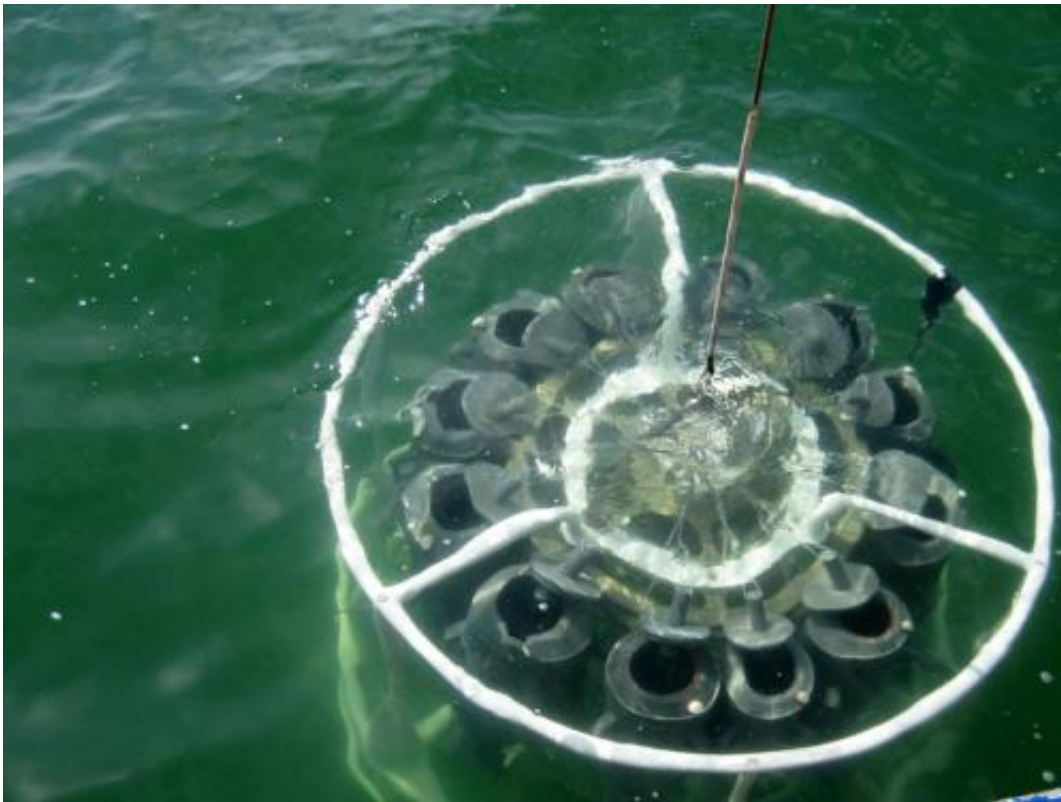


Nutrients that feed red tide 'under the microscope' in major study

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The rosette of Niskin bottles is submerged to collect water samples. Credit: Mote Marine Laboratory

The "food" sources that support Florida red tides are more diverse and complex than previously realized, according to five years' worth of research on red tide and nutrients published recently as an entire special edition of the scientific journal *Harmful Algae*.

The multi-partner project was funded by the National Oceanic and Atmospheric Administration's ECOHAB program and included 14 research papers from seven institutions.

The research team studied four [red tide](#) blooms caused by the [harmful algae](#) species *Karenia brevis* in 2001, '07, '08 and '09, plus the non-bloom year 2010. Their goal was to understand which nutrients supported these red tides and the extent to which coastal pollution might contribute, helping reveal what drives red tide in southwest Florida.

Study partners documented 12 sources of nutrients in southwest Florida waters—including some never before associated with *K. brevis*. Results supported the consensus that blooms start 10-40 miles offshore, away from the direct influence of land-based nutrient pollution, but once moved inshore blooms can use both human-contributed and natural nutrients for growth.

The project documented the microbiology, physiology, ecology and physical oceanography factors affecting red tides in new detail, provided a synthesis of results and offered suggestions for resource managers addressing red tide in the coastal waters of southwest Florida.

Florida red tide blooms—which occur naturally in the Gulf of Mexico and most frequently off southwest Florida—are higher-than-normal concentrations of the microscopic algae species *K. brevis*, a plant-like organism whose toxins can kill fish and other marine species, make shellfish toxic to eat and cause respiratory irritation in humans. These blooms occurred centuries before the mid-to-late twentieth century population boom along Florida's coast. Now, with large numbers of coastal residents and visitors in Florida, blooms can significantly affect public health and the economy.

