Changes in west coast marine ecosystems significant

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The California Current system has experienced significant changes during the past decade, resulting in dramatic variations in the ecosystem characterized by shifts in phytoplankton production, expanding hypoxic zones, and the collapse of marine food webs off the western coast of the United States. These changes, driven by new wind patterns, are consistent with predictive models of global climate change, scientists said this week at the annual meeting of the American Association for the Advancement of Science.

But the researchers stopped short of saying that climate change was the definitive cause.

"This coming year will be important," said Jack Barth, a professor of oceanic and atmospheric sciences at Oregon State University. "If the persistent wind patterns of the last few years continue through 2007, it might be enough to tip the scales in favor of climate change as a cause for these extreme variations in our West Coast marine environment.

"Our research has shown there is a 'wobble' in the Jet Stream that in some years has tended to overpower the more historic day-to-day variations in climate in favor of these two- to three-week wind patterns that influence upwelling and ultimately, ocean production."

Eight scientists, including five with ties to Oregon State University, are part of a AAAS symposium, "Predicting the Unpredictable: Marine Die-Offs along the West Coast." This week, they outlined how marine ecosystems are responding to widely different climate-driven variables, beginning in 1997-98 with one of the most powerful El Nino episodes on record.

During that El Niño, ocean waters off the West Coast grew warmer, nutrients decreased, biological production was reduced, and species from zooplankton to salmon disappeared, were drastically reduced or moved from their typical habitats. The El Niño capped what had been a series of years through the 1990s characterized by warm waters and weak upwelling.

That regime ended abruptly in late 1998, and the California Current system entered a four-year period of cold ocean conditions, according to Bill Peterson, a NOAA oceanographer who works out of OSU's Hatfield Marine Science Center in Newport, Ore. The ecosystem response to this change, Peterson said, was immediate and dramatic.

"Zooplankton stocks more than doubled in biomass, and the zooplankton community structure suddenly changed to one dominated by cold-water, lipid-rich species," Peterson said. "Salmon stocks rebounded immediately and the good conditions lasted for four years. But the cold-water period ended as quickly as it began, in late 2002, and the ecosystem began to revert to conditions seen during the 1990s."

Before the change, however, the West Coast experienced an unprecedented invasion of sub-arctic water in the summer of 2002. This cold, nutrient-rich water triggered massive phytoplankton production in the surface waters, and as the organisms decayed and sank to the bottom, they sucked oxygen out of the lower water column, leading to hypoxia and marine die-offs.

And though the ocean waters warmed over the next four years, the West Coast experienced hypoxia events every summer, according to Francis

Chan, a senior research assistant professor at Oregon State University.

"When it comes to upwelling and phytoplankton production, there can be too much of a good thing," Chan said. "Although the low-oxygen zone has varied in intensity from year to year, 2006 saw an unexpected expansion and degradation in oxygen conditions. At least 3,000 square kilometers of the continental shelf along the Oregon coast were affected.

"This latest hypoxic event," he added, "was off the charts."

Nature threw a different wrinkle at the California Current system in 2005, when the spring upwelling was delayed by a month. Winds that normally cause upwelling were absent, creating the lowest "upwelling-favorable wind stress" in 20 years. Near-shore waters were two degrees (C) warmer than average, surf zone chlorophyll levels were 50 percent of normal, and nutrient levels were reduced by one-third. Changes in water movement, triggered by the wind shifts, had a drastic effect on mussel and barnacle larvae, which decreased by 83 and 66 percent respectively.

What this showed scientists is that changes to the system are multi-faceted. Large-scale changes have an imprint on the entire ecosystem, but there are surprises in local systems that may depend on the timing of winds as much as their overall strength and duration.

"We used to think we could look at the wind and predict runs of salmon," Peterson said. "That's not necessarily the case. It's a lot more complex out there."

Bruce Menge, an Oregon State marine ecologist, said another lesson scientists have learned is that there are ecologic winners and losers during these climatic variations. The general perception that cold water cycles are good for the ocean may be true for the open ocean environment, he said, but they can wreak havoc on near-shore communities such as kelp forests and rocky intertidal zones. And while El Niño events and warm water cycles lower ocean production in general, they also can boost near-shore food webs.

"I think what we're seeing is that the Pacific Decadal Oscillation has shifted," Menge said. "The 20- to 30-year cycles are becoming less prominent than these four-year cycles. What we don't yet know is whether these last couple of four-year cycles are just blips, or the whole system has gone haywire."

Oregon State University's Jane Lubchenco, a co-organizer of the West Coast variability symposium and past president of the AAAS, said the bottom line is that the dramatic events of the past few years have shown how vulnerable our oceans are to changes in overall climate – and how quickly ecosystems respond.

"Wild fluctuations in the timing and intensity of the winds that drive the system are wreaking havoc with the historically rich ocean ecosystems off the West Coast," Lubchenco said. "As climate continues to change, these arrhythmias may become more erratic. Improved monitoring and understand of the connection between temperatures, winds, upwelling and ecosystem responses will greatly facilitate capacity to manage those parts of the system we can control."

Source: Oregon State University

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