USDA United States Department of Agriculture

climate FACTS

FOREST SERVICE – PACIFIC NORTHWEST REGION

for the greatest good

climate change & WILDLIFE MANAGEMENT

Climate Change Impacts to Wildlife

Species around the globe are responding to climate change. Changes have been observed in their phenology (life-cycle timing), distribution, and the structure and function of ecosystems they inhabit.[1,2,3]

Direct & Indirect Effects

- Climate change can directly impact wildlife through increased thermal stress and injuries during extreme weather events.[4]
- However, most climate-related changes to wildlife populations, be it decline, local extinctions, or expansions, will be realized through indirect effects.[5,6]
- Indirect effects include:
  - changes in amount/distribution/quality of habitat
  - changes in timing and availability of food and water
  - changes in predator/prey or competitor interactions
  - increased or novel diseases
  - misalignment between migratory species arrival and food availability
- Intensification of fire and insect driven disturbances has the potential to profoundly alter wildlife habitat by reconfiguring the landscape and reducing the availability of key habitat features, including food and shelter.[7,8]

Climate Change is a Threat Multiplier

Climate change impacts on wildlife habitat and populations will not occur in isolation.

- Climate change is likely to multiply the impact of stressors that already affect wildlife populations including invasive species, fire and insect disturbances, and human development.[9,10] (See boxes)
- Land managers have experience managing these stressors. Current best management practices will continue to be useful for addressing interacting stressors in a climate change future, but how those practices are implemented will need to be adjusted based on changing conditions and desired outcomes.[4]

Amphibians in the Climate Vice

Amphibians in montane habitats present a clear case study for climate change interactions with other stressors. Predatory trout were stocked in historically fishless lakes and ponds, eliminating many amphibians and other native species. Meanwhile shallow ponds and wetlands, the current primary habitat of natives, are highly vulnerable to hydrologic alteration (drying) from climate change. Proactive management will likely be necessary to reduce extinction risks.[11]

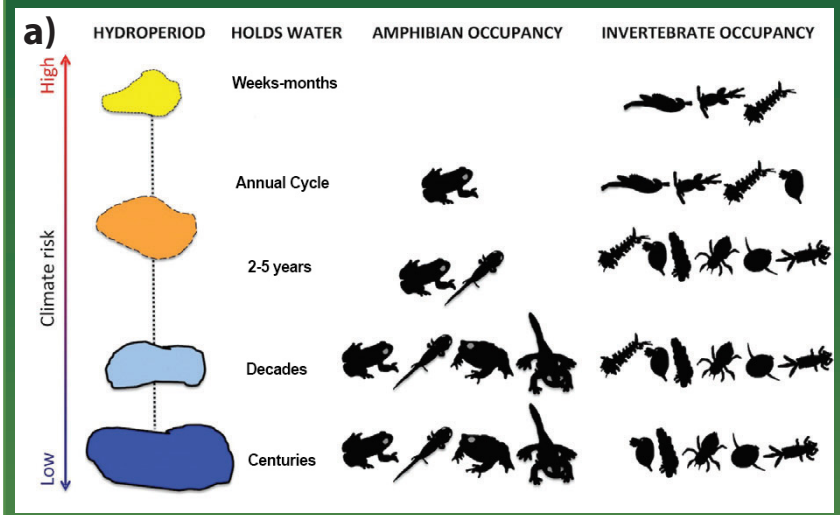

Figure 1: **a)** Climate risk decreases and species occupancy increases with increasing size of montane ponds and lakes without fish. Icons for perennial ponds from left to right are: Cascades frog, long-toed salamander, western toad, northwestern salamander, mosquito larva, cladoceran, caddisfly larva, dragonfly larva, beetle, and mayfly larva. Shorter hydroperiod ponds also have icons for fairy shrimp and copepods. (Figure from Ryan et al., 2014)[11] **b)** Introduction of trout dramatically alter the food webs and nutrient dynamics of the longer hydroperiod water bodies through their intense predation of native aquatic species. (Photo: Redband trout - U.S. Fish and Wildlife Service)