Public information and short-term forecasts help mitigate red tide

impacts, but ongoing research is critical to inform resource managers working to understand and potentially reduce nutrients available to blooms.



Dr. Emily R. Hall of Mote Marine Laboratory prepares to filter water samples for ECOHAB research. Credit: Mote Marine Laboratory

"Data go a long way toward increasing our understanding," said Dr. Cynthia Heil, Senior Research Scientist at Bigelow Laboratory for Ocean Sciences in Maine, who co-edited the special issue of *Harmful Algae* and was formerly with FWC's Fish and Wildlife Research Institute. "This report, which includes data from four different red tides and numerous laboratory studies and modeling efforts by biological, chemical and physical oceanographers, shows the collaborative efforts

needed to understand why Florida red tides are so frequent and harmful in this region."

Co-editor Dr. Judith O'Neil, Research Associate Professor at the University of Maryland Center for Environmental Science, added, "We learned that *K. brevis* is an adaptable and flexible organism. We identified 12 different sources of nutrients that it can take up and use. One of the most interesting things that hadn't previously been taken into account is this organism's ability to not just use sunlight, like plants, but to also consume other single-celled organisms as a nutrient source. Additionally, its migratory behavior and directed swimming allows *K. brevis* access to nutrient sources everywhere it finds them—at the surface, bottom and throughout the water column."

According to the study, *K. brevis* can get the nutrients nitrogen and/or phosphorus from the following sources (bold sources were newly linked to *K. brevis* blooms through the ECOHAB project):

- Undersea sediments
- Decaying fish
- Water flowing out of estuaries
- Deposits from the atmosphere
- Nitrogen from the air transformed, or "fixed," into a more useable form by the naturally occurring bacteria *Trichodesmium*. (They are a type of cyanobacteria, which use energy from sun to make food, like plants. They can multiply and form blooms.)
- Waste from zooplankton—small aquatic animals visible to the naked eye
- The "grazing" of smaller zooplankton, dubbed "microzooplankton" because they can only be seen under a microscope. (Grazing includes their "sloppy eating" of other tiny life forms, along with the their waste.)
- Picoplankton—tiny life forms that *K. brevis* consumes

- Bacteria transforming nitrogen in the water into more useful forms
- Light creating available nutrients from natural, dissolved compounds like tannins in the water
- Decay of *Trichodesmium* blooms (newly documented as a long-term nutrient source for *K. brevis* blooms)
- Nitrogen from the air "fixed" by other cyanobacteria that are NOT *Trichodesmium*

The researchers concluded that many of these nutrient sources are individually more than enough to support observed blooms, but no single [nutrient source](#) is solely responsible.

Naturally occurring *Trichodesmium* (defined above) provided the most nitrogen, but not all, for *K. brevis* blooms developing offshore. Nearer to shore and within estuaries, major nitrogen sources believed to support blooms included estuary water carrying land-based nutrients to sea, underwater sediments and dead fish decomposing, in addition to other sources.

A few coastal sources—estuary water, deposits from the atmosphere and underwater sediments—are known to carry natural nutrients as well as some enhanced levels due to human activity. With other nutrient sources—such as microscopic life forms—connections with human activities are less direct, so it is harder to predict how they might be influencing red tides.

"Nature is messy, but this project has put several new pieces in place," said Dr. Kellie Dixon, Senior Scientist at Mote Marine Laboratory and Co-Principal Investigator for the ECOHAB project. "Until now we had not looked at this many of the 12 sources and their specific quantities simultaneously. Some of the sources, like [nutrients](#) released from the sediments, had never been measured in southwest Florida's coastal

waters until we studied them for ECOHAB."

The project blended nutrient studies with physical oceanography, shedding new light on how blooms are brought to shore.

"Until now, effective management of harmful algal [blooms](#) caused by *K. brevis* was complicated because we didn't know enough about how different nutrient sources and forms taken up by *K. brevis* interacted with the physical environment," said Matt Garrett of the Fish and Wildlife Research Institute, who managed the ECOHAB project. "This project provides data that can help inform management recommendations on how to control nutrient sources and possibly improve forecasting models."

The special issue of *Harmful Algae* includes the following management recommendations:

More information: *Harmful Algae*,
www.sciencedirect.com/science/journal/15689883/38

Provided by Bigelow Laboratory for Ocean Sciences

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