JANUARY 2018 ISSUE 2

COASST

Science Update

A Perfect Storm

Overview

Science Update is a special publication of the Coastal Observation and Seabird Survey Team (COASST) that highlights recent research and scientific publications.

In this issue, we look at the mechanics behind the mass mortality event of 2009.

Scoter Alert!

In September 2009, outer coast denizens from Forks to Neah Bay began noticing unusual numbers of marine birds, dead and live, on the beaches of northern Washington. Over the next two weeks, Olympic Peninsula COASSTers; natural resource biologists from the Quinault, Quileute, Hoh and Makah tribes; National Park rangers; and Washington Department of Fish and Wildlife and Olympic Coast National Marine Sanctuary employees all contributed to a massive effort to document this "mass mortality event," mostly of two species of sea duck: Surf Scoters and White-winged Scoters.

Then, in October, COASSTers in southern Washington began to report the same story. This time, though, the dead were predominantly Common Murres, loons and grebes.

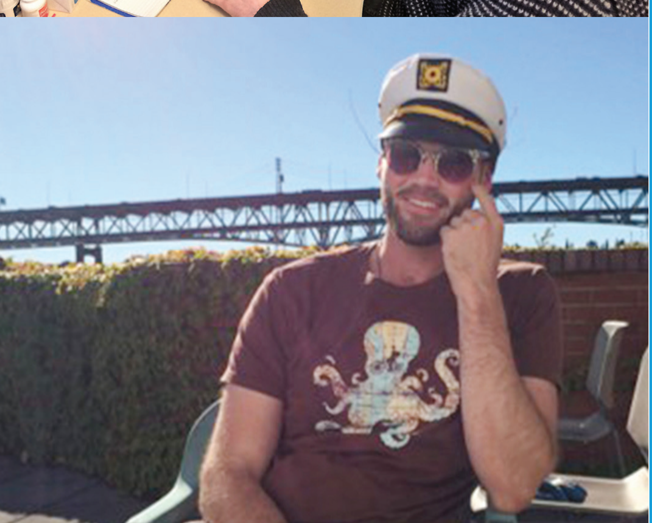
Photos: above: Penelope Chilton, COASST; at left: mirceax/iStock/Thinkstock

Photo: Chris Cook

This unfortunate Surf Scoter met his end in early September 2009, and was found and photographed by Forks Forum *editor Chris Cook. Although Chris didn't have a COASST photo ruler for scale, he improvised with a bottle, posting the photos to COASST later that day.*

Tim Jones, at work and at play.

Photos: Courtesy of Tim Jones



Solving the Mortality Mystery

Why were so many seabirds dying so suddenly? During the event, oceanographers, wildlife health experts, seabird biologists and natural resource managers teamed up to unravel what at the time was the largest single die-off COASST had ever observed. But it would take a little more sleuthing, in the form of some statistical modeling by COASST postdoc Tim Jones, to complete the story, revealing the precise way a series of otherwise normal events lined up to create a perfect storm.

A physicist turned marine ecologist, Tim has a unique ability to see the world as organisms and ecosystems, and as numbers and mathematical formulae. Equally at home sailing on Puget Sound, or hunched over his computer monitors, Tim is fascinated with COASST mass mortality mysteries. This analysis gave him the ability to combine COASST data with atmospheric and oceanographic datsets, creating a model of the perfect storm, and some pretty cool infographics to boot!

The wreck of 2009 started with a species of phyto-plankton, the single-celled dinoflagellate *Akashiwo sanguinea*. Named for its blood-red tint (sanguine = blood-red), this species "blooms" during the fall when the last vestiges of the summer upwelling season bring nutrients (think, plant food) to the nearshore surface waters. Cells grow and divide like crazy, producing dense aggregations (more than one million per liter!) that can literally turn the ocean red for kilometers of coastline.

