea-level rise alone will destroy 20% of coastal wetlands around the globe by 2080.[20]

F. Oceans

Ocean wildlife faces threats from both warming and the ocean's absorption of CO_2—the primary GHG emitted by human activities. Absorption of CO_2 increases ocean acidity, with dramatic consequences for organisms from corals to the plankton that serve as the foundation of most marine food webs.[21] This "ocean sponge" effect makes it increasingly difficult for marine organisms that use calcium to build skeletons and shells. Decreased calcification compromises fitness of individual species and ultimately threatens to adversely impact entire marine food webs, substantially altering the biodiversity and productivity of the ocean.

Warmer ocean temperature has a wide array of deleterious effects. Perhaps most visible is the massive coral bleaching events and die-offs that have occurred worldwide, including along the continental shelf of North America.[22] Two North American coral species, the elkhorn and the staghorn, were the first species ever to be listed under the ESA due in part to global warming.[23] Coral reefs are among the ecosystems that are most sensitive to climate change, and conservative estimates suggest that one-half of all reefs will be destroyed by 2030-2050. Coral reefs buffer shorelines from storms and erosion and provide habitat for countless marine species. Approximately one-half of all U.S.-managed commercial fish species depend on coral reefs for at least a portion of their life cycle.

G. Arctic

The pending proposal to list the polar bear as threatened under the ESA highlights the severe threat that global warming poses to wildlife in the Arctic. Wildlife is perhaps at greater risk in the Arctic than anywhere else on the planet because the magnitude of temperature increases substantially from the equator toward the poles. The average annual temperature in the Arctic has risen at nearly twice the rate as the global average, with the greatest increase occurring in winter months.[24] As a result, permafrost is thawing, with tundra habitat rapidly disappearing and giving way to lakes, wetlands, and a northward progression of trees and shrubs.[25] Experts expect some of these areas to ultimately turn into cold deserts because soil types are not suitable for retaining water.[26] Tundra habitats serve as major nesting areas for a variety of migratory waterfowl as well as habitat for species, such as caribou, important to indigenous people's diets.[27]

Sea ice is rapidly disappearing from the Arctic. A recent study projected that 40% of summer sea ice would be gone from the Arctic by mid-century.[28] Even this disturbing study does not reveal the full extent of the problem because it does not include the record-breaking summer sea-ice declines of 2005 and 2007. In 2007, summer sea ice diminished to 1.65 million square miles, 39% less ice than the long-term average between 1979 and 2000.[29] Commenting on these latest developments, one leading NASA climate scientist predicted that the Arctic would be mostly ice-free in the summer as early as 2012.[30]

Continued melting along this rapid trajectory will have dire consequences for Arctic wildlife and the indigenous people who rely upon this wildlife for their survival. The polar bears in James and Hudson Bays in Canada, which have suffered 15% declines in the average weight and in the number of cubs born in a recent 15-year period, provide a disturbing glimpse into the future.[31] Because polar bears depend on sea ice for hunting and because periods without sea ice have increased, these bears must go longer without feeding, and as a result suffer declines in reproduction and overall health. Polar bears are unlikely to survive the end of this century if, as some climate models predict, summer sea-ice cover completely disappears from their habitats.[32] The prospects for a number of other Arctic species, such as the walrus, ivory gulls, little auks, and several species of seals, are equally bleak if the sea ice continues to melt as forecasted under current warming trends.[33]

17. P.J. Webster et al., *Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment*, 309 Science 1844-46 (2005).
18. Sam H. Pearsall, *Managing for Future Change on the Albermarle Sound*, *in* Climate Change and Biodiversity 359 (Thomas E. Lovejoy & Lee Hannah eds., Yale Univ. 2005).
19. *See id.*
20. Habiba Gitay et al., Climate Change and Biodiversity: IPCC Technical Paper V 1 (2002), *available at* http:www.ipcc.ch/ipccreports/technical-papers.htm.
21. Joan A. Kleypas et al., *Geochemical Consequences of Increased Atmospheric Carbon Dioxide on Coral Reefs*, 284 Science 118-20 (1999).
22. Ove Hoegh-Guldberg, *Climate Change, Coral Bleaching, and the Future of the World's Coral Reefs*, 50 Marine & Freshwater Res. 839-66 (1999).
23. 71 Fed. Reg. 26852 (May 4, 2006).
24. Susan Joy Hassol et al., Impacts of a Warming Arctic: Arctic Climate Impact Assessment 19, 22 (Cambridge Univ. Press 2004).
25. *Id.* at 48.
26. *Id.* at 49.
27. Gitay et al., *supra* note 20, at 32.
28. James E. Overland & Muyin Wang, *Future Regional Arctic Sea Ice Declines*, 34 Geophysical Res. Letters L17705 (Sept. 2007).
29. National Snow & Ice Data Ctr., *News & Events*, http://nsidc.org/news/press/2007_seaiceminimum/20071001_pressrelease.html#fig4 (last visited Feb. 15, 2008).
30. National Geographic News, Daily News, *Arctic Sea Ice Gone in Summer Within Five Years?*, http://news.nationalgeographic.com/news/2007/12/071212-AP-arctic-melt.html fig4 (last visited Feb. 15, 2008) (quoting NASA climate scientist Jay Zwally).
31. Hassol et al., *supra* note 24, at 58.
32. *Id.*
33. *Id.* at 58-59.

