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The Role of ESA in an Atmosphere of Climate Change Regulations

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Introduction

Listing the polar bear as a threatened species under the Endangered Species Act (ESA) due to a loss of habitat caused by climate change may have cracked open the door for use of the ESA to regulate greenhouse gases (GHG). Environmental groups have encouraged the use of a variety of legal tools, including the Clean Air Act, as a strategy to force government agencies to rein in emissions. Most notably, in Massachusetts v. U.S. Environmental Protection Agency (USEPA), a Supreme Court majority found that the USEPA should not deny a rulemaking petition asking the agency to regulate GHG emissions from motor vehicles as an air pollutant. The Court concluded GHG emissions are pollutants due to their link to climate change and are therefore regulated under the Clean Air Act. A similar approach to applying the ESA to regulate GHG emissions was anticipated following the polar bear ruling, linking climate change to a loss of polar ice, even though former Interior Secretary Dirk Kempthorne clearly stated the ESA will not be used as a tool to regulate GHG emissions. In addition, two consecutive administrations have supported that position. The challenge now and in the future for the U.S. Fish and Wildlife Service (USFWS) is to determine how to incorporate predicted climate change impacts into their species specific assessments and recommend recovery plans for local and regional species endangered or threatened due to a global problem. An even broader question has been posed---is it likely that the ESA will be obsolete when it becomes impossible to administer the ESA in its present form? A form that requires evaluation of individual species, each with its own set of circumstances with respect to the effects of climate change.

This paper provides a high-level overview of climate change models, use and extension of these models and their results on predicting species endangerment, and a review of ESA's listing, taking, and recovering language which can be applied to impacts directly associated with climate change.

Climate Change and Impacts on Threatened and Endangered Species

The United Nations Framework Convention on Climate Change defines climate change as,

> "A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability over comparable time periods" (**www.un.org**).

Global climate change is being observed through increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC 2007). Global warming observed over the past 50 years is believed to be due to human-induced emissions of heat-trapping gases. These emissions come mainly from the burning of fossil fuels (coal, oil, and gas), with contributions from the clearing of forests, agricultural practices, and other activities (USGCRP 2009). Climate-related changes include rising temperatures and sea levels, retreating glaciers, alterations in river flows, and change in intensity and frequency of precipitation and storm events. The obvious concern to threatened or endangered species is the direct impacts on habitats and ecosystems and future availability of suitable environments for the survival and recovery of many species. In a recent report from the U.S. Department of the Interior (USDOI), the greatest environmental challenge for the survival and conservation of birds in the United States is climate change (USDOI 2010). According to this report, climate change is adding additional stress to birds and their habitats by altering habitats and allowing for the increase of invasive species, spreading disease, exacerbating the impacts of storm-surge flooding and shoreline erosion which will limit potential habitat for coastal birds, and changing the distribution and availability of surface and ground water.

Dr. C. Parmesan (2008) reports that global warming has affected every major biological group that has been studied (e.g. from herbs to trees, from plankton to fish, and from insects to mammals) and responses to the effects of climate change have been seen on all continents and in all major oceans. Globally, there is a strong consistent pattern of poleward movement of species ranges. Rare species that live in fragile or extreme habitats are already being affected. Species whose habitat is sea ice are showing drastic declines and mountain-top species, like the American pika, are dying off at their lower range boundaries, becoming more and more restricted to the highest elevations (Ruhl 2009; Parmesan 2008). The Nature Conservancy estimates that one-fourth of the Earth's species will be headed for extinction by 2050 if the warming trend continues and that the rapid nature of climate change is likely to exceed the ability of many species to migrate or adjust (**www.nature.org**).

Conservation biologists are actively addressing climate change impacts on species and ecosystems by evaluating current habitats and predicted changes of these habitats. While global warming might make certain areas suitable for some species, others will be displaced or simply run out of space (e.g. polar bear and American pika). Planning now involves the use of regional climate change models to predict habitat changes, evaluating shifting of species into adaptable habitats, and addressing possible relocation to save certain species. The question has been raised, even if species have clear pathways to new habitats, will they have time to keep up with the speed of climate change or should the species be assisted in relocation? Zimmer (2009) reports recent interest in what has been called, "assisted migration, assisted colonization, and managed relocation" of species, while others call it a game of "ecological roulette". As Zimmer points out, even carefully planned introductions of species to new areas that seem to pose no risk sometimes go awry. For example, wildlife managers introduced a North American freshwater shrimp into Flathead Lake in Montana to feed kokanee salmon. The nocturnal shrimp avoided the diurnal salmon and consumed zooplankton the salmon were eating. The salmon population died off as did the eagle population that depended on the salmon (Zimmer 2009).

