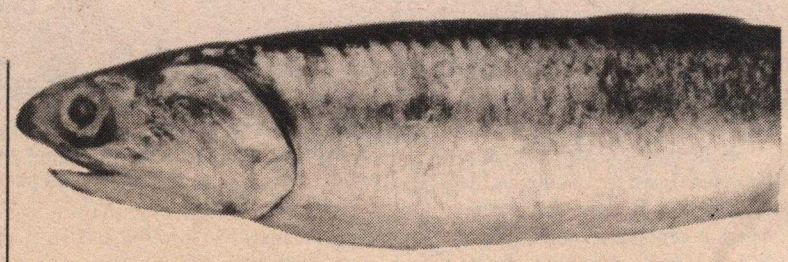
ATTACK OF THE ANCHOVIES

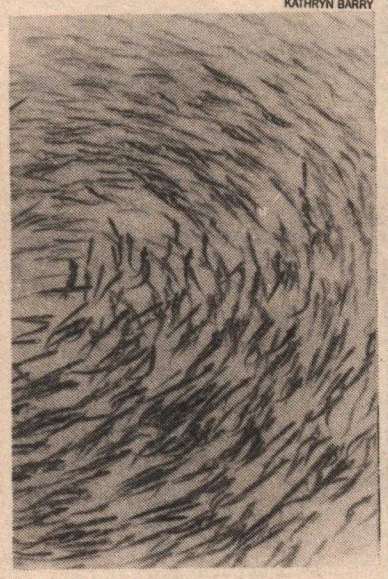
Only three inches long and an unlikely antagonist by any measure, the anchovy has become the bane of users, operators and businesses of the Santa Cruz Yacht Harbor



by Kathryn Barry

IT'S summer again, and the Santa Cruz Port District is on the lookout for one of its most troublesome and mysterious marine animals: the 3-inch-long anchovy. While these tiny fish are no more than pizza topping or fish bait to most, they pose a problem for the Yacht Harbor far out of proportion to their size.

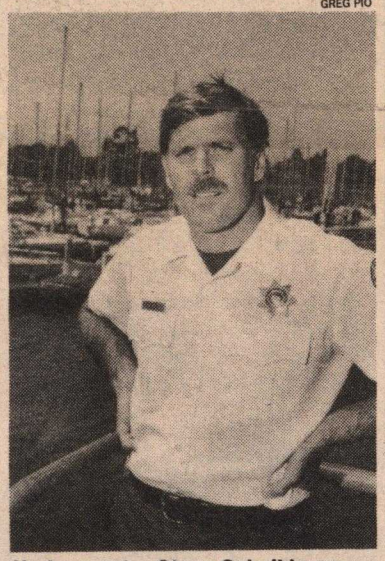
KATHRYN BARRY



Anchovy pack: Schooling anchovies are dreaded by users and officials of the yacht harbor.

In 1964, 1974, 1980 and 1984, millions of anchovies for inexplicable reasons swam into the harbor and died. The anchovies made more than a big stink; the kills caused up to $1 million damage to boats and harbor structures, along with large losses of income to harborside businesses.

GREG PIO



Harbormaster Steve Scheiblauer: 'It's a large-scale natural problem.'

This summer, as in past years, the Port District officials are combatting anchovy incursions with a combination of methods they hope will keep the fish out of the harbor. The port and UCSC scientists have also launched a research effort into the use of loud underwater noises to repel the fish from the harbor. They are hoping to find a "sound solution" to the harbor's 25-year-old dilemma of nature.

Anchovy Mystery

The kills occur when millions of anchovies come into the harbor and cannot get back out, but no one is sure why the anchovies enter the harbor in such numbers.

"My personal bias is that they might just wander in, and it's easier to wander in than to wander out," said Carl Schilt, a UCSC graduate student studying fish-schooling behavior. "Even if they're distressed and wanted to get out of the harbor, they're not the type of creature who would remember how they came in."

