Newly discovered West Coast arrhythmias cause - Interplay of climate and currents disrupts marine ecosystems

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(PressZoom) - San Francisco, CA -- Oceanographers, climatologists, and ecologists at the American Association for the Advancement of Science meeting report that unusual ocean conditions and marine die-offs are changing the way scientists think about the future of ocean resources off the US West Coast. The researchers' new synthesis of decades of atmospheric and oceanographic data reveals that increasingly wild fluctuations in winds and currents appear to account for a series of recent anomalous ocean events -- from repeated low oxygen zones larger than the size of Rhode Island to massive die offs of seabirds. The scientists say that the underlying swings in winds and position of the jet stream are consistent with climate change predictions.

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Understanding the interplay of warming, winds, and storms with ocean currents and biological productivity is a whole new area of study that is proving urgent. In 2002, when scientists first documented low-oxygen zones off the US Pacific Northwest coast, they thought it was a startling, once in a lifetime, event. But these "dead zones," which suffocate crabs, fish, sea stars, and anemones on the ocean floor, have continued, with 2006 now on the books as the largest, most severe and longest lasting dead zone on record for the west coast.

"It was unlike anything that we've measured along the Oregon coast in the past five decades," says Francis Chan of Oregon State University. "We're seeing more and more evidence that changing climate and changing currents can lead to big and surprising changes in something as fundamental as oxygen levels in the sea."

In 2005 and 2006, researchers also found tens of thousands of starving birds washing up on shore at times of the year when the birds should be healthiest. And scientists trying to predict salmon runs have recorded large swings in ocean temperatures at a much higher frequency than the past, a change that signals large shifts in the amount of food available for salmon, birds, and marine mammals. Scientists link the low oxygen zones and animal die offs to changes in the timing and strength of upwelling, a usually reliable and regular wind-driven process that brings cold, nutrient rich waters up from the depths of the ocean and fuels productive coastal ecosystems.

"We are investigating the idea that dead crabs and sea stars at the bottom of the ocean are correlated with changes in coastal winds, which are in turn driven by changes in temperatures on land," says Lubchenco.

Around the globe, areas of coastal upwelling which include the waters off the west coasts of the US, Peru, and Chile, eastern New Zealand, southwest and northwest Africa, and the Arabian Sea, are known for their abundant sea life and account for nearly 50% of the world's fisheries landings. Upwelling on the US west coast typically begins during the spring, triggering growth of phytoplankton and fueling marine food webs from the bottom-up. Many marine animals time their breeding and migrations with this influx of nutrients and growth of prey populations. But in recent years, changes in wind patterns and the position of the jet stream have changed the timing and strength of upwelling, disrupting these long-standing patterns.

"These are not just little blips," says oceanographer Jack Barth of Oregon State University. "Winds in both 2005 and 2006 are outside the envelope of what we've seen in the last twenty to forty years. They are the two most anomalous years in the last two decades -- and they are anomalous in opposite directions."

Starving Salmon

In 2005, relaxed winds delayed upwelling of cold water and nutrients by several months, resulting in water temperatures 6 degrees Celsius above normal and causing the typical boom in small, prey fish populations to occur too late for feeding salmon, seabirds, and whales.

"In 2005 we saw no upwelling in the spring, but then it came on so strong that we saw the same amount of upwelling in two months that we usually see in six," says Bill Peterson of NOAA. "The salmon go out to sea in mid-April to mid-May, that is when they always go out. But in 2005 they found nothing to eat -- by the time upwelling started, they were dead, starved to death."

Then, in 2006, unusually strong winds doubled the typical amount of upwelling, and increased the influx of nutrients to the system, but these strong winds ebbed in the month of May, just when salmon went out to sea. These mismatches in timing of upwelling are critical for many salmon species whose return to spawning grounds has been only 2-4% in recent years, and Peterson predicts that 2007 will be another low year for salmon returns.

Sea-bird Die-offs

In the spring of 2005, the volunteers who work as citizen scientists patrolling beaches found tens of thousands of seabirds washing up dead on beaches in Washington, Oregon and California. Emaciated birds littered the beaches because the normal spring upwelling that fuels food production didn't occur until much later in the season.

