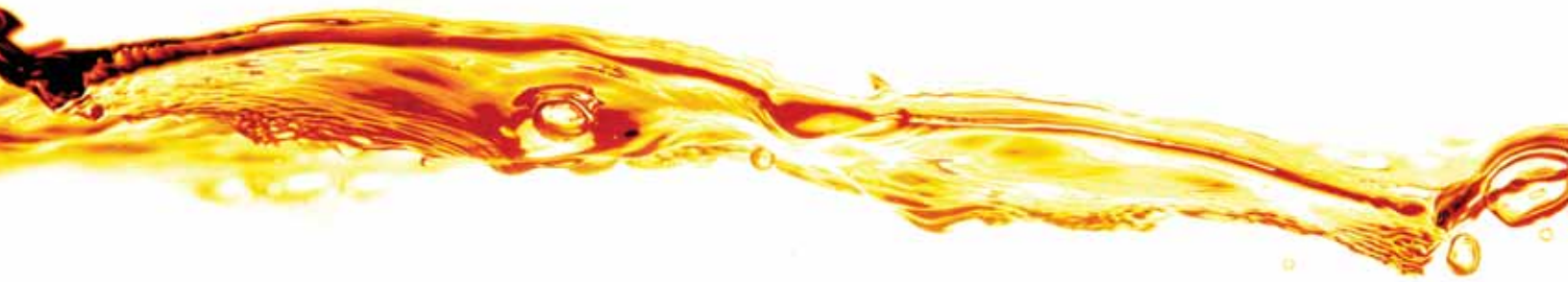
Story by Kathy Wythe

Texas Gold Rush

Scientists seek to understand and control golden alga



A free-floating microscopic alga is increasingly appearing in some Texas lakes and rivers, releasing its deadly toxins and wiping out millions of fish. Texas scientists have taken on the assignment of understanding the culprit and developing strategies for its control.

Golden alga, or *Prymnesium parvum*, was first identified in the Pecos River in 1985. Since that time, the alga with its signature golden-tea appearance has surfaced in most of the state's major river basins. Joan Glass, of the Texas Parks and Wildlife Department's (TPWD) Spills and Kills Team, said she witnessed 187 miles of dead fish along the Pecos River in 1988.

Although it can be present in waters without being harmful, the alga has caused fish kills in five of Texas' 25 major river systems. According to TPWD's statistics, the toxins from the organism have killed more than 25 million fish worth $10 million in the Canadian, Red, Brazos, Colorado and Rio Grande river basins.

In 2001, toxic blooms—explosive increases in the alga's population—killed more than 5 million fish at the Dundee State Fish Hatchery near Wichita Falls, with an entire year's production of striped bass lost. This fish kill and the others have caused major financial losses to Texas' fishing and recreational industries.

Golden alga is an enigma. Until recent research, little was known about the biology of the alga in natural inland waters, its toxins, the environmental requirements for its growth or the water quality conditions in the affected freshwaters before a toxic event occurs.

The alga is harmful when it out-competes other aquatic algae and blooms. It then begins to release toxins that affect gill-breathing animals, such as fish and clams. The toxins prevent exposed cells (cells without protective layers such as on the surface of gills and skin) from keeping out excess water and waterborne chemicals. In fish, this process leads to bleeding and lesions on the gills.

More than 13 entities are involved in golden alga research or monitoring in Texas. TPWD documents the status of golden alga in Texas waters on its Web site along with maintaining numerous informational Web pages about the alga and the current research.

Dr. David Sager, TPWD's Ecosystem/Habitat Assessment branch chief, said the department is conducting a statewide survey to determine the distribution of the alga. "The kills," he said, "are in central and western Texas, which is thought to be because of the higher salinity and pH of the water in these areas."

Sager said TPWD scientists have learned how to control golden alga in hatcheries and ponds using ammonium sulfate and copper compounds but "those controls don't work well in larger reservoirs."

Dr. Daniel Roelke of Texas A&M University, Dr. Bryan Brooks of Baylor University, Dr. James Grover of the University of Texas-Arlington and Richard Kiesling of the U.S. Geological Survey (USGS) are collaborating on projects to understand the environmental conditions that allow the organism to grow and cause fish kills. Once these conditions are understood, the researchers hope to develop a model to predict the environments that allow the alga to bloom and produce toxins and to determine cost-effective management options to prevent or disrupt the blooms.