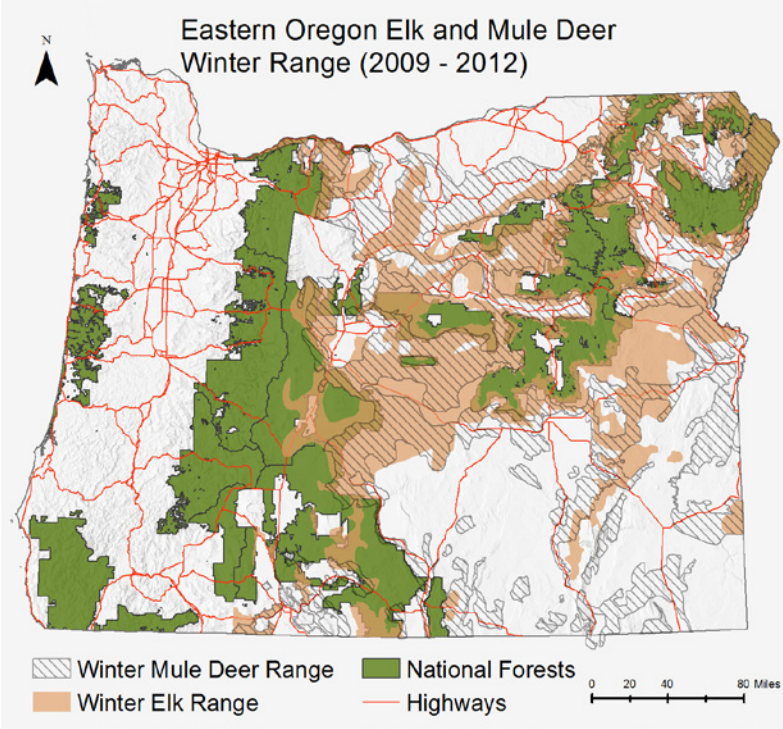

Figure 2: Low elevation areas including parts of national forestlands throughout eastern Oregon serve as winter habitat for mule deer and elk. Climate change will impact habitat suitability and migration patterns causing changes to the distribution of winter range in the future.

Migratory Ungulates

Elk and mule deer are iconic species of western interior landscapes. Their populations in the eastern half of the region migrate to track food availability and quality. A mule deer study from central Oregon shows migration benefits survival, and movement patterns have changed over decades as human influence on the landscape increased. Populations have declined in this area with humans and climate thought to be contributing factors. Climate change will affect forage distribution, quality, and timing for deer and elk. Warmer, wetter, less-snowy winters may reduce migratory movements producing cascading impacts on vegetation structure and composition in areas previously used only as summer range. Increased exotic grass may reduce forage quality and availability in winter ranges. These species adjust their behavior in response to changing conditions, but the combination of habitat fragmentation and broad-scale change to habitat quality may lead to further decline. Increasing landscape connectivity by increasing crossings at barriers like highways are a way to facilitate movement and buffer impacts.[4]

Effects on Wildlife Habitat

Food
Timing and abundance of plant and animal prey will change as growing season and precipitation regimes change, potentially creating mismatches in phenologies.[4]

Water
Changes in precipitation timing, amount, and form (more rain, less snow) will produce changes in seasonal water availability and characteristics of water features.[4]

Shelter
Availability of burrows, dens, moist spots under large logs, and other thermal refugia will become more important as animals respond to extreme heat by seeking shelter in these structures.[4]

Spatial Arrangement
Habitat features need to be present and arranged in ways that allow animals to effectively use them and to disperse to new areas. Climate-related disturbance and human modifications can limit availability of habitat and create barriers to movement.[4]

Predator and Competitor Interactions
Climate change can contribute to changes in the distribution, abundance, and behavior of interacting species.[4]

Assessing Vulnerability

- Vulnerability assessments (VAs) gather and synthesize information in order to help us better understand and characterize impacts to wildlife. Vulnerability is typically divided into three components.[4,12]
  - **Exposure** – How much will climate conditions or climate-driven processes produce change in areas occupied by a given species, habitat type, or community?
  - **Sensitivity** – How much will those changes impact wildlife habitat characteristics (food, water, shelter, security, and configuration) and key population processes (including survival, reproduction, and meta-population dynamics)?
  - **Adaptive capacity** – Are there opportunities for species to change in ways that compensate for climate effects (e.g., behavioral changes, evolutionary adaptation, range shifts, etc.)?
- Assessing vulnerability requires examination of both broad-scale (e.g., habitat, landscape pattern) and specific (e.g., individual species, fine-scale habitat features) effects.[8,13]

Climate Adaptation

Information from VAs can be used to formulate landscape principles and tactics for adaptation falling into three core strategy categories[14]:

Resistance

- Forestalls impacts to highly valued resources.
- One general principle for resistance is to protect the features that are hardest to replace.[4]

Tactics

- Identify and protect key habitat features at multiple scales.[4]
  - Legacy structures (see box) - big trees, snags, logs
  - Microclimates (see box)
  - Refugia from disturbance and extreme heat - cliffs, talus, burrows, shade, water sources

Resilience

- Improve recovery potential to a desired condition after disturbance.
- Resilient landscapes are characterized by landscape patterns and vegetation communities that are well adapted to local disturbance regimes.[15] Key challenges for restoring these communities include fragmented land ownerships and past management practices.[4,15]

Tactics

- Maximize the potential for populations to recover or re-colonize after a disturbance by maintaining permeable landscapes and viable meta-populations.[4]
- Remove invasive species.
- Manipulate disturbance processes (e.g. prescribed fire, mechanical treatments) to produce desired spatial and structural characteristics.[4]

Response

- Facilitate climate-driven ecological transitions to desired conditions.

