Cannery Row Revisited

SHARON LEVY

New research is reviving interest in the work of Edward F. Ricketts, a maverick marine biologist immortalized in the writings of John Steinbeck, who foresaw the impacts of overfishing in the Pacific more than 75 years ago. Today his scientific descendants are working to understand startling changes in the waters he loved.

Ed Ricketts was a beer-drinking, philosophizing, skirt-chasing college dropout. He was also a pioneering marine biologist who saw sea creatures in a way that in his day—the 1920s through the 1940s—was so unorthodox that some academics considered him a wild eccentric. At a time when most biologists focused on studying single animals, usually by pickling them and dissecting them in a laboratory, Ricketts was obsessed with seeing marine communities whole.

The structure of his book, *Between Pacific Tides*, a guide to intertidal life organized around environments rather than taxonomy, was so controversial that Stanford University Press delayed its publication for nine years. That book, finally released in 1939, has become a classic and is still used by students of marine biology all along the Pacific coast.

But Ricketts is best remembered as a legend created by the author John Steinbeck. Doc, the kind, bohemian hero of Steinbeck's popular novel *Cannery Row*, was modeled on Ricketts. Some readers found the book so compelling that they searched out Ricketts' commercial laboratory on the Monterey, California, waterfront where he lived and worked surrounded by stinking, bustling sardine canneries, across the street from a prosperous brothel. Total strangers knocked on his door, hoping to walk into the sweet fable Steinbeck had built around his closest friend.

This 1935 photograph shows Ed Ricketts, a pioneering marine biologist, standing in front of his lab, holding a squid nearly as long as he was tall. Photograph: Ralph Buchsbaum, with the permission of Vicki and John Pearse.

Doc's generosity, like his affinity for beer, women, and Eastern philosophies, was part of the real Ricketts. But there was another side to the man that becomes clearer as time passes. He was a remarkably foresighted ecologist, at a moment when the new science was just taking root. Today researchers working on Ricketts's old stomping grounds, from Monterey Bay to Mexico's Sea of Cortez, are expanding on his ideas and working to understand startling changes in the waters he loved.

Exploring the Sea of Cortez

In 1940, Steinbeck and Ricketts set out in a chartered sardine boat loaded with biological sampling gear and bound for the Sea of Cortez, which lies between the Baja Peninsula and Sonora on the Mexican mainland. They planned to spend six weeks studying the creatures of a remote

coast, little known to scientists. Both men were eager to get away. Ricketts's long affair with a married woman in Monterey had just ended, leaving him devastated. The recent publication of Steinbeck's masterpiece, *The Grapes of Wrath*, had brought on a flurry of both critical acclaim and shocked attempts at censorship. Steinbeck was weary of the controversy and of writing fiction. He wanted his next book to be factual, focused on seashore life, both human and animal.

By the time they sailed out of Monterey Harbor, the two men had spent so much time together, exploring tide pools and philosophizing, that they'd begun to practice a kind of intellectual symbiosis. The book that came out of their travels, *The Log from the Sea of Cortez*, was authored by Steinbeck and is full of his humor and his eye for detail. It's also packed with ideas that came from Ricketts, who often saw the battle for survival among tide pool creatures as a microcosm of human society. "Our fingers turned over the stones," Steinbeck wrote, "and we saw life that was like our life."

A section at the core of the book, the Easter Sunday sermon on the acceptance of life as it is, was Steinbeck's riff on a long essay that Ricketts had been working on for years. "Not all potential becomes reality," Ricketts wrote, citing the example of the sea hare, which spawns millions of eggs into a hostile ocean so that a handful might survive to adulthood. He would later repeat the same phrase in a letter written while he was grieving the death of his lover's young daughter.

The *Western Flyer*, the boat Steinbeck and Ricketts chartered, left in the afterglow of Monterey's annual sardine festival, a mass party held at the close of the fishing season to celebrate the ocean bounty that fueled the town's economy. During the 1930s, while most of America suffered through the Great Depression, Monterey's sardine industry boomed. More and more canneries sprang up and more boats joined the fishing fleet, and in the peak year spanning 1936 to 1937, more than 700,000 tons of sardine were landed along the California coast. Ricketts was among the few who recognized that the good times couldn't last. "Now it is warm and sunny; the canneries are going strong," he wrote to a friend in December 1938. "They will extract every single sardine out of the ocean if legislation doesn't restrain them; already the signs of depletion are serious."

Steinbeck and Ricketts saw many of these colorful Sally Lightfoot crabs during their journey to the Sea of Cortez, but they collected very few. "Everyone who has seen them has been delighted with them," Steinbeck wrote. "These little crabs, with brilliant cloisonné carapaces, walk on their tiptoes. They have remarkable eyes and an extremely fast reaction time....When you plunge at them, they seem to disappear in little puffs of blue smoke—at any rate, they disappear." Photograph: Susan Shillinglaw.