IV. Potential Management Responses

Wildlife managers can take action now to build resiliency into natural systems and thereby ameliorate the impacts of global warming. Recognizing the threat of global warming to wildlife and wildlife habitats, the Wildlife Society recommended a series of actions to increase the likelihood of wildlife survival.[34] These recommendations, as well as others prepared by scientific experts, acknowledge that the impacts of global warming on wildlife and ecosystems will exceed our ability to forecast. Despite the uncertainties of local climate projections, the actions listed below will improve the chances of wildlife survival.

The Wildlife Society report includes a category of recommended actions that require agency managers to understand and apply the science of global warming and its impacts. These include:

- **Protect coastal wetlands and accommodate sea level rise**: Managers can reduce the negative impacts associated with sea level rise through modeling of future sea-level rise and land deposition, protection of coastal wetlands, and acquisition of inland buffer zones to provide an opportunity for wildlife to move inland.
- **Adjust yield and harvest models**: As fish and wildlife populations respond both directly to climate and indirectly through climate-induced changes in habitats, their productivity and sustainability may increase or decrease. Managers will need to adapt yield and harvest regulations both in anticipation and response to these changes.
- **Build corridors for wildlife movement**: As vegetative zones move toward the poles and up mountain slopes in response to warming, wildlife managers will need to design corridors to provide potential opportunities for mobile wildlife species to move to suitable habitat types.
- **Consider global warming models as well as historical data when making projections**: Managers must be aware that historical climate, habitat, and wildlife conditions are not indicative of future conditions. Projections and planning must take into account expected changes in climate.
- **Look for new opportunities**: Managers must be ready to anticipate and take advantage of new opportunities. For example, if climatic conditions leave existing agricultural areas unusable for agriculture, they could become important wildlife conservation areas with appropriate agency and landowner collaboration.

As noted earlier, the stress of climate change on ecosystems, when added to existing stresses, means that there is decreased margin for error. Another category of actions in the Wildlife Society report calls for agency managers to continue long-standing wildlife management practices, but to implement these practices more rigorously in light of this decreased margin for error. These actions include the following:

- **Maintain healthy, connected, genetically diverse populations**: Small isolated populations are more prone to local extirpations than larger, more widespread populations. Although managers already encourage healthy populations, global warming increases the importance of this goal and will likely require adjustments in population targets.
- **Reduce non-climate stressors on ecosystems**: Reducing other human-induced stressors such as toxic pollution and habitat loss will minimize negative synergistic impacts with global warming and increase the resiliency of habitats and species to the effects of climate change and variability.
- **Prevent and control invasive species**: Rapidly changing climates increase opportunities for invasive species to spread. Prevention measures, monitoring, and control can help limit the negative impacts of invasive species.
- **Reduce the risk of catastrophic fires**: Global warming leads to more frequent fires and a greater probability of catastrophic fires. Managers can use prescribed fires and other techniques to reduce fuel load and the potential for catastrophic fires.
- **Employ monitoring and adaptive management**: Perhaps most importantly, wildlife managers will need to employ monitoring and adaptive management at a level of rigor never before seen in the history of wildlife conservation. Traditional, long-practiced methods and strategies will not be effective in light of the rapid ecosystem changes that are underway. We discuss this new emphasis on monitoring and adaptive management, along with the myriad other ways that the ESA must respond to climate change, in the following sections.

V. Global Warming Poses Unprecedented Challenges for Those Implementing the ESA

Just as climate change poses encompassing threats to the planet's ecosystems, it raises fundamental challenges to our government's ability to stem and ameliorate these threats. Though the U.S. Supreme Court labeled the ESA "the most comprehensive legislation for the preservation of endangered species ever enacted by any nation,"[35] the federal agencies charged with implementing the statute are only now beginning to consider how it can remain an effective conservation tool in light of global warming's tremendous threats to biodiversity. It is obvious that climate change will demand more of everything—more species listed as threatened or endangered, more resources devoted to assessing and reducing biological risks and to restoration efforts, and more agency personnel for implementation. In this section, we go beyond the obvious need to devote greater resources to saving threatened and endangered species in a warming world to explore the difficulties and questions that the central environmental threat of the 21st century will raise for a law enacted 35 years ago at the dawn of the modern environmental era.