The anchovies' small size, the cloudy harbor water and the fishes' lack of sonor or other navigational mechanism adds to their plight.

When large numbers of anchovies enter the harbor – likely in several schools – the fish use up the available oxygen in the water, die and begin to decay.

"The decay cycle rapidly uses up the oxygen in the water and the decay becomes anaerobic," said Harbormaster Steve Scheiblauer. The anaerobic decay of the anchovies produces hydrogen sulfide which then reacts chemically with the paint on the bottom of the boats and harbor structures; it is also given off as a gas, and corrodes metal even a few feet above the water.

A harbor clogged with dead fish causes loss of income to its businesses. "It certainly impacts the restaurants," said Bob Munsey, co-owner of the Crow's Nest. The Crow's Nest is usually upwind of the main harbor; the other businesses aren't so fortunate. Aldo's Harbor Restaurant, which features outside seating, can be greatly affected by the kills. Mauro Olivieri of Aldo's recalled the first kill in 1964: "My first thought was, 'We have an awful lot of bait. We do our own fishing and catch our own bait. We had no idea it would get to the levels that it got."

Not Exactly Fish Soup

Port Director Brian Foss said in 1964 no one cleaned up the dead anchovies, and the metal on local houses and the lead-based paint on the boats turned black from the hydrogen sulfide. The next time, "We didn't know about aeration," said Foss. "It was a disaster." Fish were cleaned up manually. "Once they go down, they're in a decay process and you'll never get them." After the second kill the port began searching for solutions.

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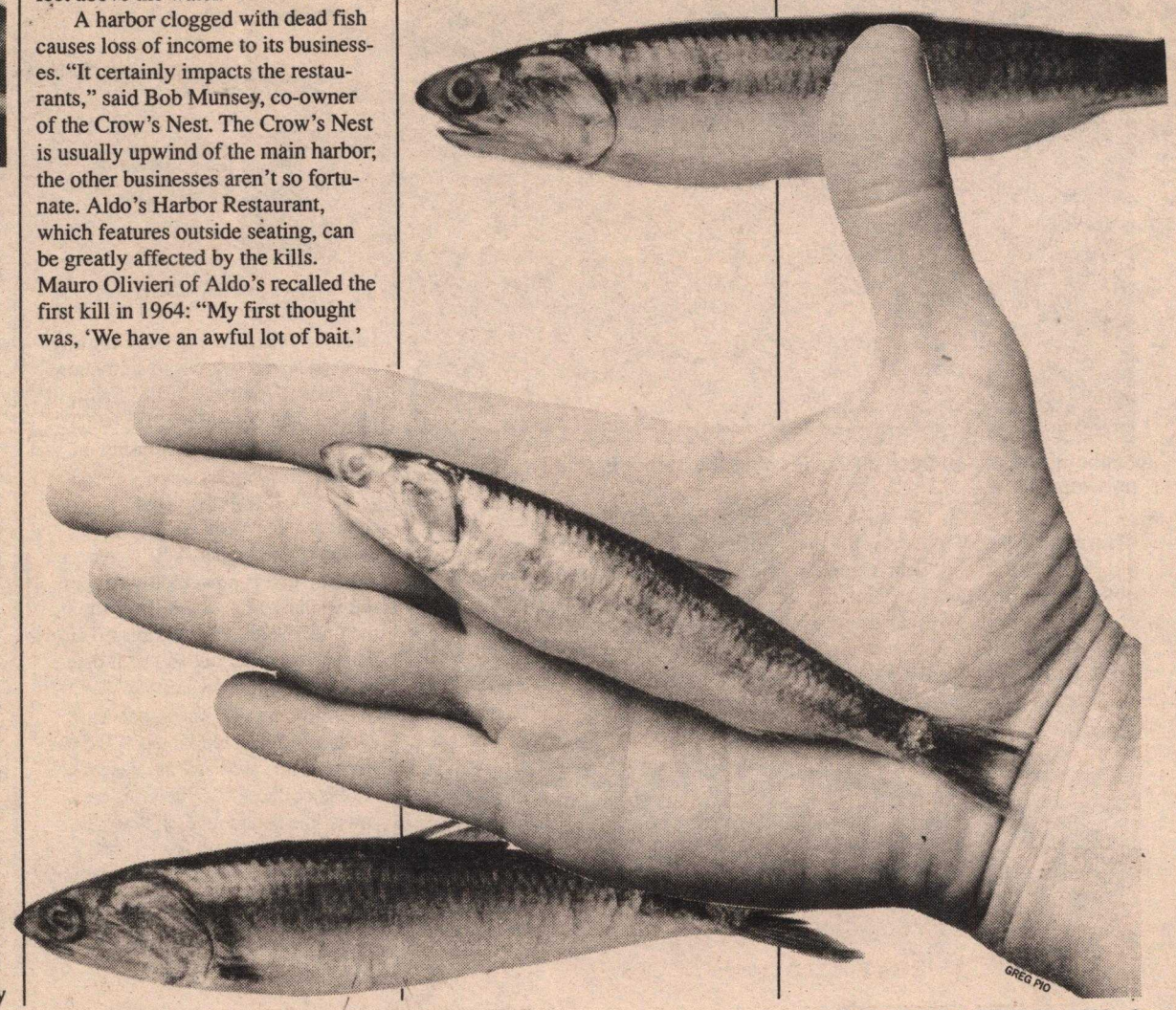

