Title
The Physics of a "Red Tide" off Huntington Beach

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The Physics of a "Red Tide" off Huntington Beach

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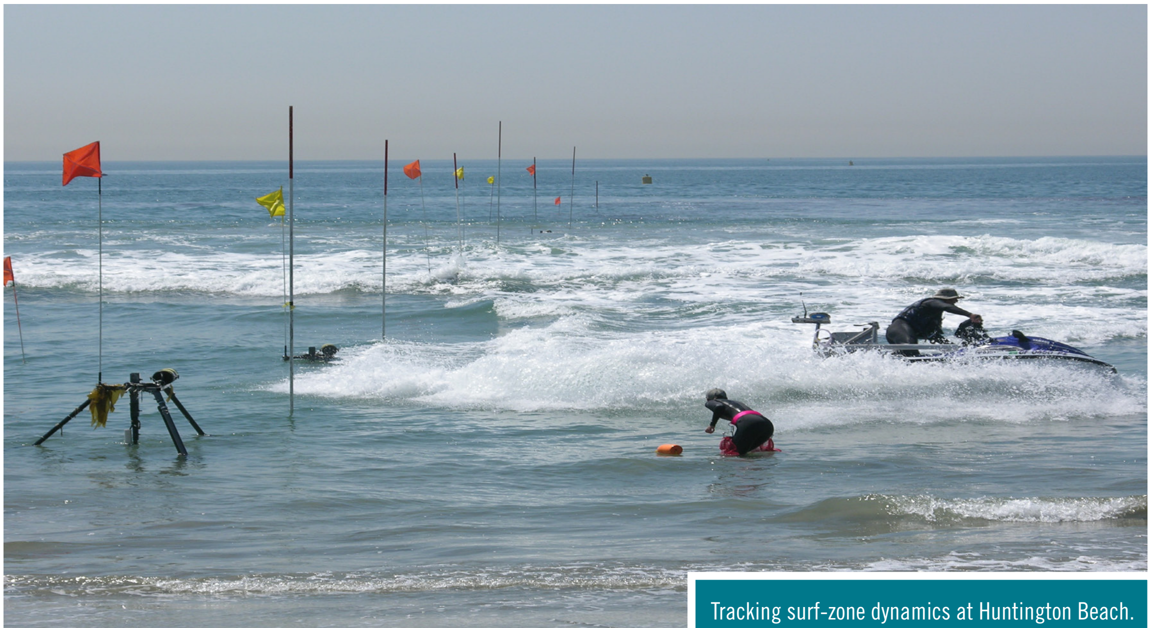
SUMMARY

In this project, scientists describe the processes by which a subsurface nearshore algal bloom is carried to the surface, swept closer to shore and ultimately blocked from entering the surfzone at Huntington Beach in Orange County.

Falk Feddersen studies the physics of the surf-zone and nearshore coastal environments. SIO/UCSD



Tracking surf-zone dynamics at Huntington Beach. D. Darnell/ SIO

PROJECT

On Oct. 12, 2006, a "red tide" was observed off Huntington Beach during a field experiment to measure surf-zone dynamics. The bloom (later shown to be of the common dinoflagellate *Lingulodinium polyedrum*) happened suddenly, was contained and persisted for only a few hours.

Usually, this type of small-scale, transient episode comes and goes without any measurements of the surrounding physical and biological environment. This project provides the first detailed quantitative description of the processes that concentrated the algae, dispersed them into the surface layer and carried them shoreward.

The data for this description come from an array of instruments, deployed for the Huntington Beach (HB06) experiment, supported by the Southern California Coastal Ocean Observing System and U.S. Geological Survey programs. A GPS-tracked jet ski also mapped surface water temperatures and chlorophyll (*Chl a*) concentrations during the bloom. (*Chl a* is a proxy for phytoplankton biomass.)

RESULTS

The origins of the bloom were traced to a subsurface patch of high *Chl* a (greater than 30 mg/L) in a layer of 16 to 17 degree Celsius water, first observed on Oct. 5. The bloom developed in this thermal environment for 7 days, becoming at least 6.5-kilometers wide during this time.

A few hours before the bloom surfaced on Oct. 12, a patch of elevated *Chl a* was observed 13 meters below the surface, in the trough of a shoreward propagating internal wave. The trough of an internal wave is a region of water convergence and hence will concentrate *Chl a*.

As the internal wave moved into shallower water, the wave "broke," creating turbulence that spread the bloom into surface waters. This surface band of high algal biomass had a maximum *Chl a* concentration of 7 mg/L.

At this peak in *Chl a*, the bloom was located about 500 meters from shore (about 8-meters depth) and was about 200-meters wide (in the cross-shore direction) and 1-kilometer long (in the alongshore direction).

Currents swept the bloom to the edge of the surf-zone, at which point a wedge of warm water halted its continued shoreward progression. The source of this warm water is believed to be from tidally driven outflows of the nearby Talbert Marsh.

The Sea Grant Trainee on the project is currently writing her doctoral thesis, a chapter of which will present findings on what may have triggered the original subsurface bloom. Her hypothesis is that a pulse of nitrate into sunlit waters fueled algal growth, and that the nitrate flux was caused by turbulent flows, generated by current shears. All of this is of interest because, in general, productivity in the California Current ecosystem is driven by upwelling dynamics. This project shows that at finer spatial scales nearshore, productivity may be driven by different processes.

Shellfish poster: Most "red tides" are harmless but some produce toxins that taint seafood with potentially deadly toxins. Washington Department of Health

An intense red tide off the pier at Scripps Institution of Oceanography in La Jolla, Calif.
P. Alejandro Díaz/Wikipedia

APPLICATIONS

Results of this project highlight the role of small-scale physical processes in determining the evolution and spread of algal blooms into the region of the beach that is most relevant to tourism, recreation and shellfish farming. In this way, findings from this project further efforts to understand and eventually forecast algal blooms and other metrics of water quality at the scales most relevant to society.

COLLABORATORS

U.S. Geological Survey

Southern California Coastal Observing System

Orange County Sanitation District

Orange County Health Care Agency

PUBLICATIONS

Omand M., Leichter J., Franks P., Guza R., Lucas A., and Feddersen F. (2011) Physical and Biological Processes Underlying the Sudden Appearance of a Red-tide Surface Patch in the Nearshore. Limnology and Oceangraphy (in press).

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