Signs of depletion

In spring, Isla Rasa, a table of rock lifted out of the Sea of Cortez by the long-ago thrust of an erupting volcano, is full of the raucous noise unique to large seabird colonies. Hundreds of thousands of birds—more than 95 percent of the world's population of elegant terns and Heermann's gulls—nest here every year, returning to harvest the crop of sardine and anchovy that thrives around the island, where a pattern of upwelling brings cold, nutrient-rich water to the surface. The upwelling here in the midriff, the center of the long, narrow stretch of ocean that is the Sea of Cortez, creates one of the world's most productive marine ecosystems.

Enriqueta Velarde, an ecologist at the University of Veracruz in Mexico, has been monitoring the birds of Rasa since 1979, when she first visited as a young college student. Velarde almost single-handedly began successful drives to stop egg poaching by human collectors and to remove the introduced rats that preyed on seabird nests. Now that those artificial threats are gone, the pattern of gull and tern reproduction on Rasa is affected most by the abundance of small fish in the waters surrounding the island.

"Working with Enriqueta showed me the tight connections between every part of the biosphere," says Exequiel Ezcurra, an ecologist at the San Diego Natural History Museum and a Pew Fellow on Marine Conservation who has collaborated with Velarde on seabird research since 1999. When they began to crunch Velarde's decades of data on seabird breeding, they found a dramatic pattern of reproductive failure that recurred every few years. These collapses correlate precisely with the Southern Oscillation Index (SOI), a comparison of sea-level atmospheric pressures at Tahiti and at Darwin, Australia, that is used to measure the intensity of El Niño events in the Pacific. "For me it was a revelation to realize that the intensity of trade winds 10,000 miles from the Sea of Cortez could so powerfully affect seabirds breeding on Isla Rasa," says Ezcurra.

During strong El Niño events, the upwelling of cold water in the Sea of Cortez stops, and nutrients remain trapped in

colder water far below the sea's surface. This affects the entire food web, and both the numbers of sardines and the reproductive success of gulls on Rasa plummet. Both populations rebound once the upwelling pattern is reestablished.

An industrial sardine fleet began fishing the sea's midriff in 1970. For nearly 20 years, as the fishing effort steadily increased, the tonnage of sardines landed rose along with it. Then, in 1990, the numbers of sardines caught abruptly dropped. Two years later, the decline was compounded by the El Niño event of 1992, and the fishery collapsed. Although catch levels have fluctuated up and down since then, the size of the fish landings no longer correlates with the amount of fishing effort—a sign, says Ezcurra, that the extraction rate has exceeded the productivity of the sardine population.

The owners of the fleet eventually put a voluntary limit on the number of boats that could go out, which allowed the sardine population to partially recover. Continued fishing pressure keeps sardine landings generally lower than they were in the 1980s.

Terns and gulls on Isla Rasa feed on anchovy, young mackerel, and other small fish when sardines are scarce. In a 2004 paper in *Ecological Applications*, Velarde and her colleagues demonstrated that the proportion of sardines in the diet of breeding elegant terns (*Sterna elegans*) is a very accurate predictor of the success of the sardine fishery, which starts in September, only two months after young terns fledge. The SOI is also a good predictor, but Rasa's terns provide information that is fine-tuned to the sardines of the Sea of Cortez in a way no traditional fishery management model can be. In years when the terns eat few sardines, the fishing fleet doesn't bring in many either, and much of the fleet's effort is wasted. Velarde and Ezcurra believe that limiting or temporarily closing the sardine fishery on the basis of the terns' diet, as well as fluctuations in the SOI, can be a key to keeping the ecosystem and the local economy healthy.

Both Mexico's federal fisheries agency and owners of sardine boats have recently begun to show interest in this technique. The fleet hopes to gain certification as a sustainable fishery, and the seabird model may be one of the best ways they can regulate their take to avoid harvesting more than the sardine population can bear.

Hundreds of thousands of birds—more than 95 percent of the world's population of elegant terns and Heermann's gulls—nest on Isla Rasa every year, returning to harvest the crop of sardine and anchovy that thrives around the island. In years when the terns eat few sardines, the fishing fleet doesn't bring in many either, and much of the fleet's effort is wasted. Photograph: Fulvio Eccardi.

Retracing the *Western Flyer*'s path

Several fisheries in the Sea of Cortez have died out since 1940. A prime example is the totoaba, a fish endemic to the northern part of the sea, which was once a common source of subsistence for people living along the coast. Totoaba typically grew three to four feet long, a single fish providing up to 300 pounds of meat. Steinbeck described times when the *Western Flyer* encountered locals paddling homeward, with a giant fish covering the entire floor of a canoe. In the 1960s, the once-common totoaba vanished, overfished and killed off as bycatch in shrimpers' dredge and trawl nets. It is now an endangered species, rarely seen in the wild.

Off the coast of Sonora, Ricketts and Steinbeck visited a ship that used dredges to pull up every living thing from the sea floor, from sponges to hammerhead sharks. The crew gathered a few pounds of shrimp from this mass of creatures, then threw the rest overboard as dead waste—a process they repeated over and over again. Both men were appalled by what the shrimpers were doing. Steinbeck described them as good men caught in a large destructive machine. Both he and Ricketts averred that dredge fishing could wipe out local shrimp, as well as other species. "And it is not true," Steinbeck wrote, "that a species thus attacked comes back. The disturbed balance often gives a new species ascendancy and destroys forever the old relationship."