While assisted relocation may be the best chance for species and ecosystems that are facing the greatest changes in their habitats, a more conventional strategy for conserving species is establishing wildlife preserves. Development of this type of conservation plan will require forward thinking and utilization of predictions from global climate change models to provide some insurance that these preserves are located in areas where the species can survive and thrive in the future.

Global Climate Change Models and Regional Downscaling

General Circulation Models (GCMs) are numerical models representing physical processes in the atmosphere, ocean, cryosphere, and land surface. These models are advanced tools that can simulate the response of the global climate system to increasing greenhouse gas concentrations (IPCC Data Distribution Center, **www.ipcc-data.org**). A number of models (simple climate models, Earth System Models, and Atmosphere-Ocean General Circulation Models) exist. The International Panel on Climate Change (IPCC) has used these models and run scenarios with differing amounts of GHGs present in the atmosphere in the future to predict changes in global climates. Model experiments show that even if all radiative forcing agents were held constant at year 2000 levels, a further warming trend would occur in the next two decades at a rate of about 0.1^{o}C per decade, due mainly to the slow response of the oceans. A much greater warming would be expected if emissions are within the range of the scenarios presented in the Special Report on Emissions Scenarios (SRES; IPCC 2000). The SRES scenarios showed an average surface temperature warming between 1.8 ^{o}C and 4.0 ^{o}C by the 2099 compared to average temperatures between 1980 and 1999, as shown in Table 1 (IPCC 2007).

Table 1
IPCC Scenario Projections of Temperature Change and Sea Level Rise.

Case	Temperature Change (°C at 2090-2099 relative to 1980-1999)[a] Best estimate	*Likely* range	Sea Level Rise (m at 2090-2099 relative to 1980-1999) Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations[b]	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Table notes:
[a] These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth System Models of Intermediate Complexity and a large number of Atmosphere-Ocean General Circulation Models (AOGCMs).
[b] Year 2000 constant composition is derived from AOGCMs only.

For application of climate change projections to regional scales, some type of downscaling must be done to understand the predictions on a regional level. Multiple downscaling approaches exist for deriving regional climate from coarse resolution model output. Woods et al. (2004) developed a method of statistically downscaling spatially continuous fields to provide temperature and precipitation projections on a regional basis. This method has been used to downscale the IPCC simulations by adjusting the GCM data from climate model spatial resolution (grid of approximately 200 km square) to a regional grid of approximately 12 km square by researchers at the U.S. Bureau of Reclamation, Santa Clara University, and the Institute for Research on Climate Change for the portions of North America. A database hosted by the Lawrence Livermore National Laboratory (LLNL) Green Data Oasis provides simulated climate projections on a regional level that can be used for impact assessment analyses (http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections/#Welcome). The Nature Conservancy developed a map using GCMs to illustrate project temperature increases across North America from 1990 to 2080 at the current rate of GHG emissions (Figure 1). These types of maps can assist in evaluating suitable future habitat for threatened or endangered species.