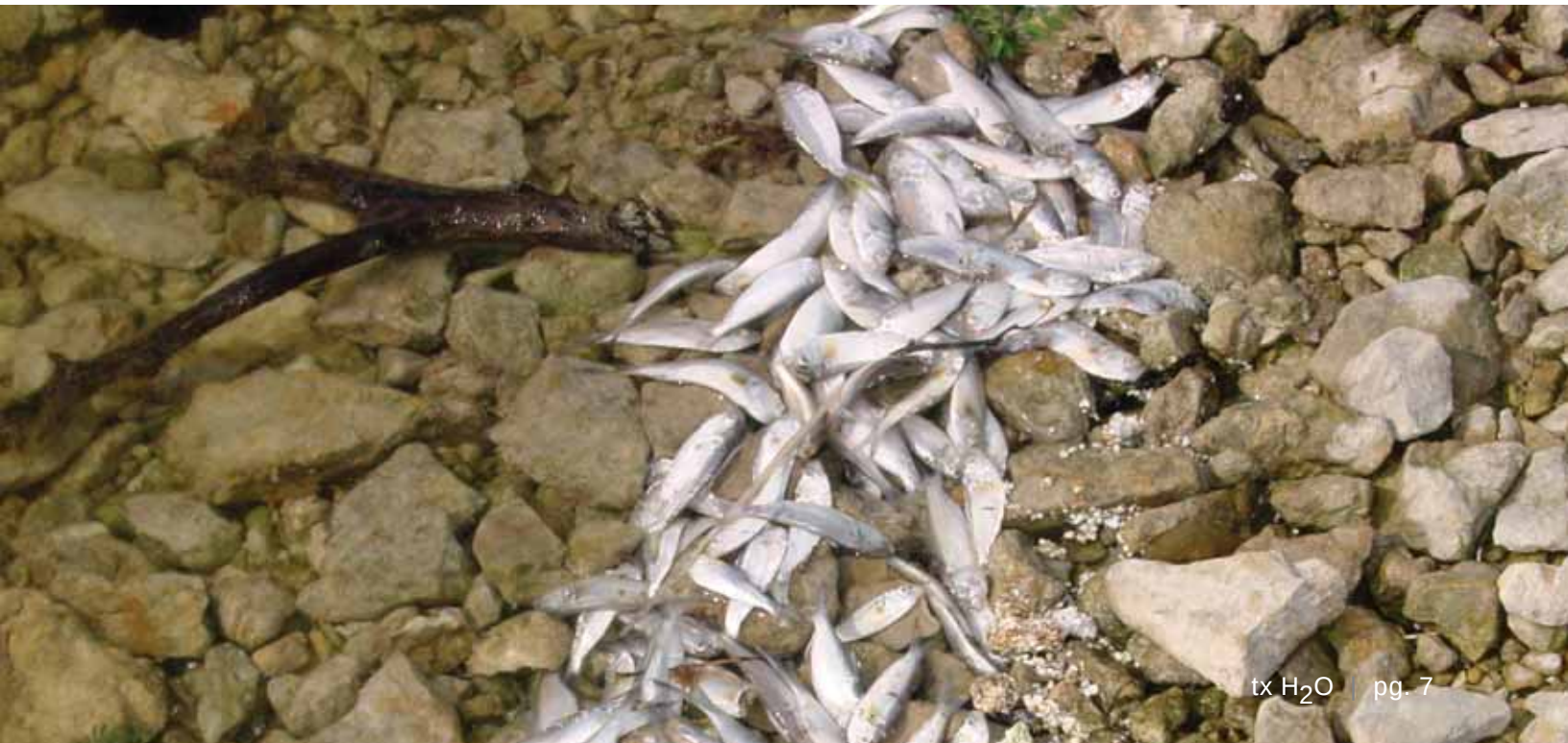
Roelke, an associate professor in TAMU's Department of Wildlife and Fisheries Sciences, said the team used a three-pronged approach to study golden alga and its environment in a TPWD project completed recently. The research team conducted in-field experiments at Lake Possum Kingdom, performed laboratory experiments comparing lab and in-field samples and identified a biosensor to measure the alga's toxicity.

