On the heels of one of the worst red tides in Gulf coast history, teams of scientists in the university's College of Marine Science are working to understand the harmful algal bloom and to minimize its impact on marine life and the Gulf coast economy.

BY RANDOLPH FILLMORE

Piles of beached dead fish. Beach-going tourists coughing in the toxic air. The smelly cleanups. If you missed it in real-time, throughout 2005 television news in greater Tampa Bay told the saga of the red tide beast as it snuck up the Gulf coastline killing off fish and birds, striking a serious blow at the fishing and tourism industries and doing its best to ruin paradise as we know it.

What is red tide? Can it be prevented? Can it be monitored and tracked so that we can at least be prepared for its insults? Best of all, can we minimize its destruction of marine life and prevent it from shattering the Gulf coast economy?

USF scientists are trying to not only answer these questions but battle the red tide beast when it shows its ugly head in our coastal waters. It is going to be a long fight, but most scientists are optimistic because we know a lot more about red tide than we used to.

What is red tide?

"Red tide is classified as a 'harmful algal bloom' or HAB," says John Paul, a biological oceanographer at the College of Marine Science who recently received a $300,956 grant to develop a hand-held sensor to detect

JAMES HARDY/GETTY IMAGES

red tide. "In Florida, the algae species that most often causes red tide is Karenia brevis, which produces a toxin that is a threat to human and ecological health and responsible for an estimated $50 million in losses in the shellfish, finfish, recreation and tourism industries. Current red tide monitoring methods are labor, skill and equipment intensive—and sometimes inaccurate. However, highly sensitive novel methods may lead to red tide forecasting."

Working with the State of Florida's Bureau of Aquaculture Environmental Services in the fall of 2005 in the Apalachicola Reserve in the Florida panhandle and in the Guana Tolomato Matanzas Reserve near St. Augustine, Paul's research group is adapting new technology into a field-ready, fast-acting, hand-held sensor for personal use.

Not all algae blooms produce toxins, but those like K. brevis that do produce toxins end up in the food web and can be transferred to other forms of life, from tiny zooplankton to birds, fish, aquatic mammals and humans.

Marine biologists point out that while red tide occurs naturally every year in the Gulf of Mexico, the 2005 red tide will likely go down in the books as one of the worst and longest duration as the Gulf coast region suffered the effects of red tide for months on end. Yet, one consequence of the prolonged red tide is that it has given scientists more time to study it and given the public more time to grow weary enough of red tide to urge scientists and politicians to come up with some solutions. Many experts at the USF College of Marine Science are engaged in what might be called the "red tide emergency" and are responding accordingly by seeking better ways to identify and track outbreaks.

Identifying red tide's effects on birds and fish

Biological oceanographer Gabriel Vargo is not only working to determine the source of the nutrients—particularly nitrogen and phosphorus—that feed HABs, but also trying to assess the pathways for transfer of toxins to sea and shore birds and document the effects of that transfer.

"My lab is quantifying the input of nitrogen and phosphorus from a number of sources in the Gulf of Mexico, but also trying to measure the flow of nutrients that runoff into the Gulf from Tampa Bay, Charlotte Harbor and the Caloosahatchee River," explains Vargo. "We want to know the routes of the toxins."

At the height of the red tide calamity this past summer, Vargo, colleagues and graduate students were in the media's eye as he and his graduate students reported on the toxic effects on birds.

"Birds that have died with brevetoxicosis symptoms are passed to us by local rehabilitation facilities for toxin analysis," says Vargo. "We also collect samples of their potential food supply to help assess the route of toxin transfer."

Developing sensors to test the blood of sea birds for toxins is ongoing work in the lab of Luis Garcia-Rubio, a chemical oceanographer.

The sensors enable researchers to identify the chemical elements of algal toxins and discover changes in blood cell shape, while identifying viruses and bacteria.

Their technique is noninvasive and will be a simple, rapid and effective sampling technique using spectroscopic techniques that identify particle distribution, says Debra Huffman, who works in Garcia-Rubio's lab.

The goal is to be able to take a blood sample and determine if the animal's blood shows the presence of any range of toxins and then determine which toxin is present and perhaps the level at which the toxin has a lethal effect.

Tracking it

Knowing where the red tide threat is and how it may evolve in time and space is an important part of the fight. Physical oceanographer Robert Weisberg and biological oceanographer John Walsh are developing ways of tracking and forecasting red tides. Additionally, David Fries and Chad Lemke in the Center for Ocean Technology are developing new sensing techniques and profiling vehicles on which the sensors can be mounted.

GABRIEL VARGO/USF FACULTY PHOTO

AT THE HEIGHT OF THE RED TIDE OUTBREAK THIS SUMMER, BIOLOGICAL OCEANOGRAPHER GABRIEL VARGO, COLLEAGUES AND GRADUATE STUDENTS WERE IN THE MEDIA'S EYE REPORTING ON THE TOXIC EFFECTS ON BIRDS.

According to Fries, one aspect of the work is developing and assessing the utility of a networked system of autonomous sampling platforms that would incorporate novel molecular biological sensors, such as the Autonomous Microbial Geneosensor (AMG), into existing physical and chemical detection buoys. Such remote platforms would form the basis of a variety of monitoring networks peppering the Gulf of Mexico, such as Weisberg's Ocean Circulation Groups' network (http://ocg6.marine.usf.edu/).

