

Anti-terror fish guard S.F.'s water Bluegill monitored to detect an attack on city's drinking supply

Keay Davidson, Chronicle Science Writer

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Chronicle / Frederic Larson

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Bluegill at the Millbrae water-treatment plant are continuously monitored to ensure against harmful contaminants. Chronicle photo by Frederic Larson

Fish are being drafted in San Francisco's war against possible terrorist threats to its water supply.

Akin to hospital gadgets that chart a patient's heart rate and breathing, a new water-quality monitoring system automatically analyzes the behavior of eight to 12 bluegill fish in a tank at the San Francisco Public Utilities Commission's water-treatment plant in Millbrae.

If the computers sense that the fish are upset by something in the water, "the system immediately triggers water samples to be taken, and the staff are alerted by pager and e-mail," said commission spokesman Tony Winnicker.

The monitoring system, which costs \$110,000 per unit, was installed in April. Instruments inside the tank listen for phenomena such as fish coughs.

Like a human who coughs to expel unwanted matter from his respiratory system, fish cough by flexing their gills as a way of clearing unwelcome particles -- say, grains of sand -- from their breathing passages.

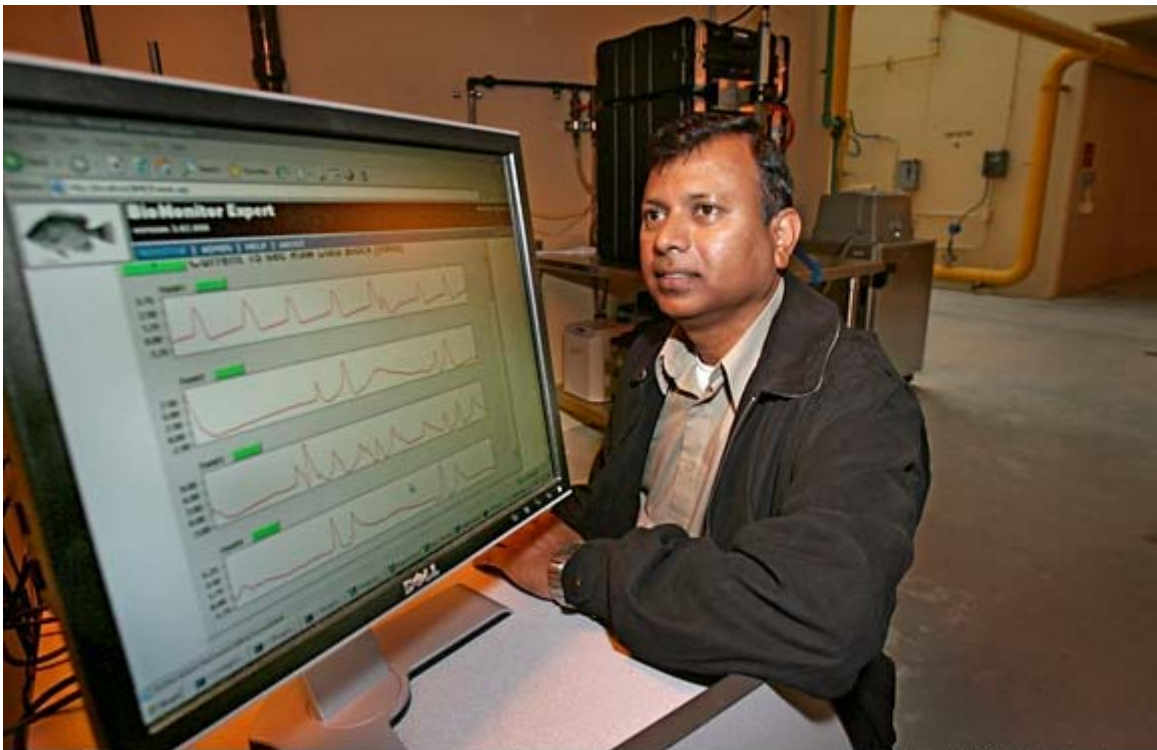
Inside the tank, the instruments are so sensitive that they can tell which fish coughed. The instruments transmit their findings to nearby computers, which compare the fish cough rates and other behaviors to their normal behaviors.