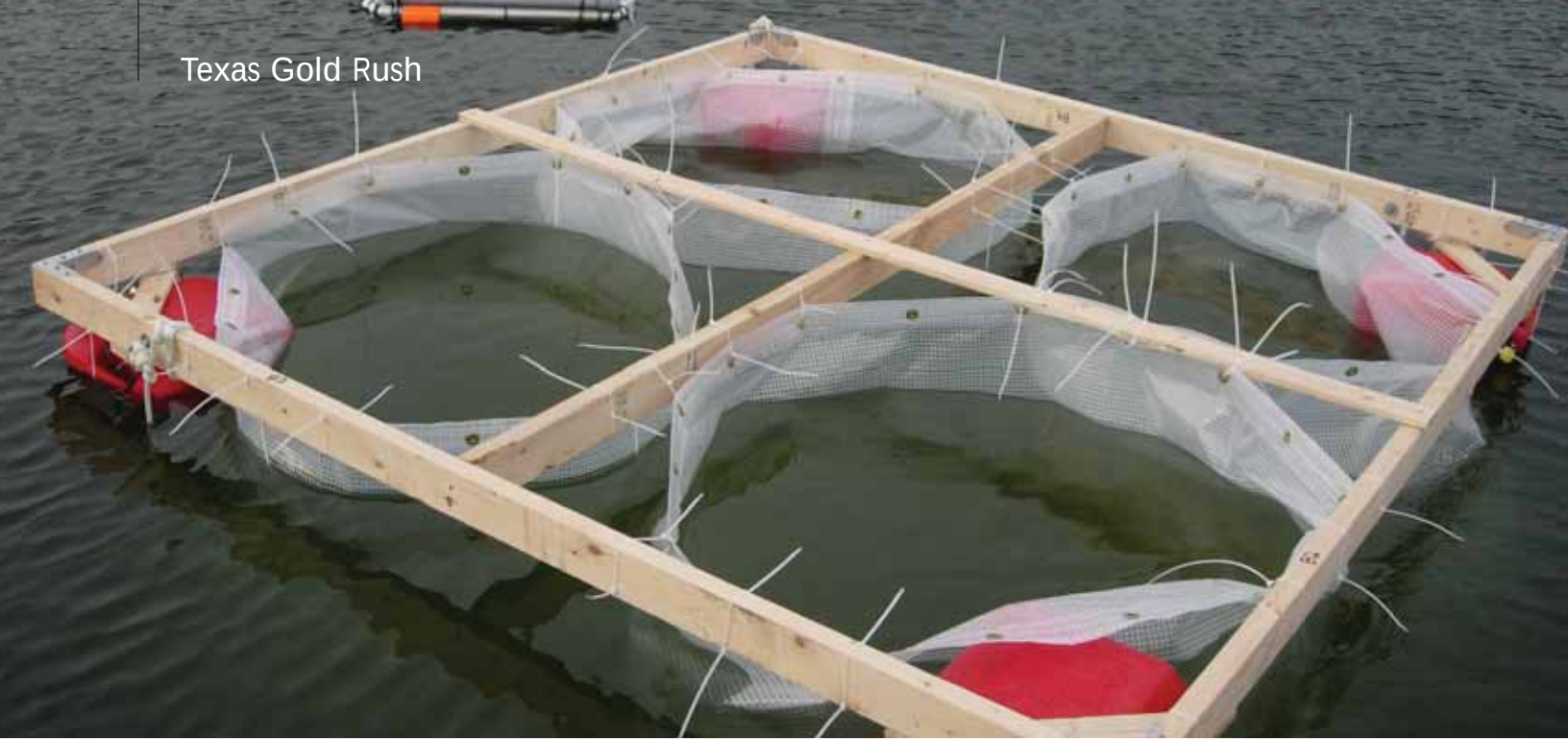
On the lake, the team floated 24 plastic enclosures or corrals filled with lake water, adding excessive nutrients of phosphorus, nitrogen and trace minerals; barley straw extract; enhanced populations of golden alga; and different combinations of the three additions.

The first finding, Roelke said, was that the barley straw extract, thought to be a natural algaecide based on research in other parts of the world, had no effect on limiting the alga's growth. "We hoped using the barley straw extract as a management tool would be the silver bullet we were looking for, but it didn't affect it at all," Roelke said.

"The second finding, which surprised everyone, was with the additional nutrients the exact opposite happened," Roelke said. When they spiked the enclosures with nutrients in excess of naturally occurring amounts in the lake, the alga grew but its toxicity was reduced, and, in many cases, was non-toxic.

Toxic golden alga, although not harmful to humans or most animals, has killed 25 million fish in Texas since 1985.
Photo courtesy of Texas Parks and Wildlife Department.





Working with the organisms in the laboratory, Grover, an associate professor in UTA's Department of Biology, found that the optimal growth of the alga occurred in higher temperatures and higher levels of salinity and light than is typical in Possum Kingdom and other Texas waters. The alga's toxicity, however, decreased under these optimal growing conditions but increased under the growing conditions found in Texas waters, Grover said.

"Winter conditions in Texas turned out to be conditions that, unfortunately, tend to promote toxicity," Grover said.

"It appears the organism is becoming more toxic under conditions that are not optimal for its growth, which implies the organism is getting stressed and releasing toxins," Brooks said.

Finally, in the project's third part, Brooks, director of the Ecotoxicology Research Laboratory at Baylor, performed bioassays with samples from the field and lab to identify toxic conditions caused by *P. parvum*. He discovered that the team could use fathead minnows as biosensors or the "canary in the coalmine" to alert researchers when the water conditions were toxic, Brooks said.

Texas Parks and Wildlife has funded the TAMU, Baylor, UTA, USGS team to continue its research at Lake Whitney where TPWD's scientists have been collecting samples for three years. Roelke said this project will look at "what other factors might cause toxic blooms and what factors might cause blooms to go away." The project will compare the amount of grazers, pathogens and salt content in Lake Whitney to Lake Waco where golden alga does not bloom to determine the roles these elements have in toxic bloom occurrences.

