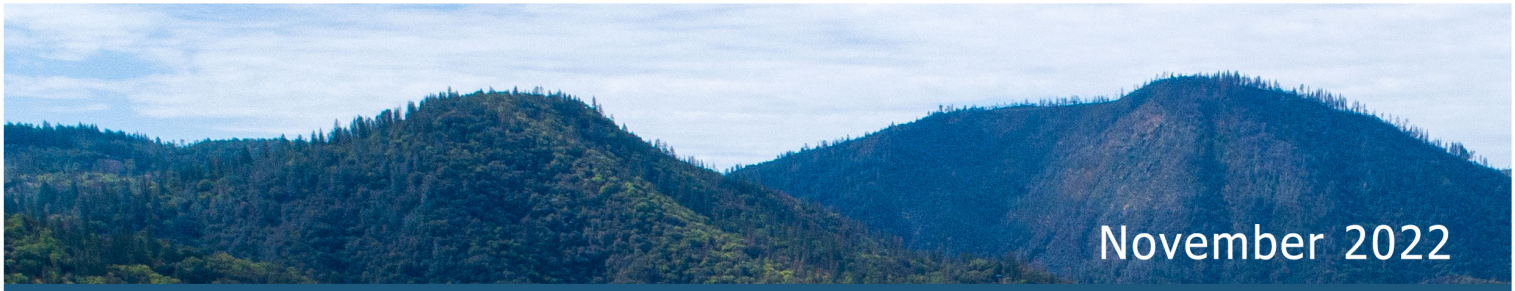
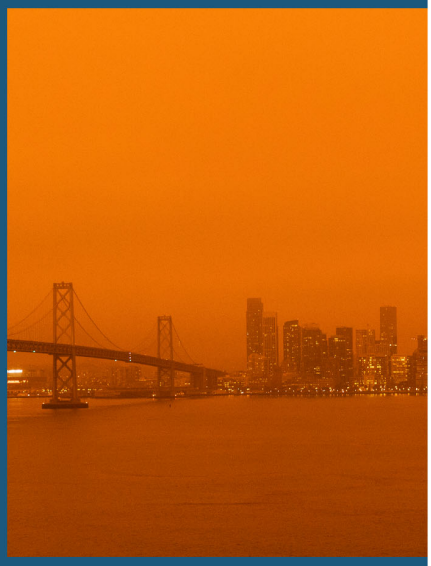


November 2022



Indicators of Climate Change in California

Fourth Edition

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INDICATORS OF CLIMATE CHANGE IN CALIFORNIA

Fourth Edition
November 2022

California Environmental Protection Agency

Office of Environmental Health Hazard Assessment

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The Office of Environmental Health Hazard Assessment (OEHHA) acknowledges that the work that led to this report took place on the homelands of California Tribes, who have lived in harmony with the land and its natural resources since time immemorial. OEHHA thanks and acknowledges the wisdom and knowledge shared with us so generously by the Tribes in preparation of this report.

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Cover photos (clockwise from bottom):
Lake Oroville (California Department of Water Resources); Thomas Fire in Santa Barbara, December, 2017; worker on a roof in extreme heat; Chinook salmon (US Fish and Wildlife Service); flooded road, 2019 (Pala Band of Mission Indians); San Francisco sky glowing orange from wildfire smoke, September, 2020.

In memory of Harry Williams (1956-2021) and Monty Bengochia (1951-2022)

Harry was a Nüümü (Bishop Paiute) Elder and internationally recognized expert in the ancestral water systems of the Payahuunadü — Owens Valley. Harry guided OEHHA along our path working with Tribes. Harry was a Warrior, a Water Protector and friend to many, especially to Mother Earth.

Monty Bengochia was a Nüümü (Bishop Paiute) Elder, water protector and advocate for sacred sites, youth, traditional foods and medicine, as well as a gifted singer. Monty was an important advisor and served on OEHHA Tribal Indicators Working Group. His guidance and insight helped us understand the impacts of climate change on the Payahuunadü.

Harry and Monty will forever be missed, but never forgotten.

Contributors

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OEHHA respects the right of Tribal nations to govern the collection, ownership, and application of their data. Tribal information is included in this report only with the explicit permission of the Tribe.

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VIII. Emerging Climate Change Issues

The stark reality of climate change in California is clear: record-high temperatures, an unrelenting drought, and unprecedented wildfires. The evidence continues to mount of the impacts of climate change on the health, safety, and well-being of the state's residents, and on its unique ecosystems that are home to one of the most diverse arrays of plant and animal species in the world. This fourth edition of the *Indicators of Climate Change in California* report captures much of this evidence.

