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The Farmer Goes to Sea

Osha Gray Davidson

"Are you ready to see the future?" Vinny Allocca calls out gleefully, his voice rising from the sun-dappled surface of the Hawaiian sea. Allocca has timed his question perfectly. He's caught me midstride off the deck of the *Ho'Okupu*, a 32-foot commercial workhorse that belongs to his employer, Randy Cates, a fisherman turned "fish farmer." My only possible answer to Allocca's question is the affirmative *ker-plunk* of my scuba fins hitting the water.

The "future" to which Allocca refers is not just 40 feet down, although that's what my depth gauge reads when we stop descending. It is also nearly two miles from shore. The combination of these two positions, depth and distance from land, makes open-ocean aquaculture (OOA) the topic du jour in the seafood industry—and a hot-button issue for many outside the trade. Most existing fish farms use shallow-water pens that hug the coastline. The arrangement has a mixed record. Workers can feed and harvest fish efficiently from docks, but poorly managed fish wastes can easily foul near-shore waters, causing "dead zones" where ocean life dies off, and leading to disease in wild fish and other species. But now, new and still-emerging technologies have aquaculture poised to take a giant stride out to sea, where proponents say that massive ocean currents will sweep away any pollution problems.

Last June, the Bush administration gave OOA a tremendous boost, sending Congress a bill that would for the first time allow aquaculture in federal waters—stretching from three miles to 200 miles off the mainland, an immense area larger than the combined landmass of the lower 48 states. The bill's stated (though vague) goal of streamlining the permitting process for OOA has supporters cheering—and critics foreseeing an under-regulated offshore industry that repeats the mistakes of near-shore fish farms. But with consumer demand for seafood increasing and wild stocks dwindling, the government's point man on the issue, Michael Rubino of the National Oceanic and Atmospheric Administration (NOAA), says that aquaculture is reaching a tipping point in this country. "Any increases in [seafood] supply," he says, "are going to come from aquaculture."

Courtesy Kona Blue

A half-raised SeaStation 3000 operated off the Big Island of Hawaii by the company Kona Blue

The water is still clouded by sand kicked up by an early morning squall, and so it's not until we're almost on top of it that I spot the Sea-Station 3000, an enormous fish cage that is impressive both for its grand scale and its elegant design. Manufactured by Seattle-based Net Systems, the SeaStation certainly looks futuristic. Or *retro*-futuristic may be a better description, since the cage most resembles a flying saucer from a

1950s sci-fi flick.

A horizontal steel rim 82 feet in diameter encircles a vertical central spar the height of a four-story building. The netting, stretched between the spar ends and the rim, has a weave less than an inch in diameter and is made of Dyneema fibers—an ultrahigh-molecular-weight polyethylene that is 10 times as strong as steel and yet floats and can be cut with a knife.

The SeaStation 3000 has an interior volume of 3,000 cubic meters (hence its name), which translates into 792,516 gallons, or more water than in most of the palatial hotel swimming pools along Waikiki Beach. The cages, which each weigh 10 tons and cost around $110,000, can be submerged in just 15 minutes by flooding the hollow spar with ocean water. At 40 feet down, they pose no hazards to passing ships and are themselves protected from large ocean waves. According to Net Systems's aquaculture manager Langley Gace, the metal framework should last 20 years in the water; he puts the net's life span at a decade.

Cates International has four of these structures tethered to the seafloor off Oahu's southern coast, 120 feet beneath the surface, and plans to add several more over the next year or two. Allocca unzips an opening in the net barely big enough for a single diver, and we haul ourselves into one of them.