The research team will build a numerical model designed to measure many parameters and predict which environmental conditions allow the golden alga to grow and test potential management strategies, Roelke said.

The team is also collaborating on a federally funded research project at Lake Granbury, managed by the Texas Water Resources Institute. The lake has toxic golden algal blooms that are killing fish and elevated amounts of *E. coli* bacteria in some of the lake's coves. The team will investigate the distribution and dynamics of the alga in relation to *E. coli* as well as the linkages between water conditions, nutrients, dissolved organic matter and blooms.

Roelke and Dr. Steve Davis, assistant professor of wildlife and fisheries sciences at A&M, are producing a high-resolution spatial map of the lake to see if the blooms are occurring in the same places as *E. coli*.

Part of the golden alga research on Possum Kingdom Lake involved adding barley straw extract; excessive amounts of phosphorus, nitrogen and trace minerals; and enhanced populations of the alga to large volume enclosures floating in the lake.

"If we get strong correlative data of *P. parvum*, *E. coli* and dissolved organic matter, we can infer the cause," Roelke said.

In another project evaluating treatment options, the Brazos River Authority (BRA) began applying bales of wheat straw in the fall of 2005 to six coves where blooms occur in Lake Granbury and six coves in Possum Kingdom Lake in hopes of developing a cost-effective means to control or prevent the toxic blooms.

The BRA project, funded by the U.S. Environmental Protection Agency, is based on an English study of applying straw to areas where the alga have been in the past. The straw is submerged just below the surface of the water. The use of straw does not kill existing cells but prevents the growth of new algal cells.

Tiffany Morgan, project manager for the BRA study, said the river authority will continue monitoring the coves until August 2006, then start analyzing the data with a final report on the results by January 2007.

Sager said TPWD has funded projects investigating other aspects of the alga.

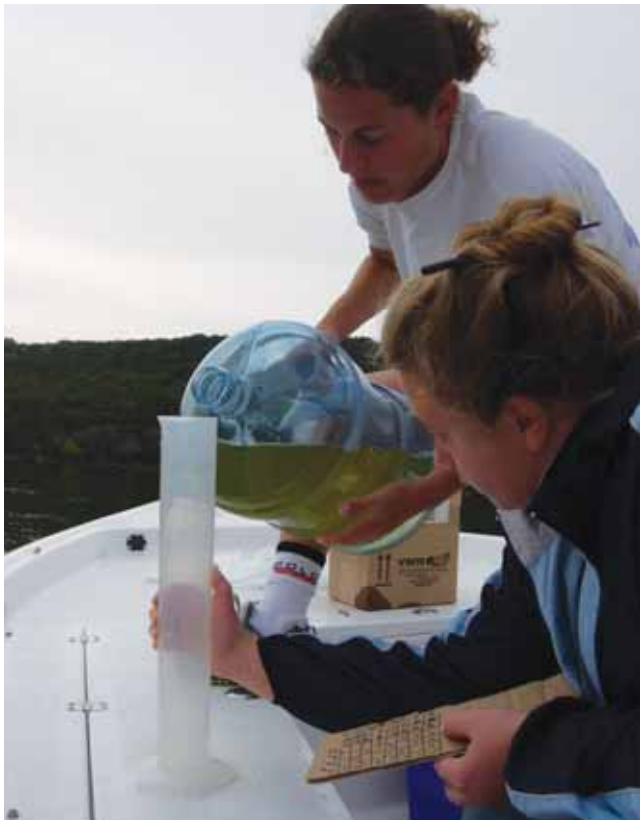
John La Claire of the University of Texas at Austin is developing a partial genome analysis of golden alga and is getting basic information needed for scientists to develop genetic probes that will be used to tell the amount of golden alga in water samples.

Dr. Chi-Ok Oh of the Department of Recreation, Park and Tourism Sciences and Dr. Robert Ditton of the Department of Wildlife and Fisheries Sciences of at Texas A&M University, studied the economic impacts of golden alga on recreational fishing at Possum Kingdom Lake. They estimated the total economic impact was a loss of $2.8 million and a 57 percent reduction in visitors from the 2001 fish kill.

Sager said TPWD is continuing its monitoring of water samples on Lake Whitney and has contracted with Dr. Ayal Anis of Texas A&M University-Galveston's Department of Oceanography to study water currents in Lake Whitney and how the currents spread the alga throughout the reservoir.

The ultimate mission for everyone is finding a management strategy to control the alga and stop the fish kills.

"It could take us years to find a good management strategy," Sager said. "But we are doing it as quickly as we can."



Texas A&M University graduate student Reagan Errera and undergraduate student Heather Thompson prepare to add elements to the large volume enclosures in Possum Kingdom Lake.