34. Douglas B. Inkley et al., Global Climate Change and Wildlife in North America (Wildlife Society 2004).

35. Tennessee Valley Auth. v. Hill, 437 U.S. 153, 180, 8 ELR 20513 (1978).

A. Listing

Section 4 of the ESA contains the statute's provisions for identifying the species to place on the threatened and endangered rolls, for designating the critical habitat of those species, and for devising recovery plans to guide activities to restore imperiled species. Already, however, climate change has presented difficult questions in this arena. The ESA includes among its factors for listing the "present *or threatened* destruction, modification, or curtailment of [species'] habitat or range," as well as the "inadequacy of existing regulatory mechanisms."[36] However, how should we interpret and apply these listing factors when it is not a stretch of the imagination to say that climate change likely "threatens" the habitat or range of at least one-third of the species in existence—and that at least at present we certainly lack adequate regulatory mechanisms to deal with the dangers it presents to these species and their habitat? The U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) (collectively, the Services) lack the resources to list as threatened or endangered thousands of species, and it is not clear that such a massive listing program, even if possible, would lead to increased conservation efforts. Will climate change render obsolete the ESA's current lists of threatened and endangered species? The pervasive dangers to the biota due to climate change, as well as our failure so far to develop legal mechanisms to control the source of these dangers at both the domestic and international levels, raise complex uncertainties about how we will target particular species (or other levels of biodiversity) to receive special legal protections.

B. Critical Habitat Designation

Identifying and protecting habitat is perhaps the most fundamental and yet most controversial part of species conservation. As the only part of the ESA that explicitly protects habitat, the Act's provisions pertaining to what the statute terms critical habitat have been the center of controversy for many years. The ESA's key critical habitat provisions are: (1) §3, which defines critical habitat; (2) §4, which sets forth procedures for designation of critical habitat; and (3) §7 (discussed below), which prohibits federal agencies from authorizing, funding, or carrying out actions that adversely modify designated critical habitat. Although somewhat confusingly worded, §3's definition of critical habitat contains the key concepts that will likely become the focus of ESA implementation in a changing climate. It defines critical habitat as habitat that is "essential for conservation" and it recognizes that such habitat may include lands or waters unoccupied by the species. In recent years, the FWS has demonstrated its hostility to critical habitat designations by excluding from such designations those lands that are unoccupied by the species, even if they could potentially provide important parts of the species' life-cycle needs and are part of the historical range. The Services should immediately end this unwritten policy of failing to recognize the importance of currently unoccupied habitat for the recovery of some species. Moreover, the Services will likely confront increasing evidence that climatic changes are causing species' ranges to shift, and that unoccupied portions of species' habitat in the United States to the north and upslope from where they now exist are essential for conservation of many listed species.

Given the complexity of determining which habitats are essential for conservation in an era of changing phenology, range shifts, and ecosystem disruptions, the Services will inevitably run into increased difficulty in meeting the statutory deadlines for designating critical habitat. Under §4, designations must be finalized within one year after listing. However, the process of listing a species does not fully answer questions about its habitat needs. Determining the future spatial arrangements of a species' habitat in a warming climate poses greater challenges than determining that it is threatened and endangered. Modifying §4 to make critical habitat designation a component of recovery planning, and imposing deadlines of three years after listing for completion of recovery plans, would strengthen the scientific basis for such designations, as well as afford the Services additional time to delineate habitats, a process which will be crucial to species conservation as the climate changes.

C. Recovery and Delisting

Climate change also vastly complicates the reverse of listing under §4—the process of planning for, working toward, and hopefully eventually recovering species listed under the ESA. This section requires preparation and implementation of recovery plans and authorizes the Services to remove from the threatened and endangered rolls those species which no longer require the legal umbrella of the ESA. However, many species now depend on habitat or ecological processes so altered by human activity that these species will need intensive management efforts on an ongoing basis simply to ensure their continued existence.[37] Such plants and animals, sometimes called "conservation-reliant" species, may never recover as Congress contemplated in §4 because they require on a perpetual basis the legal protections and management obligations imposed by the ESA. Given that by virtually any conceivable scenario we are not likely to solve the problem of climate change in the foreseeable future, many species now on the protected lists are likely to fall into the conservation-reliant category. This may mean that the emergency room analogy commonly used to describe the ESA, wherein the Act saves species from a disaster and then discharges them to their natural state, must for many species give way to seeing the statute more as long-term intensive care. Under this conception of the law, recovery of listed species would not serve as the ESA's principal goal for many species imperiled by climate change; instead, maintenance plans and their implementation would focus on perpetually managing targeted species so they do not experience significant declines or become extinct.

D. Consultation and the Jeopardy and Critical Habitat Protection Duties

The procedural and substantive protections of §7 will almost certainly continue to play a vital role in any future framework for conserving imperiled species. Its provisions require federal agencies to assess their actions and consult

36. 16 U.S.C. §1533(a)(1)(A) and (E), ELR STAT. ESA §§2-18 (emphasis added).

