The Year of Crazy—Droughts, Blooms, Warm Blobs, and other Anomalies in the Eastern Pacific

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http://oceandatacenter.ucsc.edu/
2014: The Warmest Year In the Modern Record

2015
Santa Cruz Municipal Wharf Time Series
Weekly Observations Since 2002
The Summer of Crazy

Tags: whales  whale watching  humpback  anchovies  domoic acid  El Nino

Humpback whales are crowding close to shore this summer in search of food. Photo courtesy Surfrider Foundation/Ambre Jones.

Beachings of exotic blue velella tied to wind patterns

Velella, probably carried by wind, a reminder of ocean’s diversity

Hamed Aleaziz  Updated 7:14 pm, Thursday, July 31, 2014
Green stuff on Seaside beach probably common marine algae
The blob off our coast

Scientists say a vast pool of warm water off our coast is affecting marine life and local weather, and is part of a bigger pattern that includes California’s drought and East Coast blizzards.

Source: Department of Atmospheric Sciences, University of Washington

MARK NOWLIN / THE SEATTLE TIMES
Decadal Trends in the California Current:
- Mixed Layer Depth is shoaling
- Surface temperatures are increasing
- Stratification intensity is increasing
- Nutrient concentrations, ratios shifting
Pseudo-nitzschia has characteristics of a dinoflagellate:

- It prefers weak, pulsed upwelling/relaxation and WARM water
- It forms subsurface maxima
- It does well on anthropogenic nutrients and may be more toxic with urea
- It responds to “flush” rain events in autumn

2015 data from Monterey showing the development of a subsurface layer of Pseudo-nitzschia (sitting on the nutricline). Previous studies show coupling with high-Fe waters from BBL feeding these layers.
Modeled Toxin Probability

Particulate Domoic Acid (ng/L)

Blue: 1-500 ng/L
Light Blue: 500-1000
Yellow: 1000-2000
Orange: 2000-5000
Red: 5000-7500
Dark Red: > 7500

http://www.cencoos.org/data/models/habs
2015: An Unprecedented Year

- The bloom appeared essentially simultaneously from Kodiak Alaska, to Santa Barbara (but not SoCal)
- Surface and subsurface (DCM)
- Peak toxin levels of ~110,000 ng/L (highest ever)
- **Trophic Transfer:**
  - Mussels up to 200 ppm, Dungeness up to 120 ppm
  - Anchovy 100-600, viscera (new record) >3,000 ppm
  - Barnacles 100 ppm
  - Detectable in filet of halibut, salmon, ling cod, whole body of mackerel, squid, smelt
  - Acute poisoning in pelicans, sea lions
  - Contaminated Monterey Bay Aquarium tanks
A Record-Breaking Drought

41% of the state is facing “exceptional drought” (the most severe kind).

- Abnormally dry
- Moderate drought
- Severe drought
- Extreme drought
- Exceptional drought

2011
2012
2013
2014
2015

SOURCE: U.S. Drought Monitor
VISUAL NEWS
A Tour of California Hotspots

San Joaquin Marsh—33,500 µg/L

Lake Chabot—11,000 µg/L; 800,000 µg/L scum

Pinto Lake—1,000 µg/L annually; 2.9 million µg/L scum
A Tour of California Hotspots

**Wadeable Streams:**
- Microcystin—33%
- Lyngbyatoxin—21%
- Saxitoxin—7%
- Anatoxin-a—3%

**Eel River algal mats:**
- Anatoxin-a—42%
- Microcystins—15%
- Both—5%
- ATX ~ 10x > MCY

Data Sources: Fetscher et al. *Harmful Algae*, in press
Bouma-Gregson & Higgins, Eel River Recovery Project Report 2015
San Francisco Bay: A mixing bowl for Toxins

**Mussels 2012, 2014, 2015: 25% of sites have all three toxins**

- **Domoic Acid**
  - (100% of mussels contaminated)
  - Concentration range: 1-10 ppm

- **Microcystins**
  - (82% of mussels contaminated)
  - Concentration range: 2-12 µg/kg

- **Paralytic Shellfish Toxins**
  - (25% of mussels contaminated)
  - Concentration range: 10-40 µg/100g
CLIMATE

Blooms Like It Hot

Hans W. Paerl¹ and Jef Huisman²

A link exists between global warming and the worldwide proliferation of harmful cyanobacterial blooms.

West Coast Event
West Coast Events
West Coast Event

Temperature Anomalies at the M1 Mooring, Monterey Bay California

1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015

Time

Temperature °C

Note: 60 point moving average applied to daily averaged values.
Monterey Bay Aquarium Research Institute
Updated: 20-Jul-2015
2014-2016: From Bad to Worse? Or Will El Niño Save Us?

- Historically, more toxic marine HABs during El Niño

- More rainfall may alleviate cyanobacterial problems...

...but rainfall may also flush everything into the ocean

- **Good News:** we have operational HAB forecasts, and greatly improved monitoring in both the watersheds and coastal ocean. Fantastic opportunity to test theories!
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Data Access
Southern California Coastal Ocean Observing System
Central and Northern California Ocean Observing Systems
California Harmful Algal Bloom Monitoring and Alert Network (Cal-HABMAP)