TOO HOT TO HANDLE?

Managing the Ecological Impacts of Extreme Heat in the Northwest

An unprecedented heat wave affected the Pacific Northwest in the summer of 2021, with dramatic impacts observed across a variety of organisms and ecosystems, the extent of which is still unfolding. This event, popularly referred to as a "heat dome," set all-time high temperature records in dozens of locations across Washington, Oregon and Western Idaho, with temperatures soaring to well above 100°F.

The impacts of these sustained extreme temperatures included mass shellfish die-offs, distressed wildlife and heat-scorched trees. With such events expected to become more common under future climate scenarios, Northwest scientists and resource managers require a greater understanding of the ecological risks posed by extreme heat events of a similar magnitude, as well as potential management responses and policy options to address those risks.

The Northwest Climate Adaptation Science Center's 2025 Deep Dive facilitated the co-creation of a regional synthesis that describes the state of the science, management and human dimensions of the ecological impacts of extreme heat and identifies key needs for addressing gaps in knowledge and capacity. For more info, visit: bit.ly/Heat-Deep-Dive

Key Findings

Documented ecological impacts of the 2021 PNW heat wave are primarily negative, ranging from minor physiological damage to large-scale mortality. Observation of additional, longer-term impacts is anticipated as time unfolds. Variation in observed impacts could be a function of varying levels of exposure, sensitivity and adaptive capacity to extreme heat across localities, species and ecosystems.

Few strategies have been proposed or evaluated for reducing ecological vulnerability to extreme heat, beyond a general need for climate adaptation. However, the 2021 PNW heat wave's impacts may inform efforts to lower exposure, reduce sensitivity and enhance adaptive capacity for future extreme heat events in the Northwest. Monitoring will be crucial to evaluate the effectiveness of actions to reduce vulnerability to extreme heat.

Key Findings, Continued

Available tools and datasets can provide managers with estimates of exposure to extreme heat, help evaluate the impacts of extreme heat on focal ecosystems and organisms and forecast the occurrence and impacts of extreme heat. However, few, if any, tools and datasets holistically consider vulnerability to extreme heat.

Many Northwest resource managers have observed direct mortality and ecosystem stress in response to extreme heat, as well as disrupted management efforts and diminished Tribal cultural resources, but their management responses are affected by variability in the nature of events such as their intensity, timing or duration.

Many Northwest resource managers respond to extreme heat reactively by changing management activities and/or collecting data during or after events, and, when possible, respond proactively by planning in anticipation of future events.

Many Northwest resource managers draw on a variety of technical data and information to understand and prepare for extreme heat, as well as community/place-based knowledge, collaborative networks and planning and guidance documents. They also access a range of funding sources to support their responses.

Staff time is the primary limit on Northwest resource managers' responses to extreme heat, but they also describe related challenges ranging from coordinating data collection to needing more actionable information and tools.

Extreme heat policy frameworks are inconsistent and varied, reflecting the complexity of addressing ecological impacts from extreme heat. Addressing inconsistencies requires collaboration and consensus across governance levels and sectors.

Human dimensions of the ecological impacts of extreme heat are complex, but most existing heat governance focuses on human health and infrastructure. The limited research and policy available for ecological impacts of extreme heat present challenges and opportunities.

Key Research Needs

- Quantify and synthesize the ecological impacts of the 2021 heat wave.
- Understand the mechanisms and drivers of interspecific and intraspecific variation in sensitivity and adaptive capacity to extreme heat.
- Characterize the interactive ecological effects of extreme heat and other anthropogenic, biotic and abiotic disturbances and stressors.
- Develop and evaluate management and restoration actions.
- Analyze the impacts, effectiveness and logistical considerations of immediate, reactive and proactive policy and management responses.
- Assess and improve the effectiveness and accessibility of existing tools to measure and predict general and extreme heat exposure and impacts.
- Develop and standardize monitoring protocols to assess the ecological impacts of extreme heat events.
- Understand the social and human dimensions of the ecological impacts of extreme heat.

Key Capacity-Building Needs

- Support long-term and post-event rapid ecological and microclimate monitoring.
- Improve, operationalize and expand the accessibility of existing tools and datasets.
- Provide and synthesize guidance for using tools, data and predictive models.
- Integrate knowledge from different disciplines.
- Facilitate preparation for future events.
- Enhance and better leverage staff capacity.
- Aid and support collaborations and network-building.