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"We've tried underwater lights, bubble curtains, bells and non-pneumatic (mechanical) noises. People have suggested anything from underwater salmon and shark noises – whatever those might be! – to chemicals," said Foss.

The most successful step taken so far has been to aerate the harbor water. The harbor has 22 mechanical aerators that forcibly blow tiny bubbles into the water, adding oxygen to the water and moving the harbor water around.

"We're pretty sure that in 1981 the aerators kept the oxygen at a crucial level and prevented a kill," said Scheiblauer. He thinks the 1984 kill occurred because there were too many fish and the aerators were overwhelmed.

A common factor in the kill is that all have occurred during "neap" tides, when there is little tidal change to replenish the oxygen in the water. Bob Byington, a former Harbor High School Oceanography teacher and currently maintenance expediter for the post district, discovered this relationship between kills and the tides after the '74 kills, when he started monitoring oxygen and ammonia levels in the harbor water.

Scheiblauer credited Byington for discovering the anchovies die from lack of oxygen. The port now has an automatic oxygen probe which gives them a digital readout of the oxygen level; when the oxygen level drops too low, they turn on the aerators.

The port is also using a net across the harbor mouth, made by local fisherman Sam Mazzarino, in an attempt to fence them out.

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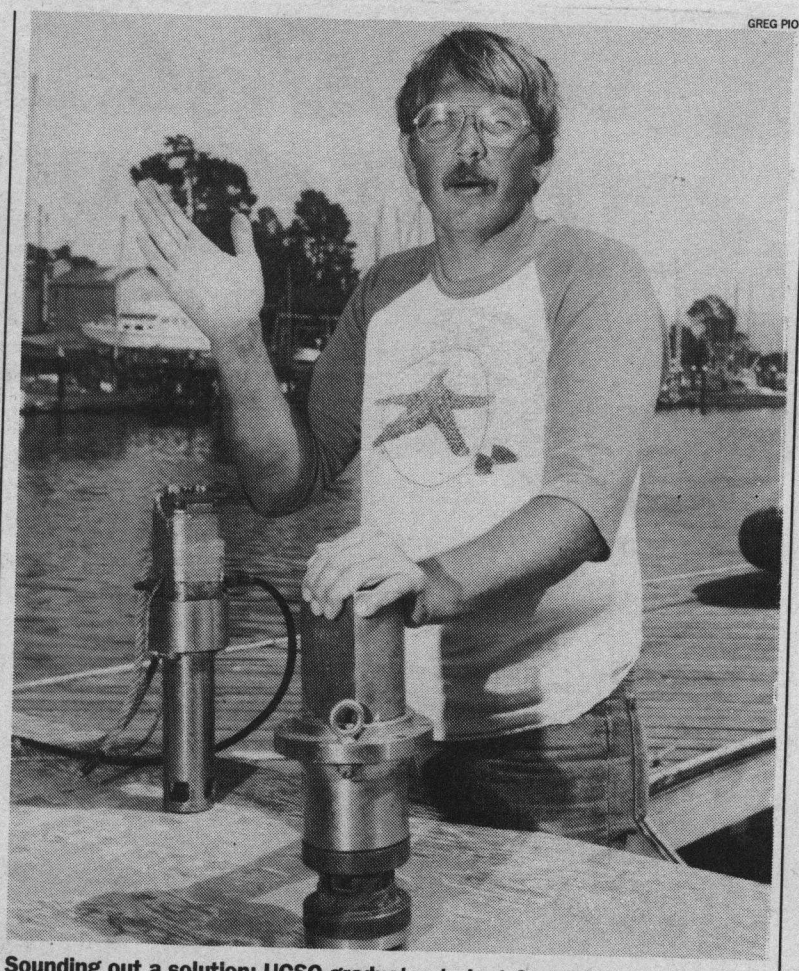


Sounding out a solution: UCSC graduate student Carl Schilt, who is studying the use of sound to repel anchovy schools. He stands with underwater 'guns' that generate powerful sounds using compressed air.

Scene of the crime: Dead anchovies clog the harbor in this view of a previous kill.

Mazzarino is happy with how the net has worked so far, but Scheiblauer noted the harbor cannot rely on it entirely. The port is still unsure it will work when millions of anchovies, along with predators such as sea lions, try to enter the harbor. The net fence must also be lowered and raised for boat traffic, which is very labor intensive.