For example, if the fish seem to be coughing more than usual, the system automatically alerts staff members. (However, Winnicker noted, there's no screeching alarm or flashing light like in Cold War-era movies about nuclear weapons crises.)

In the near future, the commission -- which has 2.4 million water customers in the Bay Area -- plans to install tanks with bluegills at a water-treatment plant in Sunol and at one somewhere "upcountry in the Sierra Nevada," said the commission's general manager, Susan Leal.

For security reasons, she and other officials won't reveal the locations of the planned installations. Officials with the commission, the manufacturer, Intelligent Automation Corp. of Poway (San Diego County), and the U.S. Army also declined to give many specifics about what the system can detect and what it can't.

Water systems already routinely use chemical treatments to protect water quality against biological agents such as bacteria. In San Francisco, Winnicker said, regular water testing and treatments provide solid protection against the kinds of water-borne illnesses, such as cholera, that terrorized the 19th century. Not only do regular chemical treatments of the water wipe out biological invaders, but water-monitoring instruments would detect an effort to overwhelm the system by dumping lots of pathogens into it. "We do more than 100,000 water-quality tests every year and hundreds of tests a day throughout the system," he said.



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The new system, said Jeff Goodrich, Intelligent Automation's president, is best able to detect nonbiological threats such as pesticides, mercury, cyanide, heavy metals, fuel spills and phosphates. "The Army tested this system against 27 toxicants, and it spotted them all," said Bill Lawler, co-founder of the company.

"The fish are monitored 24/7," Winnicker noted. "The fish lead quite happy lives -- they're well fed. Amidst the computers and equipment is a big pile of fish food and treats."

The intelligent Aquatic BioMonitoring System, as it's called, is marketed by Intelligent Automation. The firm developed the system's software to automate techniques previously developed by the Army. The Army holds the patent on the system; Intelligent Automation is the Army's authorized licensee.

The Army has quietly funded research into the use of bluegill as water-quality monitors for over 10 years, said Chuck Dasey, a spokesman for the U.S. Army Medical Research and Materiel Command at Fort Detrick, Md.

At first, the Army's main concern was to ensure that U.S. troops received clean, safe water when they fought on foreign soil, Dasey said. "The idea was this (fish technique) would be an inexpensive way to check (local) groundwater."

Of course, humans have long relied on animals as warning systems, like miners who relied on caged canaries to detect poison gases in the air. Likewise, ancient Rome is said to have learned of an impending enemy attack when local geese started honking.

John McCosker, who for many years ran the Steinhart Aquarium at the California Academy of Sciences, said bluegill are an example of what's known as a sentinel species: They're so sturdy that if they get sick in unusual numbers, you know something's wrong with their environment.

McCosker said, "Bluegill were probably the hardest fish to kill in the whole collection. They can tolerate a wide range of temperatures, and they eat just about anything."

If a bluegill is "breathing fast, if it's changing its behavior, then something is wrong in the ecosystem," and it would be prudent to pay attention. "You don't want to wake up in the morning and see that your sentinel species is dead."

Regarding the commission's bluegill system, Winnicker said, "We appreciate that there's an irony to this, that the oldest 'technology' in the world -- life -- is now being combined with high technology to keep the water supply of the region safe. We want to use what works, and if we have to become fishkeepers to do that, then we will.

"After all, life is the only 'technology' that's been proven over millions of years."

Fish police

1 Water quality is monitored by eight to 12 bluegill fish in a tank at the Millbrae water treatment plant operated by the San Francisco Public Utilities Commission.

2 Signals from the fish are transmitted using noncontact, passive electrodes to an amplifier system. The signals are amplified approximately 10,000 times before being relayed to the computer for analysis.

3 Installed in April, the \$110,000 system works with instruments that monitor the fish behavior and physiology, including their "coughing" rates.

4 If their behaviors appear to be abnormal, possibly because of a toxin in the water, then the system automatically:

- Checks water quality using chemical-measuring devices.
- Sends pager messages and e-mail alerts to plant staff.

The commission plans to install similar bluegill-equipped systems at water treatment plants in Sunol and somewhere in the Sierra.

Source: Intelligent Automation Corporation

JOHN MAVROUDIS / The Chronicle

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Chronicle graphic by John Mavroudis

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