

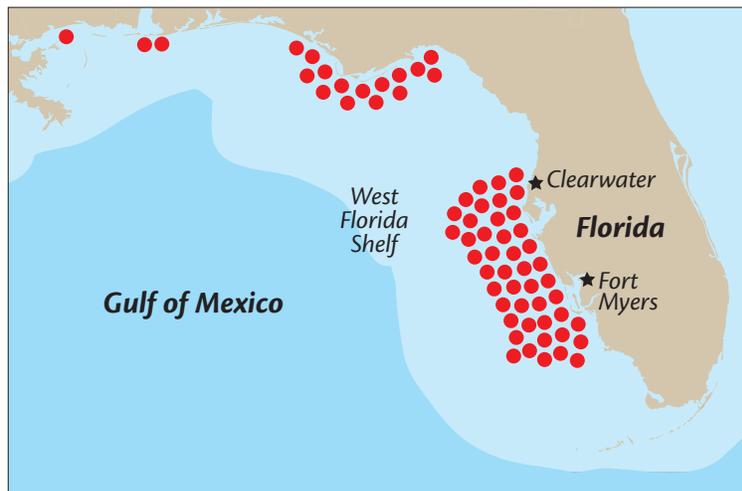
RED TIDES ON THE WEST FLORIDA SHELF

The term **red tide** is commonly used to describe certain kinds of **harmful algal blooms (HABs)**, a proliferation of a toxic or nuisance microalgal species. Not all red tides are red, and not all harmful algal blooms discolor the water. HABs can include both toxic and non-toxic species; however, all HABs have one important characteristic in common, **they can negatively affect natural resources, local economies, and human health.**

KARENIA BREVIS, THE RED TIDE DINOFLAGELLATE, IS NATIVE TO THE GULF OF MEXICO



Background concentrations (1000 cells L⁻¹ or less) of *K. brevis* are always present in the Gulf of Mexico ecosystem. Blooms occur near-annually and during a bloom event, cell concentrations can reach over 1 million cells L⁻¹. On the west coast of Florida, *K. brevis* blooms occur most commonly in the area off Clearwater, south to Fort Myers. Blooms have occurred in all months of the year but are most common in the late summer and fall.



Above: *K. brevis*, the Florida red tide dinoflagellate (Image courtesy of Florida Fish and Wildlife Conservation Commission). Right: *K. brevis* red tide events on the west coast of Florida in years 1957–2012. Each red dot indicates a year when a bloom was observed.

BLOOMS RESULT IN INCREASED ECONOMIC COSTS FOR THE WEST COAST OF FLORIDA



While blooms are not a new phenomenon in this region, they have resulted in increased economic costs for the west coast of Florida. Coastal regions of Florida have experienced some of the most rapid population growth and development in the United States. Beach clean-ups, tourism-related losses, medical expenses, and lost work days during red tide events can average over a million dollars lost annually. *K. brevis* cells produce a suite of neurotoxins which can accumulate in shellfish (oysters, clams) tissue and then be transferred up the food web. In addition, *K. brevis* blooms can result in fish, bird, and marine animal deaths. Ingestion of brevetoxin-laden shellfish by humans can result in Neurotoxic Shellfish Poisoning (NSP); however commercial shellfish beds are well monitored and there have been no NSP cases from consumption of regulated shellfish.

Left: A *K. brevis* bloom off the west coast of Florida. When *K. brevis* cells are present in high concentrations, they can discolor the water.

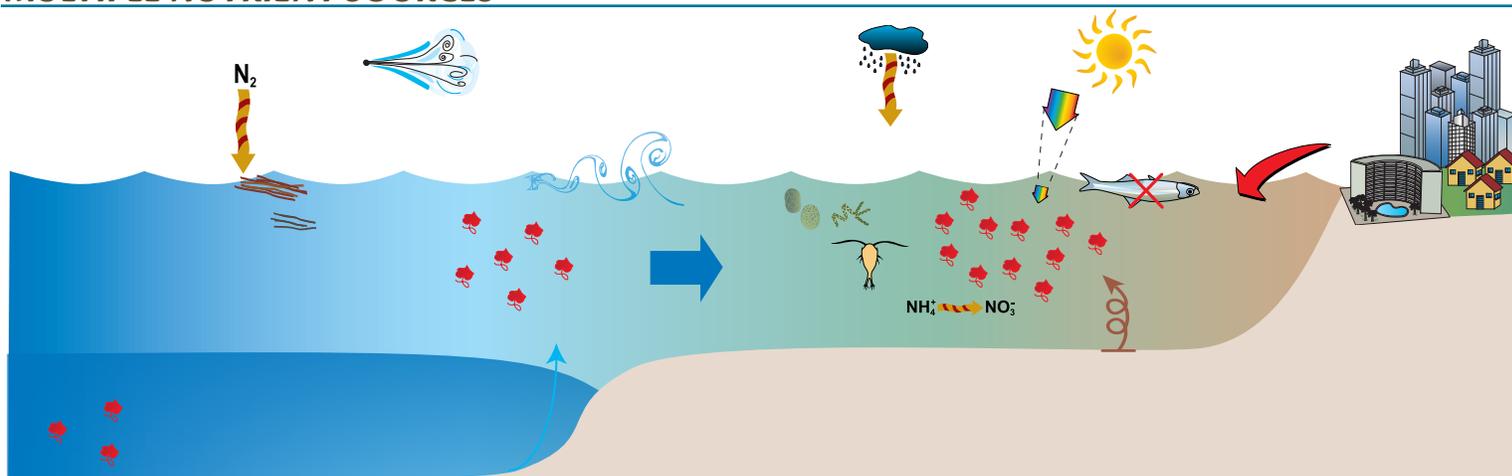
IT IS ESSENTIAL FOR RESEARCHERS AND MANAGERS TO UNDERSTAND *K. BREVIS* BLOOM DYNAMICS IN ORDER TO PROVIDE EFFECTIVE FORECASTING AND MANAGEMENT