Seeking a Sound Solution

After the 1984 kill, the port called Bill Doyle at UCSC for help. Carl Schilt, under the direction of Ken Norris and Ken Marten of UCSC's Long Marine Laboratory, took on the job.

Schilt, Norris and Marten believe certain sounds, especially very loud, low sounds, may prevent anchovies from entering the Santa Cruz Harbor.

Sound is currently being used at Ontario Hydro, a Canadian utility, to keep alewife (a herring-type fish) out of its power plant intakes; Schilt hopes to use similar techniques here.

Sound is especially attractive as an anchovy repellent, Schilt noted, because "it is environmentally benign, water clarity is not a problem, it would work day or night and sound travels well in water."

Schilt carries out his tests at the harbor by containing the fish in a large, water-filled bag and exposing them to sound sources to study how they react. The bag enables Schilt to observe and control the fish better than if they were swimming in the harbor.

Schilt is testing a sound source called a "water gun" on northern anchovies and other fish.

The gun is powered by compressed air; when Schilt fires fires the underwater, the compressed air pushes the water out so fast it opens up a "hole" in the water.

"Nature, as we know, abhors a vacuum," Schilt explained. "The cavitation slams shut and the vacuum bubble collapses." When this happens, "the sound level in water is over a million times louder than a jet engine at take off," according to Tom Boles, field applications engineer at Bruel and Kjaer Engineering in San Francisco, which makes the hydrophones and other electronic equipment Schilt is using in the project.

Schilt is also testing an air gun, which releases air suddenly, creating an air bubble which "pops," similar to, but not quite as loud as, the water gun's vacuum bubble. Both guns are on loan from Bolt Technology, a Connecticut company which makes sound sources for oil exploration.

Schooling Behavior

Last year at the harbor research station Schilt and Marten exposed northern anchovies and white croakers to the air gun for five hours, with blasts at four-second intervals, and to the water gun for three hours at 15-second intervals.

