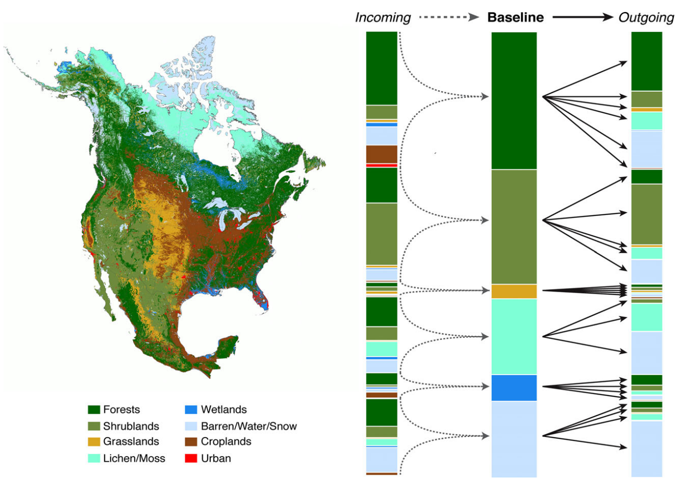
ALDO LEOPOLD WILDERNESS RESEARCH INSTITUTE
http://leopold.wilderness.net/

Potential relocation of climatic environments suggests high rates of climate displacement in the North American protection network



Keywords: climate analogs, climate relocation, climate velocity, conservation, exposure assessment, global change, land-cover types, protection network

Background & Management Issues: Ensuring the continued relevance and effectiveness of protected area networks during a period of rapid climate change is among the most crucial challenges for conservation planners. The extent to which the protected areas can fulfill their conservation role depends on the persistence of conditions that promote patterns of biodiversity. High rates of climate change are altering the spatial distribution of climatically suitable areas for organisms, habitats, and biomes. As a result, shifting climatic conditions over the next century could undermine the effectiveness of protected area networks in protecting their current suite of organisms and associated ecosystem properties.

One way to assess the exposure and sensitivity of organisms and ecological processes to climate change is to analyze the current geographic patterns of climatic conditions and how they are expected to change between a baseline time period and a future time period. The metric of climate velocity and the concept of 'climate analogs' can be used to conduct such analyses.

In this study, we used the metric of climate velocity, the concept of climate analogs, and projections of future climate to examine the vulnerability of the existing protected area network in North America (Canada, United States, Mexico—NAM) to climate change.

We compared the baseline climate (1981-2010) of the protected area network in NAM to the projected end-of-century climate (2071-2100). We compute climate velocities and, by identifying the location of the nearest climate analogs, examine the potential relocation of climates among protected and unprotected areas. To assess additional threats to the protected biota resulting from human-induced land modifications, we characterize land-cover types associated with the locations of climate analogs.

Project Objectives:

- ✓ Quantify the exposure of the protected area network in North America to climate change using the metric of climate velocity.
- ✓ Use climate analogs to examine patterns of climaticrelocation among protected and unprotected areas.
- ✓ Examine land-cover characteristics associated with the relocation of climates to evaluate potential threats to protected biota.

Climate analogs and climate velocity:

Climate velocity is a metric that reflects the pace (km/yr) at which a given isocline of temperature or precipitation (or any set of climatic conditions) is expected to relocate across space between our baseline time period and the end-of-century. It can be calculated in the forward or reverse direction using either forward or reverse analog locations. High values indicate that the location of the nearest climate analog is far away.

Climate analogs are locations with similar climates. For each pixel in each protected area, we identified two particular types of climate analogs. First, we identified the locations that, in the future (2071-2100), will have a climate that is similar to that found in a protected area during the baseline time period (1981-2010). These locations are 'forward analogs' and the relocating climates are 'outgoing climates.' Second, we identified locations ('reverse analogs') with baseline climate that is similar to the future climate of a protected area ('incoming climates').

Project Description: We assessed the vulnerability of the NAM protected area network to climate change using three approaches: (i) We calculated both forward and reverse climate velocities based on baseline (1981–2010) and end-of-century (2071–2100) climate for all pixels within protected areas, and classified each protected area as low, moderate, or high velocity. (ii) Using the specific locations of climate analogs (for both outgoing and incoming climates), we identified whether climate analogs are (a) located within the same protected area, (b) located in a different protected area, (c) located outside of the protected area network, or (d) correspond to a disappearing or novel climate. (iii) We identified the land-cover types associated with the locations of climate analogs and compared them to baseline conditions.

Management Implications:

- ❖ The protected area network is a dynamic system in which the distribution and abundance of species (currently protected and unprotected) can change over time as climate conditions shift. As such, efforts to preserve biodiversity that aim for a static version of the protected biota will fail, as will efforts that ignore the spatial matrix surrounding the protection network. Both current and future biota within the network will continue to benefit from large and diverse protected areas with minimal fragmentation and sufficient connectivity to allow for species movement among them.

Publications/Products:

❖Batllori, E., Parisien, M. A., Parks, S. A., Moritz, A., & Miller, C. (2017). Potential relocation of climatic environments suggests high rates of climate displacement within the North American protection network. Global change biology, 23(8), 3219-3230.

❖Interactive web app: https://adaptwest.shinyapps.io/climate_displacement/

For additional information:

Sean Parks sean_parks@fs.fed.us

Carol Miller cmiller04@fs.fed.us

Results: The quantitative, systematic assessment of climate velocities revealed spatially varying exposure and sensitivities of the network of protected areas to climate change. Protected areas in the western United States may be subject to lower velocities of climatic change, whereas the highest velocities would affect northernmost latitudes, eastern Canada, and southeastern United States. Although few instances of novel or disappearing climates were identified, the majority of the network will be exposed to high rates of climate displacement (>1 km/yr).

Climatic relocation patterns reveal that the majority of climate displacement involves areas outside of the network, with outgoing and incoming climates that terminate or originate on unprotected lands. Climatic relocation that occurs within the protection limits of an individual unit (i.e., a unit that retains its current climates) applies to only a small percentage of protected areas (1.6%).

The analysis of the major land-cover types associated with the location of climate analogs revealed that substantial differences exist between the land cover within the current protected areas and the land cover in locations representing climate analogs.

Shifting climatic conditions over the next century may compromise the ability of the NAM protection network to effectively preserve currently protected species and ecosystems. The estimates of the velocity of climate change show that the majority of protected areas may be exposed to high rates of climate displacement. Such forcing may promote important shifts in species distribution, with the potential for substantial alterations to ecological communities, biodiversity, and ecological processes within the network. Additionally, there is high potential for climatic relocation both from and toward unprotected areas that are degraded, further challenging conservation goals.

Encouragingly, our examination highlights opportunities to complement the current protected area network and promote its connectivity given the prevalence of natural land-cover types in locations representing climate analogs of currently protected areas.

This summary prepared by M. Snyder 5/2018