Pacific Northwest Climate Change Vulnerability Assessment

Background

Global average temperatures have increased about 0.7 °C and precipitation patterns have changed and these trends will likely continue throughout the next century[1]. In the Pacific Northwest (PNW) temperatures have increased by about 0.8 °C and models project warming of 1.8°C by the 2040s and 3.0°C by the 2080s (see Table)[2]. Precipitation is also projected to change, with general increases projected for the PNW, and with a more intense seasonal precipitation cycle - autumns and winters may in fact become wetter and summers may become drier. Further, regional climate models indicate that extreme precipitation events will increase and snowpack at higher elevations will decrease.

	Temperature Change C° (F°)	Precipitation Change %
2020s	+1.1 (2.0)	+1.3
2040s	+1.8 (3.2)	+2.3
2080s	+3.0 (5.3)	+3.8

Table: Projected average changes in temperature and precipitation for the Pacific Northwest. Changes are relative to 1970-1999, for both medium (A1B, 20 models) and low (B1, 19 models).

Impacts

Climate change and increased climatic variability have already started to impact PNW systems, from high elevation forests to coastal wetlands. Additionally, some of the region's most significant drivers, such as fire, extreme precipitation and the length of the summer dry period will likely intensify leading to substantial changes. These changes will have cascading effects on the ecological systems that the region relies on for water regulation and quality, agriculture, timber, and ecological integrity. Unfortunately, we are already seeing some of these changes, such as shifts in both the timing of ecological events and the distribution of species[3]. Phenological changes including earlier flowering, egg-laying, and the timing of migration can lead to cascading ecological effects, including rapid population declines[4].

Climatic changes such as these pose a daunting challenge for natural resource managers and threaten many of the conservation gains made in recent decades. Fortunately, resource managers already have many of the tools they will need to address climate change, such as reducing non-climatic stressors like exotic and invasive species, providing adequate and appropriate space, removing barriers to dispersal, restoring key habitats, and applying adaptive management. Although these tools can enhance the resilience of natural systems to climate change, knowing which species and habitats are most vulnerable and hence where to direct limited resources is a key first step.

[1]IPCC. 2007. Climate Change 2007. Contribution of Working Groups I and II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press Cambridge, United Kingdom and New York, NY, USA; [2]Climate Impacts Group, Washington State Climate Change Impacts Assessment Executive Summary, data from Mote and Salathe, 2009. *In* The Washington Climate Change Impacts Assessment. Available online [http://cses.washington.edu/cig/res/ia/waccia.shtml]; [3]Walther et al, 2002. Ecological responses to recent climate change. Nature 416:389-395; Parmesan and Yohe, 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421:37-42.; Root et al, 2003. Fingerprints of global warming on wild animals and plants. Nature 421:57-60; Parmesan, 2006. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology, Evolution, and Systematics 37:637-669; [4]Walther, 2002. Ecological responses to recent climate change. Nature 416:389-395.

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Response

In response to the daunting challenge that climate changes poses to natural resource managers, several key collaborators in the PNW have partnered to conduct a climate-ecological vulnerability assessment. This assessment is designed to evaluate the relative vulnerability of the species and ecological systems of the Pacific Northwest to climate change. The assessment covers an area that extends beyond the borders of Washington, Oregon, Idaho, Montana, and Wyoming (see Figure 1) and involves scientists, natural resource managers, and conservation planners. The project has six stages:

Figure 1. Study Region.

1. Develop relatively fine spatial resolution (e.g., 1km) datasets of projected future climate changes.
2. Simulate how vegetation and habitat types are likely to change in response to climate.
3. Develop a digital database of inherent climate-change sensitivities for species and habitats of concern and model potential shifts in the distribution of focal animal species.
4. Assess the vulnerability of particular species, ecosystems and managed lands to future climate change.
5. Summarize the uncertainties in simulated climate, vegetation, and species distributions.
6. Work in collaboration with conservation and natural resource managers to incorporate the results into management planning and implementation efforts.

The project will provide resource managers and decision makers with some of the most basic and most important information about how species and systems will likely respond to climate change. It will also allow researchers to answer important scientific questions regarding the potential impacts of climate change on natural resources.

Climate & Vegetation

The downscaled climate data are based on 6 future atmosphere-ocean general circulation models (AOGCM) simulated under the A1B and A2 greenhouse-gas emissions scenarios for the period 2001-2100 and downscaled using a geographic distance-weighted bilinear interpolation method. In addition to basic climate variables such as mean annual temperature and total annual precipitation, 37 bioclimatic variables representing important physiological limits of species were calculated. Using data from 6 AOGCMs and 2 emissions scenarios (for a total of 12 different projections), will enable the examination of differences in future climates simulated among the models and take into account different assumptions about the magnitude of future possible climatic changes.