The NOAA ECOHAB: *Karenia* Nutrient Dynamics in the Eastern Gulf of Mexico research program was designed to utilize scientific expertise in a collaborative laboratory, field, and modeling program over multiple years. This project aimed to identify the diverse inter-annual physical, chemical, and biological conditions that are responsible for *K. brevis* blooms on the west Florida shelf.

Left to right: Discolored water caused by *K. brevis*; a researcher counts *K. brevis* cells under a microscope; researchers collect water samples to measure environmental parameters during bloom sampling.



KARENIA BREVIS IS AN OPPORTUNISTIC SPECIES, CAPABLE OF UTILIZING COMPLEX AND MULTIPLE NUTRIENT SOURCES



Blooms of *Karenia brevis* initiate near the ocean bottom at mid-shelf, and are transported to the coastal ocean via bottom waters. On the inner shelf, cells migrate to the surface and are transported nearshore through physical forces (winds, currents, waves). Throughout bloom development on the shelf, multiple sources of nitrogen and phosphorus nutrients are available to cells. Nutrient sources vary in magnitude over this offshore–onshore gradient, with the relative importance of each source varying with factors such as distance offshore, depth, season, and bloom stage.

Nutrient sources supporting *Karenia brevis* blooms on the west coast of Florida

Offshore/Continental Shelf	Coastal	Estuarine/Nearshore
<ul style="list-style-type: none"> Upwelling of deep, nutrient-rich waters Nitrogen fixation by the photosynthetic cyanobacteria <i>Trichodesmium</i> spp. <i>Trichodesmium</i> spp. biomass decay 	<ul style="list-style-type: none"> $\text{NH}_4^+ \rightarrow \text{NO}_3^-$; Nitrification Grazing of <i>K. brevis</i> on the single-celled cyanobacteria <i>Synechococcus</i> spp. Release of nutrients (excretion) by photosynthetic microzooplankton Macrozooplankton grazing on <i>K. brevis</i> and microzooplankton, and release (excretion) of nutrients during and after feeding. 	<ul style="list-style-type: none"> Estuarine outflow Atmospheric inputs Fish kills, decaying fish Photochemical (sunlight) production Benthic (bottom) flux

CONCLUSIONS AND RECOMMENDATIONS

- Multiple nutrient sources are available to *K. brevis* blooms but these sources are dynamic and vary with bloom stage and location. We must **REDUCE** controllable nutrient sources through the implementation of best management practices with the understanding that, given the complexity of bloom dynamics, no direct impact on *K. brevis* bloom frequency may be evident.
- Current research and management are limited in their bloom predictive capabilities. Researchers must further **DEVELOP** short-term forecasting and now-casting capabilities. With increasing knowledge and understanding of red tide dynamics, the need for effective monitoring and predictive capability is also increasing.
- The specific physical and chemical conditions on the west Florida shelf make it particularly vulnerable to annually reoccurring red tides. Blooms are long-term, chronic problems. We must **ADAPT** and **UTILIZE** new and existing educational outreach programs to disseminate information and resources.

BASED ON NOAA ECOHAB RESEARCH GRANT # NA06NOS4780246

Principal Investigators: Cynthia Heil (cheil@bigelow.org); Deborah Bronk (bronk@vims.edu); Kellie Dixon (lkdixon@mote.org); Gary Hitchcock (ghitchcock@rsmas.miami.edu); Gary Kirkpatrick (gkirkpat@mote.org); Margaret Mulholland (mmulholl@odu.edu); Judith O'Neil (joneil@umces.edu); John Walsh (jwalsh@usf.edu); Robert Weisberg (weisberg@usf.edu)

O'Neil, J.M. and Heil, C.A. (in review). SUPPLEMENT: Harmful Algae–Nutrient Dynamics of *Karenia brevis* red tide blooms in the Eastern Gulf of Mexico.

SCIENCE COMMUNICATION

Fact sheet design and layout: Brianne Walsh, UMCES Integration & Application Network
 Fact sheet content: Matt Garrett, Florida Fish and Wildlife Conservation Commission
 Cindy Heil, Bigelow Laboratory for Ocean Sciences
 Judy O'Neil, UMCES Horn Point Laboratory

FURTHER INFORMATION

<http://myfwc.com/research/redtide/research/current/ecohab-karenia/>