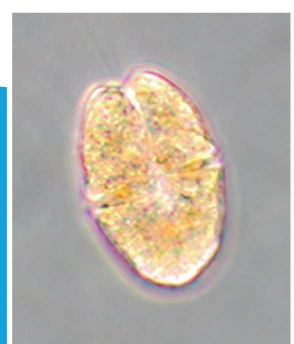
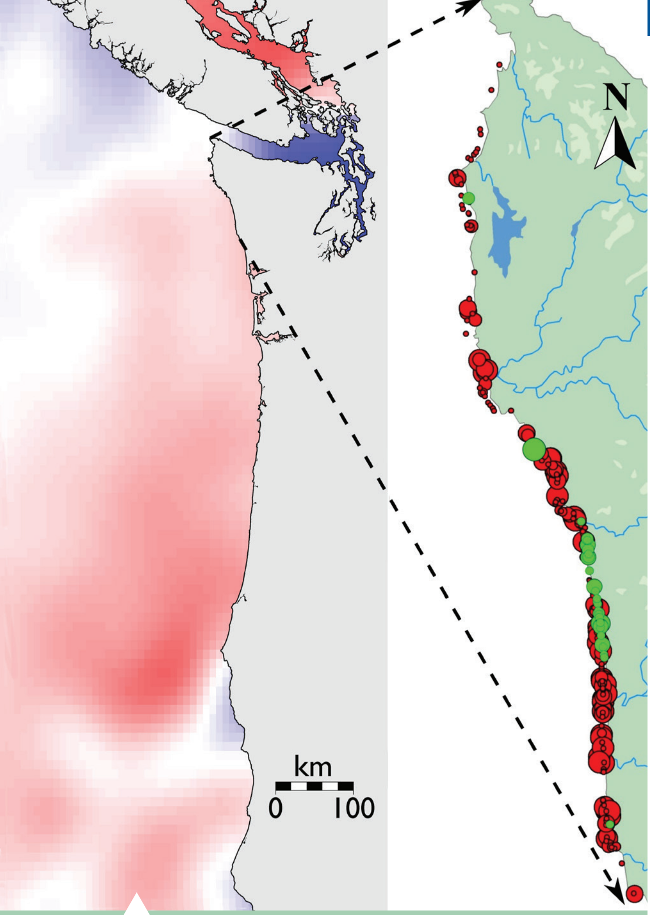


Photo: Brian Bill, NOAA

This single-celled phytoplankton is the dinoflagellate Akashiwo sanguinea, so named (sanguine = blood = red) because the reddish cast of the cells can turn the surface of the water dark when a bloom results in billions of cells.



Left: Data courtesy of NASA/NOAA AVHRR satellite; right: Joe Evenson/WDFW

The outer coast of Washington State in September 2009. On the left side is a colorized map of the sea surface temperature anomaly (difference from the long-term average), where blue indicates cooler than usual and red indicates warmer than usual—perfect conditions for Akashiwo to bloom. On the right is a map produced by Washington Department of Fish and Wildlife biologist Joe Evenson, showing the distribution of scoters counted on the water in red (that's normal for the fall season), and those hauled out on the beach in green (that's really not normal!). COASSTers surveyed all along the Washington outer coast throughout September and October of 2009, performing 230 surveys amounting to over 570 hours of work!

Such was the case in the late summer and early fall of 2009, a warmer than normal September just perfect for dinoflagellates like *Akashiwo*. And bloom it did, creating a massive collection of cells just offshore of the wave zone: 30 meters deep, 2–3 kilometers wide, and more than 70 (!) kilometers long.

But soon fall storms rolled into the coast, and upwelling shifted to downwelling, reversing the movement of surface waters towards the shore. With the upwelling conveyor-belt of nutrients fueling cell growth on pause, billions of *Akashiwo* cells began to weaken and starve. As onshore winds blew the bloom ashore, cells broke like eggs in the pounding surf, spewing their contents into the nearshore ocean where storm waves whipped the chemicals into a thick meringue. On some beaches this greasy, slightly greenish foam was knee-deep.