Both species of fish reacted to the sound by jerking suddenly and swimming away from the sound source. The anchovies continued to react to the sound every time the guns went off. "What's interesting is I did the same thing with the croakers;" said Schilt. "They got used to it right away."

Schilt said he believes the anchovies continue to respond to the sound because they are heavily dependent on schooling. While croakers school when they are in danger, they are primarily a bottom-feeding fish. The northern anchovy, on the other hand, "depends on schooling for protection from predators," Schilt said. "They integrate the schools through vision, and through feeing the motion of their colleagues in the school."

Schilt added that sound is composed of both pressure and displacement: "sound moves water." He believes anchovies respond to sound because they feel the movement of the water created by the sound source. In essence, he said, "the sound may be like telling the anchovies to move over."

Because different fish respond differently to sound, it is difficult to tell if sound will work as a repellent. Schilt must determine the right combination of loudness, frequency (how high or low the sound is), rise time (how quickly the sound reaches its maximum loudness) and distance of the sound to the source to the fish.

If the sound source is too loud or too close, it could hurt the fish; if it is not loud enough, or not close enough, the fish would not respond to it. For example, the anchovies respond slightly when the sound source is 14 meters away from the bag, but some of them died when the water gun unexpectedly went off inside the bag.

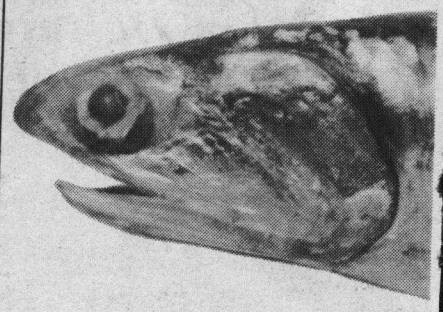
Two Steps Forward, One Step Back

The kind of sound Schilt's equipment can make is limited. Both the air and water guns make sound only at one loudness, frequency and rise time.

Originally, the researchers were going to borrow underwater speakers from the Navy, but said Schilt, "There's a limit to how loud you can make sounds with underwater speakers, especially low sounds. That's why I'm not down here playing any sound I want – whales, seals, Bob Dylan, Mozart – but that would be really neat."

Last summer, the port rented three water guns to test in the harbor. Schilt and Marten tested the equipment, though, without positive results. They used a depth finder to locate fish before and after firing the guns at each of the three locations.

"Sometimes there are fish and sometimes not, but it doesn't seem correlated with the bangs in any way. I was discouraged, and so was Bolt Technology," said Schilt.



"One of the solutions has always got to be that we just learn to live with it, because it's a large scale natural problem," said Scheiblauer. Nevertheless, the port and the researchers are still hopeful.

"It's just harder than we've envisioned," Foss said. In the meantime, the port is trying to reach a balance between research – which is "high payoff, but high risk" — and more practical measures.

This summer the port is continuing its aeration program, and recently purchased four aerators to double aeration capacity. "I'm more enthusiastic about that than anything," said Foss. He noted aeration is a direct solution to the problem – the more air, the more biomass the harbor can support.

The port also continues to use the net. "We would like to prove it a success or failure," said Foss, although he doesn't believe it will always be successful.

"Part of our problem is detection," Foss said. "They're quiet little guys. To operate the net effectively, we have to know where they are." In order to tell when anchovies are approaching the harbor, the port is using a sonar sensing device, which, in effect, paints a picture of the biomass approaching.

So far in the summer of '88 there are no signs of the anchovies. Mauro Olivieri of Aldo's echoes the hope of all who use, live by or work at the harbor: "The problem today is much better than it used to be. In the beginning, the anchovies would just come in and completely fill up the harbor, mass upon mass. They would die and this horrible smell would come out and it would take over a week's time to clear them out. ... I'm hoping this year it won't be a problem at all."•