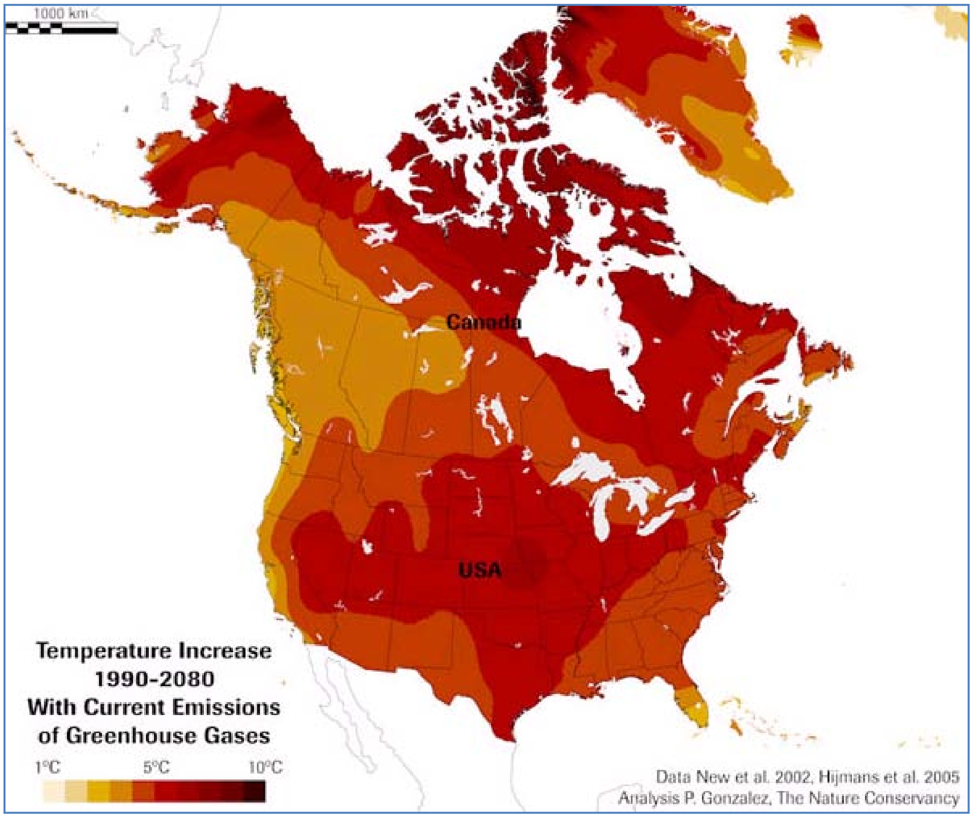

Figure 1
Temperature Increase Projections Across North America (The Nature Conservancy, www.nature.org).

On a very high level, regional models can be used to assess impacts on threatened and endangered species simply by investigating predicted changes in temperature and precipitation on habitat and ecosystems. On a more refined level, these projections can be coupled with species and biomes specific models to predict how changes in the physical climate system will affect species and their habitats. In New Mexico, there is strong evidence that the southwestern grasslands have declined due to climate change, threatening the habitat of the lesser prairie chicken, the black tailed prairie dog, and migratory birds (www.nature.org). The Bureau of Land Management, U.S. Agricultural Research Service, and The Nature Conservancy are preparing analyses that consider restoration opportunities to preserve crucial habitat under present and future conditions (www.nature.org).

Recently, the U.S. Geological Survey (USGS) funded 17 new projects through the National Climate Change and Wildlife Science Center to provide resource managers projections based on sound science that will provide information on how landscapes may change in response to climate change. Several of these projects are specifically geared towards threatened and endangered species. For example, the Trout at Risk in the West project is designed to study how fish habitats will respond to rising water temperatures, altered wildfire occurrences, and increasing demands for water resources. The data the USGS hopes to provide through this project will help managers assess extinction risks and develop appropriate response strategies (USGS 2010). Other projects address development of state-specific models predicting which species and habitats will increase or decline based on potential rainfall and temperature change as well as impacts of human-induced land use and land cover change and models for areas impacted by sea-level rise and effects on species and habitats (USGS 2010). Along these same lines, resource managers, USFWS personnel, and environmental impact assessors can utilizing regional climate change models as their first step in assessing impacts of climate change on threatened or endangered species.

Golden Cheek Warbler Habitat – A Local Concern

The Golden-cheek Warbler was listed as an endangered species in 1990. This small, migratory songbird's entire nesting range is currently confined to habitat in 33 counties in central Texas (Figure 2).