37. *See, e.g.,* J. Michael Scott et al., *Recovery of Imperiled Species Under the Endangered Species Act: The Need for a New Approach*, 3 FRONTIERS ECOLOGY & ENV'T 383 (2005).

with the Services on actions that may affect listed species or designated critical habitat in order to ensure that federal activities are not likely to jeopardize listed species or destroy or adversely modify critical habitat. Today the FWS and the NMFS conduct thousands of consultations each year. With scientists increasingly able to link climate change with specific threats to imperiled species, far-reaching questions about the future of §7 arise. For example, now that the NMFS has listed two coral species as threatened due largely to climate change, and the FWS appears poised to do the same for polar bears, what sort of federal actions "may affect" these animals and their habitats? It is clear that the impacts of climate change, such as disrupted hydrological cycles, must be addressed in ESA consultations.[38] But must the Services also assess the causes of global warming for their effects on listed species? Given that projects releasing GHGs will exacerbate climate change no matter where they occur in relation to listed species, must proponents of every single federal project causing increases in GHG concentrations consult with the Services regarding impacts on coral species, polar bears, and other species listed due to climate change? Would this consultation duty apply to future permits for construction or would it also reach continued operation of federal projects? Indeed, one can think of thousands of federal activities throughout the country—or the globe—that facilitate increased GHG emissions and thus may affect listed species at risk of extinction in part due to climate change. Will it be necessary to exponentially increase §7 consultations? Is this practical or even possible?

Similar questions arise about §7's substantive requirements. It is not difficult to imagine, for instance, FWS scientists concluding that increased GHG emissions jeopardize the continued existence of polar bears or adversely affect their sea-ice critical habitat. Since the ESA forbids such a result absent a §7 exemption by the high-level Endangered Species Committee (the God Squad), is it conceivable that the ESA would then simply ban any and all federal agency actions resulting in increased emissions? In other words, can a wildlife agency by itself apply the brakes to U.S. GHG emissions—something that Congress and the EPA have so far been unwilling or unable to do? Alternatively, will the God Squad be called upon to issue multiple—or even blanket—§7 exemptions for federal actions that contribute to climate change? Or will we simply see increased efforts by lawmakers (via appropriations riders or indirect political pressure on agencies) or the executive branch (through backroom dealings and increased coercion of agency scientists) to soft-peddle the threats and impacts of climate change? We address some of these questions in our policy recommendations below.

E. Prohibited and Permitted Takings

Application of the prohibitions, exceptions, and other authorities set forth in §9 and §10 will also grow more complex in a biosphere greatly altered by climate change. "Take" of listed species prohibited by §9 includes habitat alterations that "actually kill or injure" listed species.[39] Current uncertainties as to which activities cause take become exponentially more difficult when considering impacts of climate change. For example, does suburban sprawl in Phoenix cause take of polar bears? When an otherwise lawful activity is proposed, the Services have authority to allow "incidental take," i.e., death or injury, of listed species in return for offsetting conservation measures set forth by the project proponent in a habitat conservation plan (HCP). In providing incidental take statements to federal agencies, the Services must estimate the number of protected individuals likely to be harmed by a given activity, as well as set forth a clear upper bound of allowable take that if surpassed, will trigger additional scrutiny of the project.[40] Agency biologists already face difficulties in providing such numbers or developing adequate surrogates; uncertainties surrounding the impacts of a changing climate on members of listed species and their habitat are certain to exacerbate these challenges.

Such uncertainties will also increasingly call into question (on both policy and legal grounds) so-called no surprises regulations, an interpretation of §10 that uses long-term regulatory certainty as a carrot to encourage nonfederal landowners to develop HCPs.[41] While listed species and their habitat may appear to enjoy some long-term protection under HCPs (HCPs are often in effect for decades), such protections may prove to be inadequate in a warming climate. Yet landowners receive guarantees under no surprises regulations that they need do no more to offset the impacts of their habitat destruction even if their initial commitments prove to be inadequate. In a warming world, managing species and their habitat according to an HCP based on assumptions made decades earlier may be a recipe for disaster.

F. Introductions and Reintroductions

Section 10(j) also contains a provision that could play an important role in protecting listed species in the face of climate-driven threats. It authorizes the Services to release "experimental populations" of listed species outside the current range of the species for conservation purposes.[42] Since climate-related habitat changes could take place at a pace that exceeds some species' capabilities to relocate, such introductions could become increasingly important tools for adapting to climate change. Although in the past, such releases have involved reintroduction of a species into its formerly occupied range, it may become necessary to use the §10(j) tool for assisted migration into areas never before occupied by the species.