These climate projections will be used in conjunction with soils data as inputs to a dynamic global vegetation model to project potential changes in the vegetation of the region. Vegetation types will be defined by their relative composition of different basic plant functional types such as broad-leafed deciduous trees and grasses.

Sensitivity Database

The sensitivity database is designed to highlight and detail the inherent susceptibility of species and habitats in the study region to climate change. Some species and systems are inherently more susceptible to climate change than others and the degree of sensitivity will also depend on the scale at which it is assessed. Therefore, the database of climate change sensitivities includes all scales of ecological conservation targets in the study region (i.e., ecosystems, communities, and species). The estimated sensitivity of individual species is based on the ability of the species to disperse and whether dispersal barriers exist, dependency on disturbance regimes such as fire or flood regimes, physiology (i.e., sensitivity to temperature, precipitation, salinity, etc.), dependency on climatically-sensitive habitat requirements (such as alpine areas, shallow wetlands, and perennial streams), and finally, whether the species is a generalist or specialist and whether its existence is tied to other specific species. The assessment of the sensitivity of ecosystems and communities is based on hydrological sensitivities, component-species sensitivities, proximity to the coast, and the effects of disturbance regimes. The database is used in conjunction with a sensitivity index to produce a ranking of over 600 species and systems with respect to their sensitivity to climatic change.

Species Modelling

A hierarchical modelling approach is being used to project current and potential future distributions for 12 bird and mammal species in the Pacific Northwest (for example, see Figure 2). First, continental-scale models (Lawler et al., 2009) are used to predict future species distributions at a 50-km^2 resolution across the study region. These predictions provide estimates of the future range boundaries of the each species. Then, within the projected future ranges, projected future distributions at a 1-km^2 resolution are developed using regional distribution models that take both changes in climate and changes in vegetation (habitat) into account.

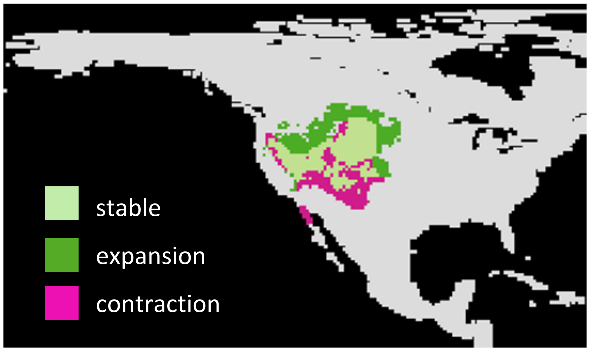

Figure 2. Pinyon Jay range projections (using the U.K. HADCM3 model and A2 emissions scenario for the years 2071-2099). Adapted from J. Lawler (2010).

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Implications

This study makes an important contribution to understanding the impacts of future climate change on the species and habitats of the Pacific Northwest. The analyses of the simulated climate and vegetation changes provide an indication of the potential magnitude and spatial character of future climate change and its impact on vegetation. The database assesses the sensitivity of the Pacific Northwest's conservation targets to climatic changes. And the simulated changes in species distributions reveal how climate change may affect the future distributions of species in the region.

Ultimately, this study will integrate these results and produce an assessment of the vulnerability to climate change of species and systems in the Pacific Northwest. The level of uncertainty associated with the projected changes will be described and, as in the other parts of the study, project collaborators will work closely with land managers and natural resource decision makers to identify management and policy relevant decisions and to produce evidence that clearly documents the implications of climate change to natural resources and that will be useful in developing management and planning responses to projected climate change effects. Case studies highlighting the use and implications of the study results will be developed.

Collaborators

This project is a collaboration among researchers, managers, and planners at many institutions including: University of Washington, University of Idaho, U.S. Geological Survey, National Park Service, U.S. Forest Service, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, Idaho Department of Fish and Game, Montana Fish Wildlife and Parks, The Nature Conservancy, and the National Wildlife Federation.

Funding

This project is currently funded by the USGS National Climate Change and Wildlife Science Center, the Nature Conservancy, National Park Service, and National Wildlife Federation. The entire project is projected to be completed in 2013, with major portions of the work being completed in 2012. The total cost of the project is roughly $1M.

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