Most sea foam is harmless, but *Akashiwo* foam has a unique soap-like property that washes marine bird feathers of their naturally oily waterproofing. A seabird covered in *Akashiwo* foam quickly loses insulation against the cold ocean water and may die of exposure if it can't escape

Photo: Penelope Chilton, COASST

Blanketed by Akashiwo foam, this Common Murre has completely lost its natural waterproofing, giving the feathers a scraggly, unkempt appearance.

Ordinarily, birds are able to fly away from encroaching foam patches. But not the scoters. Having finished breeding in the inland Arctic, many scoters migrate to the West Coast where they promptly began their annual molt. Unlike some birds that lose flight feathers a few at a time, scoters go through a "catastrophic molt" losing all their flight feathers at once. Unable to fly, they were, in effect, sitting ducks.

The whole process—upwelling, bloom, downwelling, storm, foam, molting birds, mass mortality event—repeated itself in mid-October and farther south, but with murres, loons and grebes. You guessed it: all catastrophic molters.

In all, COASSTers reported finding over 1,400 carcasses during the *Akashiwo* bloom. At 140 times the baseline, peak encounter rates were way higher than normal—an astounding 12 scoters per kilometer, well over the usual one scoter for every 11 kilometers.

So how many birds died? Using the COASST data to build a mathematical model, Tim determined that somewhere between 10,500 and 12,500 birds perished overall: more than 7,500 scoters in the September event, and more than 1,000 Common Murres in the October event (along with a few hundred loons and grebes). All told, it was the largest mass mortality event ever definitively linked to a harmful algal bloom anywhere in the world!

A Gloomy, Bloomy Future?

As for the lessons learned, the first was that harmful algal blooms (HABs) can—in fact—be quite harmful to marine birds. While the mass mortality event of 2009 likely didn't have population-level effects on either scoters or murres, it did highlight *Akashiwo* as a uniquely threatening phytoplankton species. What are the chances *Akashiwo* will bloom again? Although he can't (quite) predict the future, Tim did look for clues from the past. His analysis showed that the "perfect storm" sequence of environmental conditions that occurred twice in 2009 was very rare, especially when laid over the "molting season" of marine birds.