This section generally affords artificially released populations fewer legal protections than naturally occurring populations of the same species. This differing legal treatment could work against efforts to conserve listed species in the face of climate change by placing lower legal priority on those populations that may represent some creatures' best hope of avoiding extinction. The Services should thus limit its use of "non-essential" designation—which results in the fewest legal protections—for populations relocated due to climate change.[43]

38. *See* Natural Resources Defense Council v. Kempthorne, 37 ELR 20305 (D.D.C. Nov. 30, 2007) (overturning biological opinion due to its failure to take into account climate change in addressing the impacts of water projects on the delta smelt, a listed fish species).

39. 50 C.F.R. §17.3 and §222.102 (2007) (defining harm).

40. *See* Oregon Natural Resources Council v. Allen, 476 F.3d 1031, 1037-38, 37 ELR 20048 (9th Cir. 2007).

41. 50 C.F.R. §17.22(b)(5).

42. *See* 16 U.S.C. §1539(j).

43. *See id.* §1539(j)(2)(B) (the Secretary must determine whether an experimental population "is essential to the continued existence" of a listed species).

In sum, climate change and its associated impacts on listed species, their habitat, and the ecosystems that sustain them will place enormous strains on key provisions of the ESA. Beyond simply increasing the numbers of species facing extinction and the magnitudes of threats they face, the changing climate will force us to wrestle with interpreting and applying the provisions of an aging law to the challenges of a rapidly evolving problem. Climate change is likely, in very short order, to force those implementing the ESA—and the American people as well—to consider whether we are willing to retain the ESA's commitment "to halt and reverse the trend toward species extinction, whatever the cost."[44]

VI. Conserving Wildlife in a Changing Climate: Policy Recommendations

We have already begun to see the initial effects of climate change, and we must now act quickly to put in place new legal mechanisms to deal with its pervasive threats to biodiversity. At a broad level, it is crucial that Congress include within any climate change legislation specific provisions—and specific funding—to conserve biodiversity in a warming world. At the same time, policymakers must reaffirm the ESA's role as a primary legal tool for protecting the nation's at-risk species and their habitats. As noted above, the statute's comprehensive provisions and inherent flexibility enable it to deal with climate-based threats without major modifications to the law itself. However, within the framework of the existing statute, we recommend new policies and implementation schemes to ensure that agencies meaningfully confront threats to biodiversity posed by climate change. A key premise underlying these recommendations is that lawmakers, agencies, and the American public must reaffirm the nation's commitment to protecting other species and the ecosystems upon which they depend. Myriad reasons exist for doing so, but one should suffice—given the tremendous value of wildlife and ecosystem services to humans, our economies, and our very survival, we cannot afford not to.[45]

A. Addressing Endangered Species in Federal Climate Change Legislation

While lawmakers do not appear poised to make fundamental changes to the ESA itself anytime in the near future, it seems likely that Congress will soon enact legislation with consequences for endangered species that are much more far-reaching than any ESA overhaul. As of this writing, lawmakers in the 110th Congress have introduced nearly a dozen bills that would place caps on emissions of global warming pollution, allow trading of emissions credits, i.e., permits, and generate substantial public funds (tens of billions of dollars) through an auction of emissions credits. Most of these bills contemplate that a portion of the auction proceeds would be devoted to programs to conserve wildlife threatened by global warming. The U.S. Senate Committee on Environment and Public Works has passed a bill with strong emissions caps and substantial funding for conservation of wildlife and other natural resources threatened by global warming,[46] and the leaders of both the U.S. House of Representatives and Senate have indicated a strong desire to enact this or a measure of similar breadth and strength into law.

This is encouraging news for wildlife. As noted above, Congress can take no more important step to help wildlife and ecosystems than to legislate substantial, economywide reductions in global warming pollution. It is also crucial that auctions of emissions credits be used to generate billions of dollars of dedicated funding annually to enable federal and state natural resource agencies to confront inevitable global warming. Although some may consider dedicating a substantial sum of such new annual funding for wildlife (say, $5 billion) a steep price to pay for biodiversity protection given the other urgent priorities for addressing global warming, it is in fact a necessary investment to maintain and restore the natural systems that serve as the foundation of our economy and quality of life.

Rather than trying to create new wildlife programs, Congress should direct natural resource agencies to spend these new dollars on updating their implementation of the ESA and other conservation programs so that they fully integrate global warming science. One historically underused provision of the ESA could play a key role in this process. Section 7(a)(1) directs all federal agencies to carry out, in consultation with the FWS and the NMFS, programs to conserve threatened and endangered species; unfortunately, most agencies often ignore this affirmative mandate.[47] Lawmakers should breathe new life into this provision by directing federal agencies to craft comprehensive programs for conserving wildlife and ecosystems threatened by global warming. To facilitate this process, Congress should create one or more global warming and wildlife science centers within the federal agencies.[48] Such centers, coupled with the consultation mandate of §7(a)(1), would enhance all agencies' scientific capacities to conserve listed species in the face of threats posed by climate change.