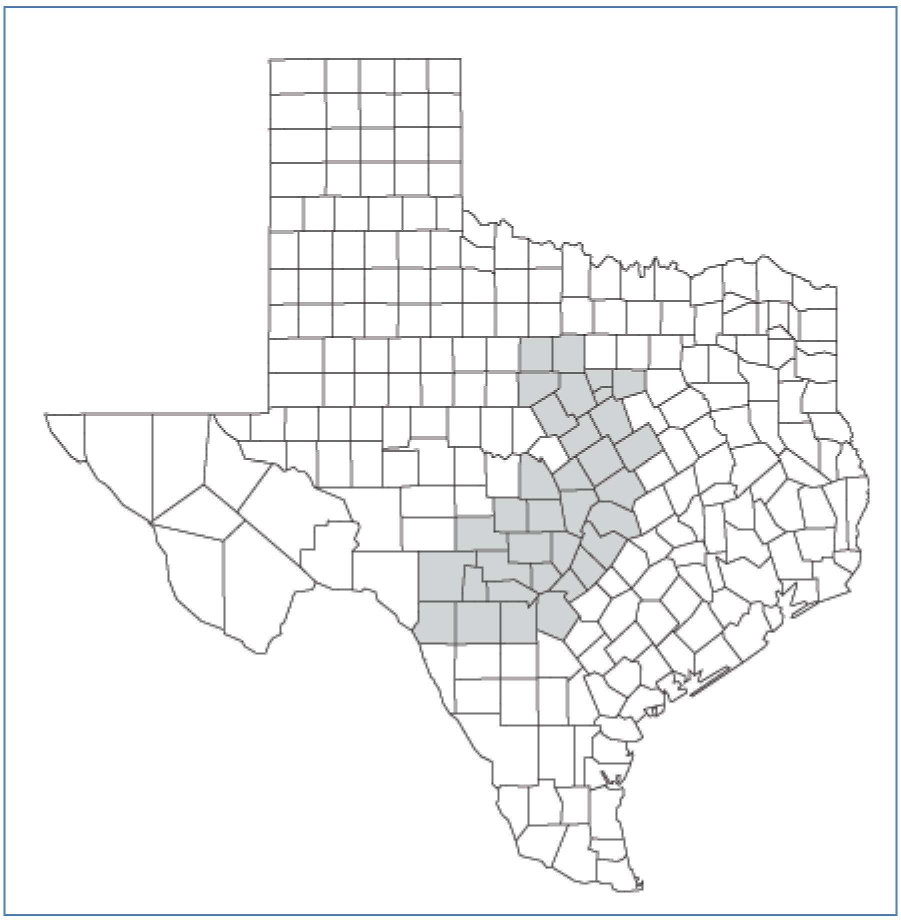

Figure 2
Golden-cheeked Warbler Nesting Habitat (Texas Parks and Wildlife 2006).

The most serious problems facing the Golden-cheeked Warbler today, as in the past, are habitat loss and fragmentation (Texas Parks and Wildlife 2006). Warblers need a combination of mature Ashe juniper and hardwood trees in their nesting habitat. Depending on the location and quality of habitat, Golden-cheeked Warblers forage and nest in areas of habitats ranging in size from five to 20 acres per pair.

Regional projections of temperature and precipitation changes, coupled with growth predictions under these conditions for Ashe juniper and hardwood trees can be used to evaluate potential future conservation areas. For example, using the database of scenarios archived at the LLNL Green Data Oasis, temperature and precipitation changes for the Golden-cheeked Warbler's current nesting habitat can be used to estimate potential future nesting habitats. A comparison of the predicted temperature in the future to current conditions in the nesting habitats can first illustrate the additional stress on the Golden-cheeked Warbler as well as potential future habitats. Figure 3 illustrates the average annual temperature difference between 2009 and 2050 (IPCC's SRES CSSM B1 scenario) and shows 1.5 ^{o}C to 2.5 ^{o}C increase in temperature over the current habitat. Counties in the northern portion of the habitat show smaller increases in temperatures, and therefore could be considered for future habitat if Ashe juniper can also exist in the northern counties.