Tactics

- Provide key habitat characteristics in areas projected to be suitable in the future.[4]
- Constructing habitat enhancements like artificial burrows and water sources.[4]
- Consider assisted migration of threatened species to newly suitable areas.[4]

Legacy Structures

Biotic components of a community that persist after disturbance generally have the greatest influence on the formation of the post-disturbance community.[16] These "biological legacies," especially big trees, living and dead can greatly affect the habitat quality for wildlife in an area. Old trees are ecologically important to the region's mid-elevation forests, especially early seral species like Douglas-fir and ponderosa pine. They have decaying parts, cavities, brooms, or are snags/logs which provide a range of diverse structures for many species to utilize. It is uncertain what climate change's effect will be on forest types that produce large, old tree biological legacies. Models project potential expansion in the region, but they will be sensitive to more fire and insect disturbance.[4] Since these legacy features take decades to develop, climate change's influence on disturbance, tree mortality, and biotic interactions puts them at risk in the future.

Figure 3: Pileated woodpeckers are an example of a species that benefits from legacy structures. Large standing and down wood are important for foraging and nesting cavities. It's excavations in turn benefit other species. When these structures are present in small numbers or absent in forests, the plant and animal communities they harbor are smaller. (Photo: USDA Forest Service)

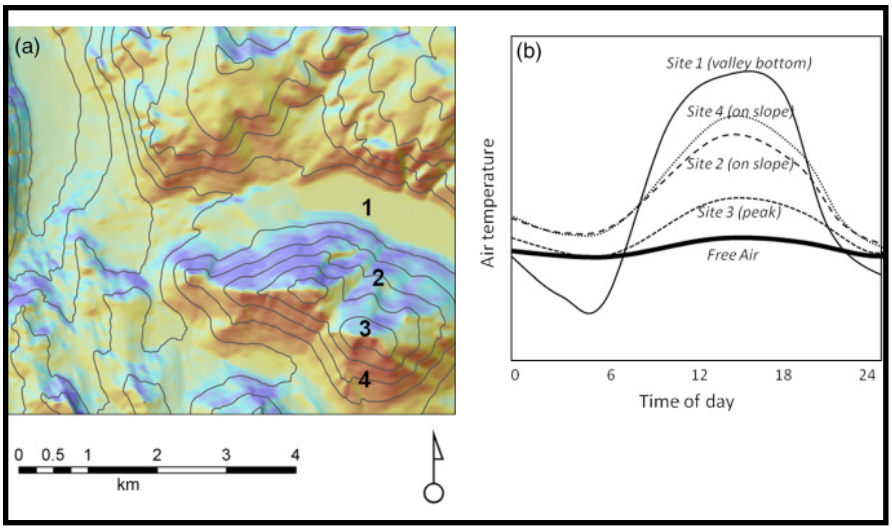

Figure 4: Representations of how terrain affects microclimate. **a)** Shaded relief shows area of high (warm colors) and low (cool colors) solar insolation with the locations of four hypothetical sites. **b)** Typical pattern of diurnal temperatures for four different site types (1 - valley-bottom, 2 - northern slope, 3 - peak, 4 - southern slope) as compared to the free air environment. (From Dobrowski et al., 2011)[17]

Microclimate

Wildlife can respond to combined habitat and climate conditions at relatively fine-scales. Recent evidence suggests complex terrain and vegetation structure (e.g. old-growth vs. plantation) are major factors that influence microclimate. Observations show valley-bottom temperatures can be de-coupled from temperatures of the greater atmosphere as well as accumulate higher concentrations of water and soil.[17] Old-growth forest areas can maintain temperatures cooler than the greater atmosphere.[18] Identifying microclimate areas where plants and animals have a greater chance of persisting is a topic ongoing investigation in climate change science.

Land managers will likely have to take an approach encompassing all three strategies to accomplish conservation objectives. The overarching adaptation principle of promoting and protecting landscape heterogeneity addresses resistance, resilience, and response.

This may apply to more than vegetation type. Some suggest maximizing available combinations of abiotic factors (topography, geology, soils) that are functionally connected helps to "conserve the stage." This yields more options for either biological recovery and/or reshuffling that allows novel but functional communities to develop and evolve.[19]

The Challenge Ahead

It will be challenging to provide all the habitat characteristics needed for wildlife. However by using some core landscape principles, managers can work toward retaining and recruiting diverse vegetation communities in appropriate mixes and configurations that will accommodate disturbance and produce a shifting mosaic of high quality habitat supporting functional wildlife communities.[4,15]

Looking for More?

Please see the cited references (located on the back) for more in-depth information about climate change impacts in the region.

The US Forest Service Climate Change Resource Center hosts a wide array of information from basic science to forest impact topics – **www.fs.usda.gov/ccrc**

Climate Facts is produced by the Pacific Northwest Region 6 Climate Change Team. US Forest Service, 1220 SW 3rd Ave., Portland, OR 97205.

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