B. Making Adaptive Management a Central Focus of the ESA

Although each year scientists are able to identify and project the ecosystem changes attributable to global warming with increasing degrees of precision, the exact consequences of global warming will always defy prediction. The average surface temperatures around the globe already exceed levels ever experienced since modern wildlife management began roughly a century ago, and they will soon exceed levels experienced since the beginning of human civilization approximately 13,000 years ago. This means that careful observation and the flexibility to change course in response to new information will be especially important components of ESA implementation in the coming years.

The concept of adaptive management is not new. In recent years, natural resource agencies have often touted the use of adaptive management in implementing the ESA and other wildlife programs. Unfortunately, however, agencies' use of

44. Tennessee Valley Auth. v. Hill, 437 U.S. 153, 185, 8 ELR 20513 (1978).

45. *See, e.g.*, Gretchen Daily, *Benefits Supplied to Human Societies by Natural Ecosystems*, 2 Issues Ecology 1-18 (1997).

46. S. 2191, the Climate Security Act of 2007.

47. *See* 16 U.S.C. §1536(a)(1).

48. The Omnibus Appropriations Act of 2007 takes a positive step in this direction, appropriating several million dollars for such a center in the U.S. Geological Survey.

this term has often proven to be more in the way of lip service than actual implementation. In order to practice adaptive management, the Services should enact regulations that insist upon a high degree of rigor in carrying out adaptive management programs. Key elements of any adaptive management program promulgated by the Services would be:

- Systematic observations of the impacts of global warming on wildlife and wildlife habitats;
- Projections and conservation planning based on these observations and on models of future climate conditions;
- Conservation actions pursuant to such projections and plans;
- Monitoring and evaluation; and
- Adjustments to projections, plans, and conservation actions based on monitoring and evaluation.

The Services must incorporate these adaptive strategies into day-to-day implementation of the ESA, as we discuss more specifically below. To make such a rigorous program feasible, Congress must provide the needed funding. Ideally, as discussed above, this funding would not be subject to the vagaries of the annual appropriations cycle, but instead would be a dedicated stream provided through climate change legislation.

The ESA, with its mandate to conserve all species listed as threatened and endangered and to incorporate the best available science in all management decisions, is well suited to help our nation meet the challenge of addressing global warming's impacts on wildlife. However, defining what constitutes the best available science will be a major challenge. Given the rapid pace of ecological change brought about by global warming, agencies cannot simply assume that data collection and studies produced on an ad hoc basis will be adequate to answer top-priority management questions. As we proceed into a warming century, providing answers to these questions requires integrating into ESA implementation a new and rigorous adaptive management program.

C. Other Important ESA Updates

1. Ecosystem-Based Approaches

Given the overwhelming numbers of individual species likely to be put at risk due to climate change, it will be vital for the Services to develop methods of identifying species at risk and planning for the conservation of listed species that are more efficient than the current species-by-species approach to listing and recovery planning. Though largely ignored for the past few years, the FWS in 1994 adopted a policy statement calling for an ecosystem approach to implementing the ESA; the policy specifically mentions making listing decisions and developing recovery plans on an ecosystem basis when possible.[49] The Services should update this policy statement to address how ecosystems will be defined and managed in light of changes in species distribution, disassembly of ecological communities, and other disruptions caused by global warming. Regardless of how these difficult definitional issues are resolved, it will remain essential to pursue ecosystem-based listing and recovery planning strategies. In places where climate change affects a large number of species—in Arctic and coral reef ecosystems, for example—such strategies would advance conservation with much less cost and much greater speed than carrying out listing and recovery planning actions on an individual species basis.

In addition to updating and giving life to its ecosystem policy, the FWS should revise its current schemes for prioritizing listing and recovery planning decisions to explicitly afford greater priority to ecosystem-based actions.[50] Such action would substantially accelerate legal protections and conservation actions for groups of species imperiled by climate change.

Congress could support such ecosystem-oriented strategies by authorizing and funding programs to conserve ecosystems particularly hard-hit by climate change (drawing lessons learned from the Chesapeake Bay, Everglades, and Great Lakes programs). River basins, estuaries, and other aquatic systems deserve particularly urgent attention in light of the prolonged droughts and other major disruptions of hydrological cycles currently underway due to global warming. Such programs will need to go well beyond the confines of federal natural resource managers and elicit the participation of state, tribal, and local governments.

2. Recovery Planning and Implementation

Historically, implementation has been a key shortcoming of the recovery planning process; plans often occupy shelf space rather than substantially influence real-world activities. With much less room for error in an era when climate change greatly exacerbates threats to biodiversity, science-based blueprints for stabilizing and conserving listed species and their habitat must drive management decisions affecting listed species. While additional resources are necessary to carry out more affirmative measures in recovery plans, the Services could also improve plan implementation by explicitly linking recovery plans to the §7(a)(2) consultation process. The Services often pay little attention to recovery plans in determining whether proposed federal agency actions—including approvals of HCPs and incidental take permits (ITPs)—jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. The Services likewise do not necessarily look to recovery plans in designing reasonable and prudent measures and associated terms and conditions to minimize incidental take by federal agencies. The Services could change this by requiring that recovery plans serve as the yardsticks for assessing jeopardy and critical habitat modification, as well as the templates for designing measures to minimize incidental take. Directly linking actions and prohibitions set forth in recovery plans to these §7 determinations would provide a powerful mechanism to ensure that day-to-day decisions of federal agencies are consistent with maintaining and even recovering listed species. Such an action would also be consistent with recent court decisions holding that consideration of impacts to species' recovery

49. *See* 59 Fed. Reg. 34274 (1994), *available at* http://www.fws.gov/endangered/policy/pol001.html.