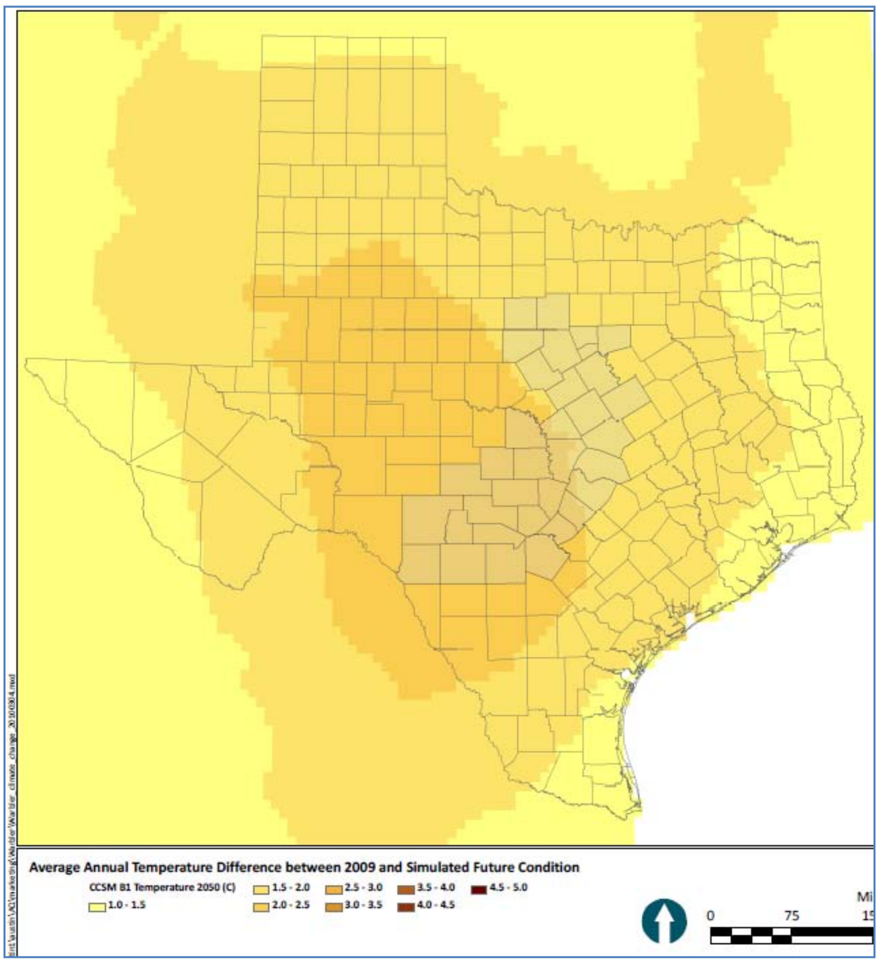

Figure 3
Temperature Change Predicted Between 2009 and 2050 Based on IPCC SRES CCSM B1 Scenario

Figure 4 illustrates the average annual precipitation difference between 2009 and 2050 using IPCC's SRES CCSM B1. The majority of the nesting habitat will experience drier conditions with the northern portions of the habitat experiencing little or no difference.

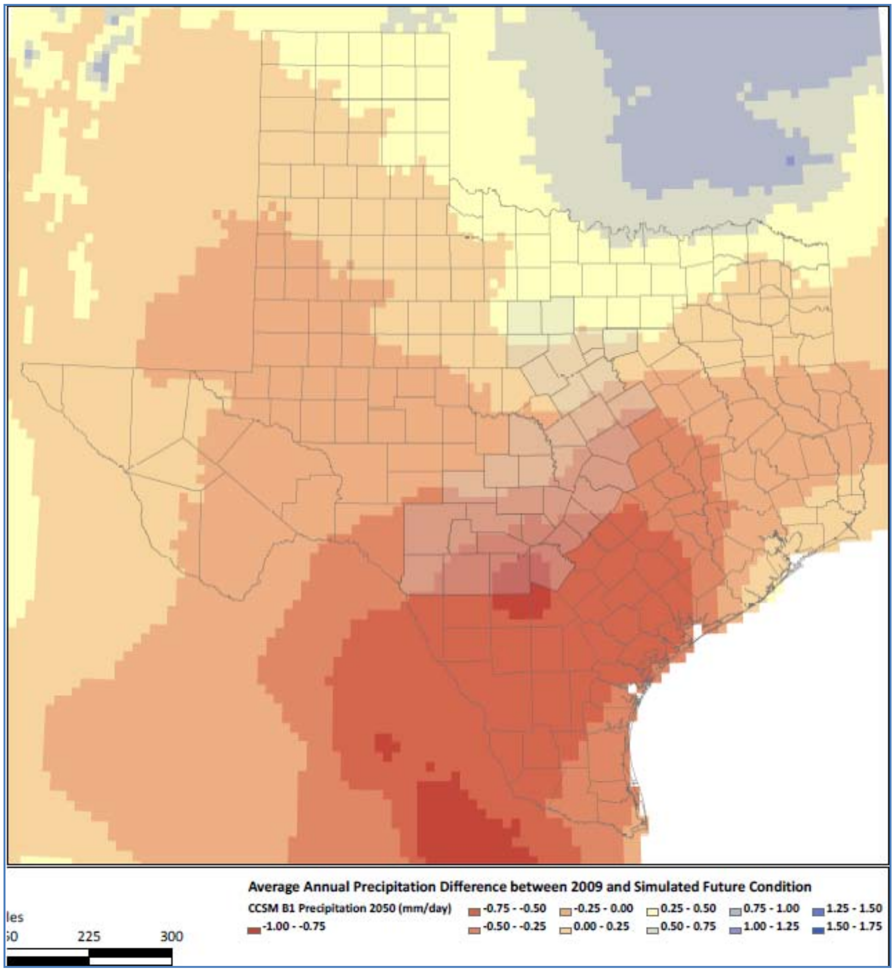

Figure 4
Precipitation Differences between 2009 and 2050 Based on IPCC SRES CCSM B1