At first, I feel a bit like Alice must have after stepping through the looking glass, but instead of white rabbits and mad hatters, this marine wonderland is filled with 100,000 silvery fish that swirl around the central spar. They are adolescent moi, also known as Pacific threadfin or *Polydactylus sexfilis*. For the first 50 days of life, the moi are raised on land, in a series of progressively larger tanks—from fertilized eggs smaller than grains of salt to two-inch fingerlings. The young fish are taken by boat to the submerged cage and pumped into it through a long tube. The moi swarming around the spar now each weigh half a pound. But in a few months they'll have doubled or tripled in size. At that point, the moi will be harvested and sold at fish markets and to top restaurants across Hawaii, where they are a much-coveted delicacy. Ancient Hawaiians considered moi so delicious that only the *alli'i*, or royalty, were allowed to eat them. Apparently, it's not just humans who like the taste of moi. Several sandbar sharks circle the cage, their hungry eyes fastened on the fish of kings.

If this mammoth cage full of fish is a bright vision of the future, as Allocca insists, it is also a reflection of a darker past. Once plentiful, moi have been fished nearly to extinction. As recently as 1967, commercial fishing operations landed 10 tons of the royal fish. By the new millennium, that figure had plummeted to just 740 pounds—about as much seafood as popular restaurants here serve on a busy Saturday night.

Overfishing isn't just a Hawaiian problem, and it is not a relic of the past. In a 2001 report to Congress, the National Marine Fisheries Service could say with certainty only that 22 percent of fisheries in U.S. waters were in good shape. Because of commercial fishing, three quarters of fishery stocks worldwide are either on the verge of depletion or have already been pushed over the edge, according to the United Na- tions Food and Agriculture Organization. Even worse, after a decade of crunching numbers from every major fishery from pole to pole, in 2003 biologists at Dalhousie University in Nova Scotia published a study in the journal *Nature* showing that 90 percent of all large predatory fish in the global ocean—including shark, tuna, cod, marlin and grouper—had been wiped out. "Their depletion not only threatens the future of these fish and the fishers that depend on them," warned Boris Worm, co-author of the article, "it could also bring about a complete re-organization of ocean ecosystems, with unknown global consequences."

I caught a glimpse of this looming catastrophe nearly a decade ago, while interviewing fishermen on Barang Lompo, a small island in central Indonesia. A man in his mid-30s recalled a time when catching dinner was simple. When his wife started boiling water for rice, he paddled his dugout canoe just offshore, caught his fish, and returned just before the rice was ready to eat. But then the foreign commercial trawlers came, and everything changed. At the time of my visit, the man said, it took him several hours to catch enough fish for a single meal.

Open-ocean aquaculture itself won't replenish the world's wild fish populations. And it's unlikely that the types of large predatory fish that have become so scarce will ever be raised in house-size nets like the SeaStation. But farmed fish, argue Allocca and other OOA proponents, *can* take the pressure off wild populations—and give consumers the types of fish they want, for a reasonable price.

Courtesy Kona Blue

Kona Blue's offshore-farm managed Kydd Pollock with some members of his herd

"It's simple," Allocca tells me after we're back onboard the *Ho'Okupu*, scooping half a ton of fish food into two hoppers that mix the pellets with seawater and carry the slurry down tubes and into the cages below. "People want to eat fish. And the fish have to come from somewhere." He nods down toward the nets and adds emphatically, "This is where you're gonna get 'em."

In 1999 the state of Hawaii granted Cates International permits to set up operation in state waters, and the company became the first private OOA outfit to start production in the U.S. Randy Cates currently sells 8,000 pounds of moi a week, but with plans in the works for a total of 16 cages and a new hatchery already going up, he expects to be selling four million pounds of the fish annually within two years—more than the total caught in Hawaii over the past half-century.

Cates was the first, but others are rushing to catch up. Snapperfarm Inc. in Puerto Rico raises cobia and sells it—still in small quantities—to restaurants in Miami and New York. There's another fledgling farm in the Bahamas, and off the Big Island of Hawaii, a company called Kona Blue is raising sushi-quality yellowtail in SeaStation cages.

The U.S. now leads the world in designing and building cages for OOA, but that doesn't mean the industry's future in this country is guaranteed. "We are light-years behind the rest of the world in all other aspects of fish farming," maintains Cates, citing basic biological research on promising species, development of more-efficient hatchery technologies and a political consensus to develop a globally competitive fish-farming industry.