"The OCG looks at the physical oceanographic aspects of the red tide program," says Weisberg, who heads the group. "We want to know more about the role ocean circulation plays in the initiation and maintenance of red tide blooms. Biology and chemistry control the growth of the blooms, but it is ocean circulation patterns that unite the nutrients with light to facilitate photosynthesis, allowing for a concentrated bloom that moves up and down the coastline and distributes the organism."

With Walsh, they are developing models to simulate the development and movement of red tide blooms.

Using the OCG's off-shore, data-gathering and wireless data-sending moored buoys, the group can observe and track surface currents that facilitate the migration of red tide.

CMS graduate student Heather Holm in physical oceanographer Mark Luther's lab is working with Cindy Heil from the Florida Fish and Wildlife Research Institute to track red tide.

"My research aims at finding out how blooms of red tide are brought into Tampa Bay and how they were transported once they got into the bay," explains Holm. "There may be a large-scale residual circulation in the bay that carried them through the entrance."

According to Holm, a circulation computer model is being used to simulate flow and tides during the spring and summer of 2005, discern the release points and track the blooms through the bay's circulation. She compares the computer generated data with observed data.

"The model results were very similar to the actual observations," reports Holm. "We are looking at the possibility that the HAB blooms were transported into the bay well below the surface through shipping channels along with colder, denser water from the Gulf of Mexico."

Another CMS group, the Institute for Marine Remote Sensing (IMaRS), uses NASA satellite data to track red tide. Several times daily as NASA satellites pass over the USF St. Petersburg campus, infra-red and visible light (color) images are downloaded and converted to data about red tides.

Using near real-time data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensors aboard the NASA satellites Terra and Aqua, IMaRS scientists track blooms by measuring the color of chlorophyll in the blooms, which absorb blue-green light but also emit red light. This absorption and fluorescence phenomenon varies depending on the concentration of chlorophyll.

"The K. brevis blooms that cause red tide can turn the water red, brown or even black," says biological oceanographer and IMaRS director Frank Muller-Karger.

The satellite's eye-view gives scientists a distinct advantage because they can see all of Florida at once—every day—and measure the change in the color and temperature of our coastal waters.

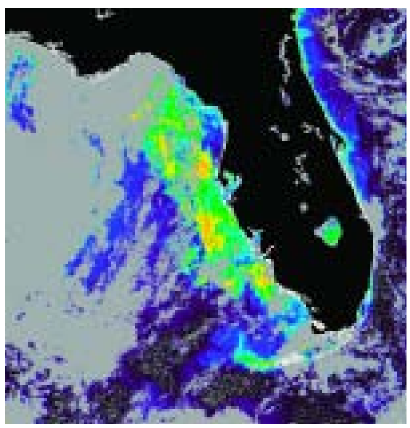
"We have made great progress in identifying HABs from space," says IMaRS researcher Chuanmin Hu. "We can differentiate phytoplankton blooms from other suspicious features."

Hu also used MODIS data to track Mississippi River discharge that makes its way along the west Florida coast, through the Florida Keys and into the Atlantic Ocean.

These tools and efforts to understand the origin and fate of red tide, as well as measure its intensity, are part of the Southeastern Coastal Ocean Observing System (SEACOOS). SEACOOS (http://www.seacoos.org/) ranges from the Carolinas to Alabama and is focused on understanding the links between the oceans, our health and the economy.

Physical oceanographer Ken Carder and Walsh are also using satellite imagery to try to distinguish HABs from "color dissolved organic material," or CDOM, by looking at the chlorophyll concentration.

"If we see more chlorophyll than CDOM—decaying plants, phytoplankton and other organic material—that may indicate red tide," says Carder.



USING MODIS SENSORS ABOARD NASA SATELLITES, USF SCIENTISTS TRACK BLOOMS BY MEASURING THE COLOR OF CHLOROPHYLL. YELLOW AND RED AREAS IN THIS SEPTEMBER IMAGE SHOW RED TIDES.

Carder and Walsh suspect that iron-rich dust from seasonal Saharan storms may have something to do with the formation of red tide in the Gulf of Mexico when the dust is carried westward on trade winds.

"As levels of iron in the waters rise, a bacterium called Trichodesmium uses the iron to convert nitrogen in the water to a form more useful for K. brevis," explains Walsh. "If we have a lot of dust and increased Trichodesmium, there is a chance that we are going to have red tide appear in or near that Trichodesmium bloom."

Measuring the damage

The damage from red tide can be both economic and emotional. USF economist Philip Porter, an avid angler and diver, has an emotional reaction to red tide's devastating effects on marine life.

"I've seen 200-plus pound Goliath grouper carcasses floating in the bay," says Porter. "Diving, I've witnessed an absence of life on the Pinellas artificial reefs when they should be teeming. I've seen hundreds of large snook floating in Sarasota Bay. It makes me want to cry."

The true economic costs may be more difficult to quantify. Anecdotal cost estimates vary from industry to industry and county by county. On a case-by-case basis, the costs of hauling away dead fish can be tabulated. Drops in tourism are more difficult to blame on red tide. The overall, state-wide economic impact of a long red tide outbreak is an unanswered question.

According to Rob Magnien of the National Oceanic and Atmospheric Administration, NOAA is interested in determining the costs of HABs nationwide and in Florida particularly. "We are funding a nationwide effort to look at the national economic impacts and recently held a workshop on just how we might approach studies of the social and economic impacts of HABs," he said, adding that NOAA has a major investment in funding USF HAB research and that many USF scientists concerned with red tide have NOAA grants to help with their work.

What is certain is that red tide will be back in 2006. How bad will it be?