These comparisons are an initial step in evaluating future suitable habitats and ecosystems for threatened or endangered species. Building of these initial projections, further evaluations considering physiological sensitivity to changes in temperature or precipitation are to be considered as well as ecological limitations of the species' habitat. Such an evaluation was completed using a proposed framework by USEPA/Galbraith and Price (2009) that considers direct and indirect vulnerability of species to climate change. Using predictions from GCMs and species specific information, results from the proposed framework indicate that the warblers are critically vulnerable to climate change.

Endangered Species Act – Species Protection

The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend (USFWS 2009). Species are listed as endangered or threatened exclusively on the basis of their biological status and threats to their existence. Endangered species are those in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future. With the polar bear listing, the foreseeable future was within the next 45 years and the first listing that utilized global climate change models in the prediction of the future.

Protection of endangered and threaten species is through the prohibition of "taking" of listed animals and the interstate or international trade in listed plants and animals. The definition of take includes "harm" of a species which is defined as,

> "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering" (USFWS 2009).

The ESA also requires the designation of "critical habitat" for listed species where prudent and determinable, and includes areas that contain the physical or biological features essential to conservation of the species (USFWS 2009). The linkage between climate change impacts and harm as described by the ESA is clear if such impacts can be linked to the modification or degradation of significant habitat to the point of injuring or killing threatened and endangered species. However, the regulation of GHGs through the ESA is much more difficult in attempting to pin-point global sources causing local impacts.

J.B. Ruhl (2009) proposes that the ESA not be used to regulate GHG emissions, but rather that efforts through the ESA be focused on establishing protective measures for species that have a chance of surviving the climate change transition and establishing a viable population in the future climate regime. In developing this proposal, Mr. Ruhl addresses the pressures climate change will place on the U.S. Fish and Wildlife Service to develop policy on what constitutes endangerment, take, jeopardy, and recovery of species with climate change being the basis for a listing. For instance, is any person emitting GHGs "taking" the species? In terms of recovery and designing conservation initiatives, Mr. Ruhl questions the long-term effectiveness of such measures as rising sea levels, rising temperatures, and the general reshuffling of ecosystems to alter the underlying premises used to design them. However, when evaluating climate change impacts, the critical habitat program could lend considerable flexibility to the USFWS policy in several respects. The provision allowing designation of specific areas outside the geographical area occupied by the species at the time it is listed if these areas are considered essential for conservation may provide USFWS a way to respond to ecological reshuffling. Mr. Ruhl notes that to the extent downscale models can predict with reasonable certainty where a species might successfully migrate to adapt to changes brought about by climate change, the agency could "reserve" those areas through critical habitat designations.

Conclusions

Regional models can be used to evaluate climate change impacts on current threatened and endangered species and can be used in the assessment of suitable habitats to guide USFWS and environmental impact assessors to address climate change. The ESA most likely will never be used to regulate GHGs like the

Clean Air Act; however, additional regulations are being developed for all federal agencies on evaluating impacts of climate change. For example, on February 18, 2010, the Chair of the Council on Environmental Quality released the Draft National Environmental Policy Act (NEPA) Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions. This guidance is intended to help explain how agencies of the Federal government should analyze the environmental effects of GHG emissions and climate change when they describe the environmental effects of a proposed agency action. Specifically, the environmental analysis and documents produced in the NEPA process should provide the decision maker with relevant and timely information about the environmental effects of the decision and reasonable alternatives to mitigate those impacts (CEQ 2010). For sources of the best scientific information available on the reasonably foreseeable climate change impacts, the CEQ Draft Guidance directs environmental assessors to relevant scientific literature. The Draft Guidance recommends that in situations where agencies consider climate change modeling to be applicable to their NEPA analysis, agencies should consider the uncertainties, limitations, and variability in the capacity of climate change models to predict change on a regional scale. The advances in downscaling of global models will continue to support the use of these tools in evaluations of climate change impacts and will make them extremely useful to the USFWS in administering the ESA.

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