SeaStation inventor Gary Loverich is similarly rankled. Since selling his first two cages to a company in the Philippines in 1996, he says, about half of the 35 giant cages built have ended up in foreign waters. The list of countries experimenting with OOA includes Australia, Chile, China, France, Ireland, Italy, Japan, Korea, Mexico, Norway, Portugal, Russia and Spain. "And in the U.S.," says Loverich, frustrated, "we are still debating whether or not fish farming should be allowed."

Part of the disparity is cultural, says Net Systems's Langley Gace. "Aquaculture is relatively new for most Americans. But it's been a part of Asian life for thousands of years." Market forces also account for some of the difference, he adds. A typical American eats a single pound of seafood for every three consumed by his or her Japanese counterpart, for example. Gace mentions a final hurdle: "Some environmentalists just don't want to see this happen."

Actually, critics of OOA are from a broad social spectrum, including environmentalists, technophobes, commercial fishermen and marine biologists. Likewise, opposition ranges from ideological intransigence to skepticism rooted firmly in science. "We are not against the idea of open-ocean aquaculture," says Becky Goldburg, a senior scientist with the nonprofit Environmental Defense. "We *are* opposed to it getting the green light without any environmental safeguards in place"—which is how she and other opponents characterize the Bush administration bill to open federal waters to fish farming. (Under the bill, permits to set up an OOA operation would be issued at the sole discretion of the secretary of commerce, who oversees NOAA; environmental safeguards would be codified by the Environmental Protection Agency only after the bill became law.)

"Aquaculture has a bad name in the U.S.," says Loverich, and he concedes, "There's good reason for that." According to a 2003 report by the Pew Oceans Commission, an independent expert panel funded by the Pew Charitable Trust, "Over the past decade, nearly one million non-native Atlantic salmon have escaped from fish farms and established themselves in streams in the Pacific Northwest," where they compete for food and spawning grounds with the salmon native to the area. Many of the problems, Loverich says, can be traced to the lack of government oversight as the industry was getting started in the 1970s. Diseases and deadly parasites swept through overcrowded pens, wiping out entire farms and spreading into wild populations.

Probably the most common problem came from allowing fish cages in the wrong places. "A single farm might work well in a bay," Loverich explains, "but then with success, others wanted to do the same thing, and they were permitted to set up in the same area. It's kind of like saying a septic system works well for one house, so let's put two or three on the same system. Eventually it doesn't work so well anymore, and everyone yells like hell." Proponents maintain that OOA eliminates that problem, thanks to enormous currents that carry away fish wastes and dilute them into virtual nonexistence. "It's like throwing a pinch of flour into a fan," says Randy Cates.

Michael Weber groans when he hears this kind of talk. "We've seen this movie before," insists the former special assistant to the director of the National Marine Fisheries Service. "And it doesn't end nicely." He cautions that our history is filled with grand schemes for fishing, backed by the government and focused solely on increasing production. People thought any problems or miscalculations would be swallowed up by the vastness of the sea.

"So much of the boosterism around aquaculture today reminds me of the 1960s," Weber says. "Scientists back then believed that we could take 500 million metric tons a year from the ocean, so that's how our fisheries were managed." But the ocean could afford to give up only about 20 percent of that figure. "We're living with the consequences of that error today," he observes, in crashed fisheries and the economically shattered communities left in their wake. And even if the increased volume of seawater does take care of nutrient pollution (a few studies suggest that that may be the case, but the issue is far from settled), Weber charges that OOA does nothing to address some of aquaculture's other problems, such as the spread of disease from farmed to wild fish and "gene pollution" from escapees interbreeding with local populations.