50. The FWS' current schemes for making decisions about which species to prioritize for listing and recovery planning dates back to 1983, and do not consider, much less prioritize, ecosystem-based listings or recovery plans. *See* 48 Fed. Reg. 43098 (1983), *available at* http://www.fws.gov/endangered/recovery/48fr43098-43105.pdf.

is relevant to assessing jeopardy and adverse modification of critical habitat,[51] and that the Services should consider recovery plans in deciding whether to approve HCPs and ITPs.[52]

Since it is impossible at this point to prevent some disruption of ecosystems due to climate change, it is crucial that recovery plans incorporate adaptation actions. These plans should explicitly address the key adaptation challenges and opportunities facing the species, including: (1) corridors for species movement that allow transitions to more hospitable areas; (2) measures particularly aimed at managing and protecting vulnerable resources such as water availability and specialized habitat needs; (3) better use of population and habitat availability projections; (4) stronger adaptive management programs for long-term operations such as dams; (5) protection and acquisition of northerly or higher elevation portions of species' ranges; and (6) targeted population supplementation and reintroductions.

Finally, the Services should ensure that their actions to implement recovery plans are integrated with broader public and nongovernmental initiatives to adapt to climate change. This means participating in the numerous stakeholder planning processes that have been launched to respond and adapt to the inevitable impacts of global warming on current and future infrastructure, human health, natural resources, and natural resource-based industries.

3. Applying the ESA to the Causes of Global Warming Pollution

As noted in the previous section, the ESA will increasingly intersect with a broad array of activities whose only connection to risks to listed species is emissions of GHGs. The trigger for application of §7's substantive and procedural obligations is a federal action that may affect listed species.[53] Rather than denying the impact of global warming pollution on listed species, the Services should construe any action that results in non-trivial net increases of GHGs as meeting this threshold. Similarly, the Services should interpret §9's prohibition against take of protected species as covering the actions of nonfederal GHG emitters.

While it is important to acknowledge the vast array of actions that threaten biodiversity by contributing to climate change, casting such a broad net also poses a danger of overwhelming the Services' §7 and take enforcement programs. Indeed, going through the consultation process at the individual project level for all federal actions that may affect listed species as a result of GHG emissions would pose a virtually insurmountable obstacle for federal agencies. Even assuming that substantial additional resources will be made available for ESA implementation in the coming years, such resources should not be directed toward projects with no connection to listed species or their habitats beyond their GHG emissions. The Services are simply unqualified to address technical questions about how projects can reduce their GHG emissions. The Services and other agencies should use any additional ESA implementation funds to acquire, restore, and manage habitats and otherwise improve the ability of listed species to survive global warming.

For projects with no impacts on listed species apart from GHG emissions, the Services should develop a streamlined programmatic method for ensuring ESA compliance with §§7 and 9. The ideal—and most simple—method would be development of a form in which the emitter simply certifies compliance with the applicable national program capping GHG emissions.

This solution has three potential weaknesses. Most glaringly, no national GHG cap currently exists to which the Services can tie ESA compliance. This absence will hopefully prove temporary; current momentum in Congress appears to present a strong likelihood that lawmakers will enact a national GHG cap in the near term. While the nation awaits this crucial legislative action, there remains the possibility of an effort at ESA enforcement against agencies or other entities based solely on their GHG emissions. This scenario holds the potential to create a legal "train wreck" between ESA requirements and the practical difficulties of implementing the statute in a warming world. While no agency or environmental group has yet sought to combat such global warming pollution through ESA enforcement—elkhorn and staghorn coral have been listed for nearly two years without ESA claims against GHG-emitting projects—such a showdown will become increasingly likely if Congress does not directly mandate reductions in carbon emissions. To date, conservation groups have focused their efforts to reduce global warming pollution on energy and transportation policy and carbon sequestration, but impatience with continued inaction in Washington, D.C., could cause some environmental groups to turn to the ESA.