"In Oregon, the volunteers would literally wade through 80 dead birds in a mile. They feared no birds would survive," says Julia Parrish of the University of Washington who leads the citizen scientist program. Murres' and cormorants' breeding cycles are timed to coincide with the boost in prey fish in the spring. Tied to coastal breeding colonies, they are not strong enough fliers to travel hundreds of miles to find new food sources.

In 2006, scientists have also documented unusual die-offs of migratory seabirds such as auklets that visit the US West coast during the winter months. "They appear to be starving to death at sea. It's not bird flu, not another disease, not oiling or some other chemical," says Parrish.

Increases in the severity or frequency of storms, a prediction from climate change models, may also be a major factor in the survival of these seabirds. Winter die-offs are linked to stormy weather conditions.

"The total number of wrecks (die-offs) is increasing over time, as is the severity of these events and their duration," says Parrish. "This year we are heading into a mild El Nino and we are sitting on pins and needles to see what happens."

Unprecedented Dead Zones

The supercharged upwelling in 2006 also created thick, green-brown waters off the coasts of Oregon and Washington. When these phytoplankton and zooplankton blooms sank to the sea floor and decayed, they consumed large amounts of oxygen, creating a 3,000 square kilometer "dead zone" that took up nearly two thirds of the water column and squeezed mobile animals like rockfish into shallow habitats and suffocated everything that could not swim away.

"Phytoplankton blooms are normally thought to be a good thing because they ultimately support the food webs that produce the crabs, salmon and tuna," says Bruce Menge or Oregon State University. "But too much of a good thing can be bad."

Two months into the dead zone, the scientists surveyed the sea floor. "We were shocked to see a graveyard," Chan said. "Frame after frame of carcass, carcass, carcass. Dead crabs, dead worms, dead sea stars." Two weeks later the scientists returned to the same place. This once biologically diverse habitat was covered with a white bacterial mass, indicating that the system had turned from low to no oxygen.

"The fact that we saw no fish - alive or dead - suggests that many were able to escape," says Lubchenco. "In previous years, fish that have escaped the low-oxygen area appear to have returned once the oxygen was renewed. This year may be different, however, because unlike earlier years, the living habitat was also suffocated. This year there was no home for them to return to."

Predicting the Unpredictable

"Climate change is upon us, there is no doubt about that, but what we don't know is exactly how it is going to affect upwelling," says Peterson. "What's catching us by surprise is the rate at which warming is hitting us. And, of course, how fast the ocean has changed -- that is what amazes

me."

The scientists hope that by better understanding the interplay of warming, winds, and storms with ocean currents and biological productivity, they will be able to help managers and fishermen plan for changing ecosystems. Predicting shifts in ocean ecosystems requires sustained observations. "We are poised to deploy a fleet of underwater robotic sensors to enable better understanding and useful predictions," says Barth. If scientists can predict the impact of dead zones or years of low salmon returns, for example, managers can better adjust fishing quotas or regulations accordingly and fishermen can modify where and when they fish.

Scientists hope to get ahead of the curve on these surprises, but many mysteries remain. Despite intense hypoxic zones, for example, Dungeness crab catches in Oregon have been high in the last few years. In California, scientists are trying to understand why rockfish populations appear to be congregating in the northern and southern ends of their ranges. Future changes in the timing of upwelling may favor particular seabird or salmon species, changing the make up of animals along the coast. And animals that live their adult lives close to shore, like mussels and barnacles, are likely to react differently than fish that live further offshore.

"We need to think differently about using and managing these ecosystems," adds Lubchenco. "We should be expecting more surprises. Climate models predict increasing uncertainty, with wild fluctuations. And this is exactly what we are witnessing."

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NOTE: The scientists will discuss their findings at an AAAS News Briefing on Friday, February 16 at 3:00 PM Pacific time, in the Hotel Nikko. Research from a new paper to be published in PNAS will be presented at the press conference (Article #00462: "Delayed upwelling alters nearshore coastal ocean ecosystems in the northern California current"). For more information please contact the PNAS News Office at 202-334-1310 or e-mail PNASnews@nas.edu

The corresponding AAAS session titled, Predicting the Unpredictable: Marine Die-Offs Along the West Coast, is on February 17th at 2:00 p.m.

For visuals (video and photographs), please visit the AAAS virtual newsroom on EurekAlert! or contact Jessica at jbrown@seaweb.org or #(831) 331-0507.

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