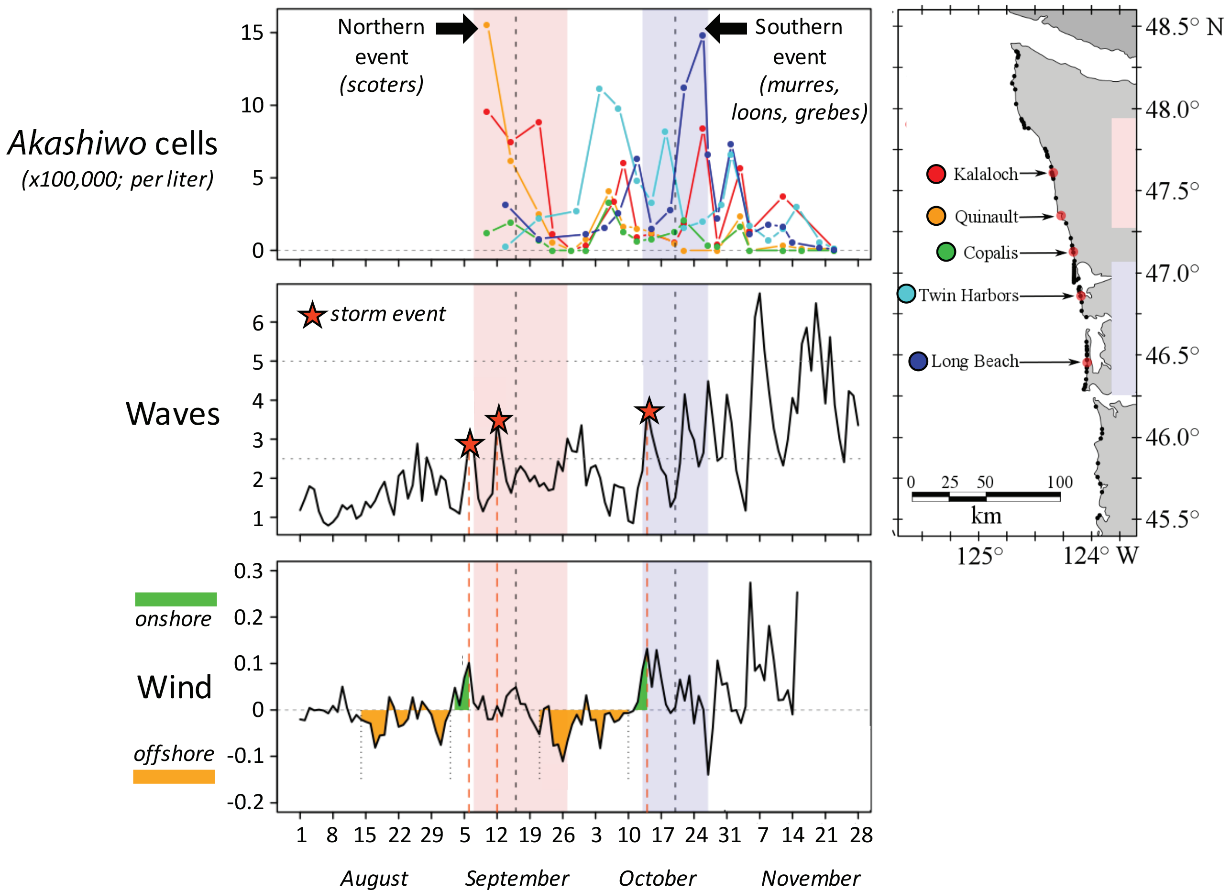
Photos: COASST

COMU wings: left: premolt ratty; middle: molt; right: fully grown out

But that doesn't mean it can't happen again. As waters warm, oceanographers who study phytoplankton biology have been seeing an increase in HABs, including *Akashiwo*, throughout the North Pacific, and that means COASST will continue to keep watch.

If you want to read the complete article by Tim, Julia, and a host of their colleagues, please contact the COASST office and we'll be happy to send you a copy.

Mass mortality of marine birds in the Northeast Pacific caused by *Akashiwo sanguinea*. T. Jones. J.K. Parrish. A.E. Punt. V.L. Trainer. R. Kudela. J. Lang. M.S. Brancato. A. Odell. B. Hickey. Marine Ecology Progress Series 2017 579: 111–127.



What makes a perfect storm for marine birds? Offshore winds created upwelling conditions that brought nutrients to the ocean's surface (bottom panel in orange) feeding the single-cell dinoflagellate Akashiwo until these cells "bloomed" to densities exceeding a million per liter (top panel; sampling stations on map at right). Wind reversals during storm events stopped the flow of nutrients to the surface, pushed the bloom onshore (bottom panel in green) and resulted in high waves (middle panel) which broke the nutrient-starved and weakened Akashiwo cells apart. The resulting foam events are outlined in pink (northern event) and blue (southern event) in the graphs and on the map. Notice that there was a third Akashiwo bloom at Twin Harbors, but no foam. Why? A lack of onshore winds and big waves kept cells healthy and largely offshore.

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Mission

The Coastal Observation and Seabird Survey Team (COASST) is a citizen science project of the University of Washington in partnership with state, tribal and federal agencies, environmental organizations, and community groups. COASST believes citizens of coastal communities are essential scientific partners in monitoring marine ecosystem health. By collaborating with citizens, natural resource management agencies and environmental organizations, COASST works to translate long-term monitoring into effective marine conservation solutions.

Vision

Realizing the pressing needs of marine natural resource management and coastal conservation, and the twin benefits of increasing science literacy and an environmental stewardship ethic among citizens, COASST sees a future in which all coastal communities contribute directly to monitoring their local marine resources and ecosystem health through the establishment of a network of citizens engaging in science, where all collect rigorous and vital data. Through their collective efforts, and the translation of their individual data into baselines against which any impact—from human or natural origins—can be assessed, nearshore ecosystems worldwide will be actively known, managed, and protected.

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