Red Tide & HAB Studies in Monterey Bay

Monterey Bay Sanctuary Advisory Council Meeting    August 15, 2008

John Ryan
Phytoplankton are single-celled, microscopic algae
fuel most of the oceanic food web through photosynthesis
produce much of the oxygen we breathe
are central to biogeochemical cycling, including CO₂
can impact the ecology and economy of coastal waters as harmful algal blooms (HABs)
influence ocean optics and physics
act as biological tracers and indicators of ocean circulation

Photos by Susan Coale (UCSC)
Red tides & HABs

- Dense accumulations of certain phytoplankton make the ocean appear reddish. These are commonly called **red tides**.

- Some phytoplankton blooms can cause harm via toxins, oxygen depletion, or tissue damage. These are termed **Harmful Algal Blooms (HABs)**.

- Red tides can be harmful but are not always, & HABs can occur without a dense red tide bloom.

- HABs can have significant economic impacts: fisheries, human health, recreation & tourism, monitoring & management.

- Increasing occurrence of HABs is evident globally.

- About 50% of red tide species & 75% of HAB species are **dinoflagellates**.
Red tide blamed for hundreds of dead, injured seabirds along California’s Monterey Bay

By TERENCE CHEA Associated Press Writer
Friday, November 30, 2007

SAN FRANCISCO (AP) — Hundreds of dead or injured seabirds have washed up on the shores of Monterey Bay in recent weeks, and scientists believe a red tide of marine algae is to blame.

About 600 birds have been found stranded on beaches in Monterey and Santa Cruz counties since a large rust-colored algal bloom began circulating in the bay about three weeks ago, scientists say.

Molecular Probes Link Sea Lion Deaths To Toxic Algal Bloom

ScienceDaily (Jan. 7, 2000) — MOSS LANDING, California — New molecular probes used to identify toxic diatoms allowed researchers to link a bloom of these algae to the deaths of more than 400 California sea lions in Monterey Bay during May and June 1998. Dr. Christopher Scholin, a molecular biologist at the Monterey Bay Aquarium Research Institute (MBARI), and colleagues report their research results in the 6 January issue of the journal Nature.
Upwelling Shadow

August - November Climatology
Bird’s eye view of a red tide bloom in Monterey Bay
Microscopic view of a bloom... motility!

Akashiwo sanguinea  Cochlodinium fulvescens

S. Coale, UCSC
Waterline view

Akashiwo sanguinea

J. Rines, URI
Bloom detection

![Bloom detection graph](image)

- **13 µg L⁻¹**
- **42 µg L⁻¹**
- **54 µg L⁻¹**

**Rrs (sr⁻¹)** vs **Wavelength (nm)** from 400 to 800 nm.
Examples of extreme blooms

MCI = 2

~ 400 mg m\(^{-3}\)
Statistics & environment of extreme blooms

Bloom Probability (%)

Mean MCI (mW m$^{-2}$ sr$^{-1}$ nm$^{-1}$)

25 m

AUV

Stress (Pa)

SST (°C)

13 13.5 14 14.5
Retention within a “red tide fountain”

2004 Bloom Study

August 25  August 27  August 31  September 1  September 3
Travels and tales of a robotic submarine...
Water column structure beneath the “incubator”
Example of bloom patch observed in situ

A diverse assemblage of dinoflagellates

Dominant: *Ceratium cf. divaricatum*

Common: *Akashiwo sanguinea, Ceratium furca, Ceratium cf. lineatum, Cochlodinium cf. fulvescens, Preperidinium sp.*

Present: *Alexandrium catenella, Prorocentrum gracilis, Oxyphysis oxytoides, Dinophysis sp., Gonyaulax sp.*
Incubator as source, example 1

October 1, 2002

October 7, 2002
Incubator as source, example 2
The central bay is a land-sea artery

The “extreme bloom season” overlaps with the rainy season.
A bio-optical signature of land-sea arterial flow?

Average during “extreme bloom season” (August - November)
Land-Sea coupling indicated in harmful 2007 bloom
Sluggish circulation nearshore: retention of perturbation
Along-coast connectivity
Northward export of a bloom

Drifters: July 10 1200 to July 13 1000, MODIS: July 12 2007

* A third drifter released further south was lost...and found right next to the other two.
Northward export as seen from a mooring
Environmental influences on a diatom HAB species
Mapping and tracking a diatom HAB species
Ocean Observing Systems
SUMMARY

- Phytoplankton do much good, however their blooms can cause harm at times.
- Coastal ocean environments are extremely complex and challenging to understand. Technology helps us understand.
- A very important research area is understanding the linkages between human activities and coastal ecosystem health.
- Monterey Bay is an excellent model system.