Cates has anticipated these objections. Disease is unlikely to be a problem for him, he says, because of the cleansing effect of the strong ocean

currents off Oahu—and because his cages aren't overpacked or crowded into one area (conditions likely to lead to an outbreak). Since he raises moi, a local fish, gene pollution isn't a concern either. If you spend any time with Cates, it's easy to see him as a poster boy for OOA, creating a financially successful business that's sensitive to the environment. But that's exactly the problem, maintains Michael Hirshfield, chief scientist with the nonprofit advocacy group Oceana: "Not everybody is a Randy Cates. That's why we need strong regulations—to require *all* OOA operators to be diligent about taking care of the environment."

Courtesy Kona Blue

A snorkeler checks up on Kona Blue's farmed yellowtail

Despite these concerns, it's clear that OOA is moving ahead. A barge carrying 20 tons of fish pellets recently made its maiden voyage out to Cates's moi cages. Once it's moored in place, with feeding lines attached, the barge doesn't require a human presence. From his office on shore, Cates uses his PC to tell the barge's computer to release the right amount of food at the right time. Cates can even monitor the operation with images beamed from cameras mounted on the barge and in the cages themselves.

Others are leaping even farther ahead, at least conceptually. Cliff Goudey, who directs the Center for Fisheries Engineering Research at the Massachusetts Institute of Technology, sees OOA's move from shallow-water anchorage to deep-water anchorage as a good first step. The next step is to let go of the anchor. "Once you free yourself from a mooring," he explains, "all of a sudden you realize you're no longer at the mercy of all that nature throws at you. You use the ocean currents, rather than resist them."

Goudey has worked for years on Ocean Drifter, an untethered fish cage with a diameter three times as large as the SeaStation's and remote-controlled thrusters to maneuver within ocean currents. Goudey envisions a flotilla of Ocean Drifters, each filled with hundreds of thousands of fingerlings in Florida and set loose in the Gulf Stream. The warm Caribbean current is like a river within the sea, carrying the cages across the North Atlantic and delivering the by-then-grown fish to markets in Europe.

For now, the largest Ocean Drifter is an 18-foot-diameter prototype whose greatest journey was inside the Navy's David Taylor Model Basin in Bethesda, Maryland. "It's not quite ready for prime time," Goudey admits. But, he hastens to add, OOA "is the only way to meet future demand for seafood. And the Ocean Drifter, or something like it, is the future of open-ocean aquaculture."

The past is often the best crystal ball in which to catch glimpses of the future. With this in mind, while in Hawaii, I take a day trip to a fish pond that is said to be 1,000 years old. He'eia Pond is just 14 miles from Cates's moi cages, over the Koolau mountains on Oahu's windward side. The first Hawaiians began building fish ponds 2,000 years ago, not long after arriving from the Marquesa Islands. In 1778, when the British explorer Captain James Cook arrived in Hawaii, he found some 360 fish ponds producing nearly two million pounds of seafood. The ponds are great feats of engineering, a happy marriage of marine biology and technological skill. They are shallow, to provide the optimal amount of sunlight to grow algae for young fish to eat. And they have sluice gates—slots large enough to allow young fish in but small enough to trap them when they've grown, as well as to keep predators out. Behind the sluice gates are solid gates. The combination allowed workers to clean the pond by trapping water at high tide and releasing it when the tide ran out. Nearly a mile around, the 88-acre He'eia Pond is a model for sustainable aquaculture.

“Yeah, there’s a lot to the ‘old school’ ways,” says Will Ho’o’pi’i, a native Hawaiian who’s out walking his dogs when I drive up. “They raised moi in there,” he says as we look down on He’eia Pond. I ask if he’s heard about the underwater cages, where 100,000 moi swim in what some think is the future of the seafood industry. No, he hadn’t heard about them, but the idea makes him smile. “It could be the future, you know,” he says, “if they do it the way the old people did.”

How was that? I ask. He looks at me for a moment as if it’s obvious. Then he gestures toward the ancient pond. “Carefully,” he says. “Very carefully.”

To find out where you buy OOA fish, see popsci.com/fishfarming.

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