least one group of fish, the rockfish, do respond to water temperature and zooplankton abundance. Ralston has been part of a team studying juvenile rockfish off the central California coast since 1983. Rockfish feed on zooplankton in their first year of life, Ralston says, and in years of unusually warm water these young fish seem to die before they can reproduce. "We have a major reduction in the abundance of young-of-the-year rockfish in El Niño years," he says. "It's pretty much a disaster in terms of [reproductive success]."

Zooplankton eaters with feathers may be suffering even more than those with fins. Richard Veit, an ornithologist at the University of Washington, has been monitoring seabirds off the coast of southern California, and they seem to be in serious trouble. Four times a year between 1987 and 1994 Veit counted seabirds from the deck of a research ship. "Over that period the total abundance of birds has gone down by 40%," Veit says. "The species that's declined most dramatically is called the sooty shearwater," by far the most common seabird in the California Current. Its population, he says, has fallen 90%.

These birds nest on islands in the Southern Hemisphere, and Veit at first suspected a disaster in the nesting grounds. But when he wrote to colleagues in New Zealand, they were surprised to hear about a possible problem, and Veit now thinks the cause is more likely to lie in the shearwater's feeding ground off California. "The bird and zooplankton declines match each other so closely," he says, that "it sure looks like there's a strong connection."

Birds seem to be declining elsewhere in the California Current as well. David Ainley of the Point Reyes Bird Observatory has documented decreases in several seabird populations around the Farallon Islands, offshore from San Francisco. He says one zooplankton-eating bird, the Cassin's auklet, has suffered a 60% population decline since the late 1970s—a period when, like McGowan and Roemmich to the south, Ainley and his colleagues noted increased temperatures and shifts in the zooplankton community.

All these researchers caution, however, that their data sets are too short to distinguish between a long-term climate change and shorter term environmental fluctuations. And other data suggest that this region may be prone to at least one strong natural cycle. Clues from an underwater basin off Santa Barbara indicate that the California Current ecosystem has a boom-and-bust history, possibly driven by cycles of ocean warming and cooling.

Oxygen is depleted in this closed basin, so there are no mud-dwelling animals to disturb the annual layers of the sediment. By counting the layers and examining the fish scales they preserve, says Tim Baumgartner of Scripps and CICESE, a research institute in Ensenada, Mexico, he and his colleagues have developed a nearly 2000-year-long record of anchovy and sardine populations. The record shows the two species rising and falling seesawlike, in alternating cycles lasting about 30 years. Because sardines prefer warmer water and anchovies prefer cooler, Baumgartner suspects cyclical warming and cooling is to blame for the population swings: "There's evidence that the anchovy and sardine variability is driven by an ocean climate oscillator."

"If it's part of a natural cycle, then it'll reverse itself."

—John McGowan

If so, it's happening again, now. The sardine population last crashed in the 1940s, destroying the California sardine fishery—an event documented by John Steinbeck in the novel *Cannery Row*. Now, after decades of negligibly small populations, sardines are returning to the California Current, while anchovies are declining. And that suggests that the present warming along the California coast could be the latest swing in a natural oscillation—one that Nicholas Graham of Scripps' Climate Research Division thinks may operate on a larger scale. Graham speculates that the ocean/atmosphere system of the whole North Pacific region periodically flip-flops between different modes, warming or chilling the California Current.

But even if the warming of the California Current is part of a natural cycle rather than a greenhouse warming, it offers researchers a chance to study how longer term climate change might affect ocean ecosystems. To take advantage of the opportunity, Berkeley's Powell and other oceanographers in a program called U.S. GLOBEC (GLOBal ocean ECosystems dynamics) hope to treat the California Current as an ongoing natural experiment. They are laying plans to trace its ecosystem cycles and how they respond to climate forcing.

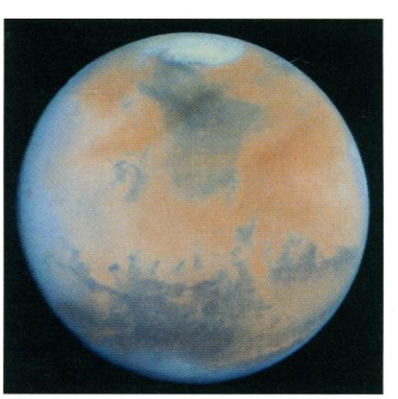
Like surfers watching for early signs of a perfect set of waves, these researchers are waiting for the Pacific Ocean to offer up clues to its future. As Powell puts it, "I can't think of a better place to study how human pressures could modify the ocean's long-term natural cycles."

–David K. Hill

David K. Hill is a science writer in San Francisco.

PLANETARY SCIENCE

Hubble Glimpses a Hazy Day on Mars



PHILIP JAMES (UNIV. OF TOLEDO)/STEVEN LEE (UNIV. OF COLORADO)/NASA

Talk about global change! Since the late 1970s, when the Viking spacecraft visited Mars, ground-based radio telescopes monitoring its atmosphere have recorded a drastic, 20°C cooling. And last month, when Earth passed close to its neighbor, the Hubble Space Telescope photographed one legacy of this increasing chill: a near-global veil of high cirrus clouds, formed when water vapor froze out of the thin atmosphere. A 25-kilometer-tall volcano pokes through especially heavy clouds in the west (left), where the planet is emerging from the cold martian night.

The immediate cause of the colder, cloudier weather compared to Viking days is dust—or more precisely a lack of it. Globe-girdling dust storms can churn micrometer-size, red-orange dust particles high into the atmosphere, where they absorb solar energy, notes Steven Lee of the University of Colorado, a member of the team that took the Hubble images. Two such storms roiled the planet just after the Vikings arrived 19 years ago, warming the atmosphere. But lately martian dust storms have not struck with the same frequency or fury as in the late 1970s.

Why the storms should have abated, allowing the atmosphere to cool, no one can say. Clues might have come from the Mars Observer spacecraft, but it was lost in 1993 as it prepared to enter orbit around the planet. Until it is replaced, planetary scientists will have to rely on more long-distance views from Hubble, which will periodically turn a weather eye on Mars.

–Richard A. Kerr