The Office of Environmental Health Hazard Assessment (OEHHA) prepares these reports on behalf of the California Environmental Protection Agency under state law (Public Resources Code Section 71080 et seq.), which designates the Office as the lead agency for the development and maintenance of environmental indicators for the Agency. The report presents a collection of indicators that track climate change, its drivers, and its impacts. Indicators are scientifically based measurements of observed phenomena that describe, and facilitate communication about, the various aspects of climate change.

The first edition of this report in 2009 presented 27 indicators showing evidence of the discernable impacts of climate change in California consistent with global observations. Today, the evidence for human-induced climate change is unequivocal. An ever-growing body of data – from paleoclimate studies, instrumental measurements, satellite imagery, and improved computer models – allow scientists to better understand climate processes, including extreme events. Since the first report, California has witnessed a continuation of most trends: increases in air, ocean and freshwater temperatures, rising sea levels, and declining spring snowmelt. This report and the previous edition show that recent years have been punctuated by alarming discontinuities: record high temperatures, record low snowpack, exceptional drought, record-breaking wildfires, unprecedented marine heat waves, and disappearing glaciers, among other things.

A new section in this fourth edition focuses on how climate change has impacted California's Tribal Nations. Tribal experiences and knowledges, acquired from long histories of interactions with the Earth, is a key component in advancing the full understanding of climate change and addressing its impacts. This section recognizes the value of Tribal knowledges, which embody long-term observations and perspectives that pre-date instrumental records, in informing decision-making across California.

By documenting historical trends, this report adds to the body of scientific information on the understanding of climate change and its impacts on the state. More than 100 scientists and researchers in state and federal government, academia and research institutions, as well as over 40 California Tribes, contributed to the development of this report. The report showcases reliance on data and scientific research as the foundation for the state's climate policy. By bringing together indicators that provide a retrospective picture of climate change in California, it complements the California Climate Change Assessments, which focus on original research and projections to advance the understanding of climate-related vulnerability; the State Adaptation Strategy, which outlines what the state is doing to address impacts and build resilience; and the Scoping Plan, which lays out approaches to reach California's emissions reduction goal and to move towards carbon neutrality. It also serves as a resource for scientists, educators, and the public.

Report structure and content

This report is organized into six sections, starting with the (1) human influences on climate, or "**drivers**," followed by (2) **changes in climate**, then their impacts (3) on **physical systems**, (4) on **plant and animal species**, and (5) on **human health**. The report contains a new section (6) on the impacts of climate change on **California Tribes** in eight chapters written by their respective Tribe, along with summaries of three listening sessions during which additional Tribes offered their perspectives.

Of the 41 indicators in this report, 6 are new, 24 have been updated to incorporate new data (including five indicators with additional metrics), 5 are updated with relevant information but without new data, and 6 are the same as the Third Edition (2018).

Each indicator chapter presents one or more graphs or maps illustrating the change over time, followed by a discussion of:

- What does the indicator show?
- Why is the indicator important?
- What factors influence the indicator?
- Technical considerations (describing characteristics, strengths, and limitations of the data)
- Contributor(s) to the chapter
- References cited

The section on Tribal impacts captures the knowledge, observations, and perspectives of each tribe regarding the direct and indirect impacts of climate change on their lives, livelihood, and ecosystems.

The last section of the report on ***emerging climate change issues*** identifies changes in California's environment that are plausibly — but not yet established to be — influenced by climate change. The link to climate change is supported by scientifically defensible hypotheses, models, and/or limited data. However, factors such as land use and environmental pollution, as well as the inherent variability of the climate system, make it difficult to attribute these changes as impacts due to climate change. Additional

data or further analyses are needed to determine the extent to which climate change plays a role.

To support its efforts to update existing indicators and identify new indicators, OEHHA continually monitors the scientific literature, publications of research organizations, governmental entities and academia, and other sources for information relating to climate change and its impacts on California. Since 2013, OEHHA has compiled bibliographies of selected publications presenting observations and new or emerging scientific information on climate change, with an emphasis on California. The bibliography is available online as a searchable database.

This indicator report will continue to be updated periodically. OEHHA welcomes input from the research community, governmental agencies, Tribal governments, non-governmental organizations, and other interested parties. It is our goal that the indicators, both individually and collectively, address the key aspects of climate change and promote informed dialogue about the state's efforts to monitor, prepare for, and mitigate climate change and its impacts.