



A blue copper butterfly on the Sonoma Coast. (Photo by [icosahedron](#), iNaturalist CC)

Climate Change

‘There’s No Ambiguity. It Will Be Gone.’ How Animals Will Feel the Warming Climate

by [Jane Braxton Little](#)
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A blue copper butterfly perches waist height on a buckwheat blossom blooming in the cloud dunes near Bodega Bay. In the thick fog its gossamer wings are folded, keeping its sky-blue hues to itself and the milk-white flower. Normally found at higher elevations in California’s Sierra Nevada and Cascade mountains, this colony of blue coppers exists in this chilly coastal prairie because of the low clouds that drip with moisture.

If the fog belt burns off permanently, this butterfly population will become extinct. “There’s no ambiguity. It will be gone,” said Arthur Shapiro, an evolution and ecology professor at University of California, Davis.

Heat is threatening animals around the world. At a time when scientists are certain that human greenhouse gas emissions are warming ocean waters and raising temperatures, however, they are still sorting out how turning up the thermostat is affecting the specific ecosystems that plants and animals rely on – including the coastal fogs so critical to redwoods, these blue coppers and a host of other species. Researchers are also raising questions about the impacts of an additional 8 degrees Fahrenheit on California’s inland species, from the Central Valley to the Sierra Nevada. While there is little doubt that changes in climate are shifting the habitats of virtually every living being on Earth, an examination of Northern California, one of the most biologically diverse places on the planet because of its mix of habitats, illustrates the challenges of trying to predict the future for evolving species.

Clearly there will be losers. The latest Intergovernmental Panel on Climate Change report found that around 1 million animal and plant species are now threatened with extinction, many within decades, more than ever before in human history. But there may also be winners, at least temporarily. As scientists wrestle with the impacts of global temperatures already 2.7 degrees hotter than pre-industrial levels, they are entering a phase of scientific inquiry without parallels, said Shapiro: “Climate change is leading to environments that have no analog in our modern world.”



A Cassin’s auklet on the Farallon Islands. (Photo by Duncan Wright, [Wikimedia Commons](#))

In the San Francisco Bay Area, the effects of climate change on local species begin at sea. Like oceans around the world, the Pacific has warmed by as much as a half-degree Fahrenheit every decade since 1910. For Cassin's auklets, the results have been devastating. These chunky fist-sized birds are common in the waters around the Farallon Islands. During the winter of 2014 more than 1,200 young Cassin's auklets washed up dead – and tens of thousands are thought to have starved, said Shaye Wolf, a climate change scientist with the Center for Biological Diversity. An enormous slog of warm water had developed off the Pacific coast. Known as the Blob, this marine heat wave caused massive die-offs and a 30 percent drop in the population of humpback whales.

The warming waters hit Cassin's auklets, along with many other seabirds and marine mammals, through their food supply. The auklets feed on krill and copepods, small crustaceans found in most of the world's oceans. Scientists believe the over-heated waters drastically reduced the numbers of the shrimp-like krill, depriving the birds of a dietary mainstay. Warm waters also drew southern copepods north. And while Cassin's auklets will eat them, they are less nutritious than their fat northern counterparts, “a kind of junk food,” said Wolf.

Scientists detected [another heat wave developing this summer](#) in the same area of the previous Blob, this one already 4 degrees Celsius above normal in places. With warmer waters leading to less food, Cassin's auklets suffered an alarming breeding failure this summer. “Parents abandoned nests and chicks just starved,” Wolf said.



A Chinook salmon on the Feather River. (Photo by California Department of Fish & Wildlife, [Wikimedia Commons](#))

Warming waters are also taking a toll on salmon, threatening these cold-loving fish in several ways. Chinook, the largest of the salmon family, live in both ocean water and freshwater at different stages of their lifecycle. They are extremely resilient and have adapted to some of the warming, said Lisa Crozier, a National Oceanic and Atmospheric Administration salmon researcher and lead author of a July [study](#) published in *PLOS One*. Still, Chinook, already listed as a federally endangered species, are stressed by warmer temperatures in the Sacramento and other rivers. That makes them susceptible to parasites and disease. If stream temperatures rise beyond 3.6 degrees Fahrenheit above the pre-industrial era all bets are off, Crozier said. Chinook salmon in the Central Valley may be the first of the many salmon species to blink out.

In inland California, butterflies at various elevations have shown mixed responses to record-setting temperatures. During the state's five-year drought, researchers found the number of butterfly species and individuals observed per year increased at lower elevations but decreased at higher elevations. A 2018 [study](#) documented those at sea level reversing long-term declines, while butterflies in the Sierra Nevada were severely harmed, said Shapiro, the UC Davis professor.

Butterflies generally do not do well in warm, wet winters, he said. During the drought, species at low elevation sites benefitted from hot sunny days and cold nights with minimal humidity. But the drought reduced the high-elevation snowpack that helps overwintering butterflies survive until spring. It may also have caused them to emerge earlier in the season, which could have put them out of sync with the flowers and other resources they depend upon. When ecosystems warm to the extent that they are no longer capable of supporting these and other species, "it's bye bye," Shapiro said.

How animals will respond is not always straightforward. When [Jay Roberts, a Point Blue forest ecologist](#), began a study of birds in the Sierra he assumed the five-year drought that killed 147 million trees would be analogous to the climate conditions predicted to occur in the future. He expected to find negative effects to the dusky flycatchers, golden-crowned kinglets and others among the 45 species he monitored. Instead, his [research](#) documented an overall abundance of birds. Nearly half of the species responded positively to higher temperatures; only 20 percent declined. As climate change continues to increase temperatures, Roberts believes many species may benefit, especially if it is coupled with an increase in precipitation.

We can't conclude this trend will continue, Roberts said, but the birds' response to a drastic shift in temperature over a very few years demonstrates that they are resilient. Like other species in the Sierra, birds have evolved to adjust to disturbances that include drought and fire. "These responses are in their DNA," he said.

Still, if some of the effects of heat on animals are counterintuitive, the general results are not. Of the state's 300 at-risk species, those already gone include two populations of the Bay Checkerspot butterfly. [California's Fourth Climate Change Assessment](#) predicts temperatures will climb another 5 to 8 degrees Fahrenheit by 2100. Glaciers will continue to melt. In the San Francisco area, where sea level is already 8 inches higher than a century ago, the 2018 assessment projects it will rise an additional 4.5 feet by 2100 – and possibly as much as 9 feet along the California coast. Northern California farmers will face water shortages of up to 16 percent in some regions. Winter storms will likely become more intense in a boom-bust cycle with very wet and very dry years. And in the Sierra Nevada, the snowpack will decline by two-thirds over the next century and temperatures will increase up to 9 degrees Fahrenheit, according to an assessment led by David Ackerly, a biology professor at University of California, Berkeley.

As scientists continue to document the sometimes surprising ways that animals respond to heat, blue coppers will continue to lay eggs and nibble on buckwheat as caterpillars before spreading their bright blue wings as butterflies. But for how long? These are uncharted times in a hot and entirely novel climate regime.

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