Second, currently available scientific data cannot predict how much additional GHG pollution—if any—can be emitted without jeopardizing the existence of listed species or otherwise violating the ESA. If a species is already declining due to the impacts of global warming, any project that is not carbon neutral or better could potentially jeopardize that species. Ideally, when Congress enacts national caps on GHG pollution, it will do so with full recognition of the need to avoid or minimize further disruption of ecosystems. A prudent cap would enable the Services to initially tie federal agencies' compliance with §7's prohibitions against jeopardy and critical habitat destruction to adherence to the national GHG emissions standard. To deal with uncertainties surrounding the impacts of climate change, lawmakers should provide substantial dedicated funding for scientific research to explore further the topic of what is needed for native species to survive global warming. Once the scientific community reaches a firmer understanding of what atmospheric GHG concentrations, surface temperatures, and other targets are needed to maximize the chances for species survival, Congress may need to revisit the ESA to ensure that its programs and strategies play a significant role in achieving these targets.

Finally, under this proposed solution, it would be virtually impossible for the Services to identify a reasonable and prudent alternative if a proposed project were to exceed its allocated share of the national cap on GHG emissions and thereby jeopardize listed species affected by climate change. Presumably, therefore, any failure of a project to

51. *See* National Wildlife Fed'n v. National Marine Fisheries Serv., 481 F.3d 1224, 1237-38, 37 ELR 20079 (9th Cir. 2007); Gifford Pinchot Task Force v. U.S. Fish & Wildlife Serv., 378 F.3d 1059, 34 ELR 20068 (9th Cir. 2004).

52. *See* Southwest Ctr. for Biological Diversity v. Bartel, 470 F. Supp. 2d 1118, 1136-37 (S.D. Cal. 2006).

53. 16 U.S.C. §1536(a)(2).

comply with that project's allocation under the national cap would be subject to EPA enforcement action pursuant to whatever global warming legislation is enacted as well as enforcement or citizen suit under the ESA. The availability of an ESA action for injunctive relief to protect wildlife at risk of extinction would serve as an additional deterrent against violations of GHG emissions limits.

4. Habitat Conservation Planning

The Services should take more modest steps under §10 to more effectively regulate nonfederal projects that directly affect the habitat of species threatened by climate change. Current regulations require HCPs to include provisions for "changed circumstances,"[54] but to date, the Services have not required consideration of climate change impacts to be considered changed circumstances. The agencies should reverse this policy and require that long-term HCPs contain adaptive management provisions to deal with climate change-related impacts as a condition of HCP approval and issuance of ITPs. The Services should grant regulatory assurances only for limited time periods and only for applicants that include climate change-oriented adaptive management provisions in their HCPs.

Although many recent HCPs contain a nod toward adaptive management, the Services and permit applicant must agree on what kind of changes may be made to the conservation measures set forth in an HCP. Moreover, the no surprises policy in ESA regulations bars important changes to agreed-upon measures even if the Services would pay for the modifications. Given the uncertainties and rapid ecological changes surrounding climate change, it will be crucial to remove such prohibitions and to empower the Services to make any necessary changes to rescue imperiled species. Such adaptive management is among the funding needs that a federal cap-and-trade climate change program, discussed above, must address.

5. Private Landowner Incentives

Climate change produces an array of threats to imperiled species that require affirmative conservation measures and are not well suited for remedying through traditional regulatory prohibitions. For example, experts already point to ways that global warming exacerbates the spread of invasive species and wildlife disease, which often require aggressive prevention and control measures. When such problems arise on private land, private landowner incentives such as technical and financial assistance provide perhaps the best strategy for confronting them. Existing programs already provide such incentives to a limited extent, and they would expand to a significant degree under tax legislation currently moving through Congress.[55] However, a major expansion will be needed as the climate changes. These incentives provide yet another example of the funding gap that a federal cap-and-trade climate change program would need to address.

VII. Conclusion

Congress took a bold and decisive step in 1973 when it enacted the ESA in response to its recognition of the significant threats to biodiversity. Today, similarly bold and decisive action is imperative to reduce global warming pollution and to ensure that the impacts of inevitable global warming do not wipe out the conservation gains of the past 35 years. Although the United States must commit to significant additional research on global warming impacts and potential management responses, we already have substantial scientific information on steps needed to protect species and their habitat in a warming world. First and most urgently, Congress must put in place a national cap on global warming pollution, with aggressive annual reductions in pollution levels, and the United States must work at the international level to achieve similar commitments from other nations. Second, policymakers and natural resource managers must design and apply adaptive management strategies so that both projected and unanticipated changes on the landscape can be addressed. Ultimately, we must integrate biodiversity protection and necessary funding into a comprehensive federal regulatory response to climate change.

While the ESA in its present form will provide an effective tool for conserving species and habitats in the face of global warming, legislative and administrative changes will be needed to strengthen its ability to deal with the dangers and uncertainties of climate change. The most important variable in determining the success of species protection efforts, however, is both simple and enormously challenging: our continued resolve to ensure the secure future of all life on earth.

54. *See* 50 C.F.R. §17.22(b)(5)(i).

55. *See* S. 700, recently passed by the Senate as part of the Farm Bill.