"Our own interest lay in relationships of animal to animal," Steinbeck also wrote in *The Log from the Sea of Cortez*. "If one observes in this relational sense, it seems apparent that species are only commas in a sentence, that each species is at once the point and the base of a pyramid, that all life is relational to the point where an Einsteinian relativity seems to emerge.... It is advisable to look from the tide pool to the stars and then back to the tide pool again."

Ezcurra tries to teach his students to see this quote as more than metaphor. "Steinbeck was saying that we need to see the complex interconnections in nature," he says. "Studies of the local impacts of large-scale changes like global warming, El Niño events, and widespread coastal pollution are now leading more people to think in the way Ricketts and Steinbeck did. What seemed like metaphysics in their time is becoming more a part of practical, applied science."

In 2004, William Gilly, a marine biologist based at Stanford University's Hopkins Marine Station, a short walk from the site of Ricketts's old laboratory in Monterey, organized an expedition that would retrace the path of the *Western Flyer*. The scientific justification for the trip was to sample crabs, urchins, sea stars, and other creatures in the same places the *Western Flyer*'s crew had visited in 1940, to begin to evaluate the ways in which the intertidal ecology had altered. But Gilly and the scientists who joined

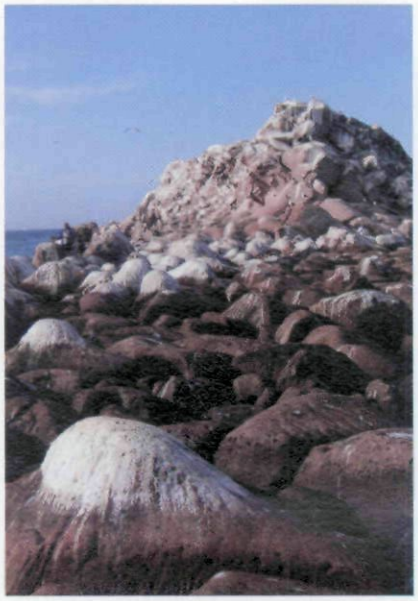
him on the journey had a more visceral reason to make the trip: a search for the joyful spirit of exploration that Ricketts and Steinbeck brought to the Sea of Cortez.

Gilly's group found dramatic changes at some sampling points. At Cabo San Lucas, for instance, Steinbeck had described the rocky intertidal zone as "ferocious with life," teeming with a variety of creatures, including three different kinds of sea stars. The town in 1940 was a remote outpost with a single dreary cantina; the arrival of the *Western Flyer*'s crew, who bought rounds of beer for all the locals, was a noteworthy event.

Now the town is packed with hotels, bars, and tourist amenities of every kind, and the water offshore is crisscrossed by party boats, jet skis, and glass-bottomed taxis. But the rocky shore has been smothered in sand, probably the result of dredging the harbor to accommodate yachts and cruise ships. Gilly found few intertidal animals, far fewer species than Ricketts had recorded, and not a single sea star.

As Gilly and his crew traveled the shores of the Sea of Cortez, following the path mapped out by Steinbeck and Ricketts, they found a repeating pattern. Intertidal sites of great abundance and diversity were almost always in places far from hubs of human population. Areas that had been built up since the 1940s had lost their tide pool communities in the process.

But the great revelation of the trip came when they stopped following in the *Western Flyer*'s wake and took off to explore the San Pedro Martir basin, in deep water north of Guaymas, Sonora. Michael Beman, a Stanford graduate student, had e-mailed Gilly satellite images showing an intense tidal upwelling event centered near Isla San Pedro Martir. Upwellings like this create transient high-productivity zones. "Such places are ephemeral," says Gilly, "and you will not find them on any map. But they are where all the life is—plankton, fish, squid, and whales. The entire food chain driving a regional ecosystem can be witnessed from a boat, simply by drifting."



William Gilly's 2004 expedition found a rich diversity of species at the edges of Isla Cayo, a lonely, guano-covered pile of rocks north of La Paz. Lobsters were particularly abundant. Ricketts and Steinbeck visited the same site in 1940 and described it as bleak, with few intertidal animals. "Perhaps the intertidal actually has improved since 1940," Gilly speculates, "but it's more likely that Ricketts and Steinbeck were badly hungover after Easter weekend in La Paz and just didn't feel like crawling around in the blazing sun that day." Photograph: Susan Shillinglaw.

Of squid and men

Gilly and his crew found the access to Isla San Pedro Martir guarded by a group of sperm whales, whose favorite prey is the jumbo or Humboldt squid, *Dosidicus gigas*, a beast that can grow up to seven feet long. Ricketts and Steinbeck made no mention of either sperm whales or jumbo squid in *The Log*, and it's likely that the big invertebrates were rare back in the 1940s. But they've recently invaded waters far north of their usual range in great numbers, reaching first Mexico, then Monterey Bay and the coasts of Oregon, Washington, Canada, and Alaska. The squid have become the focus of a major fishery in the Sea of Cortez. During the 1990s, squid landings there shot up from 6200 to 140,000 tons.

Drifting for three days and nights in thick fog, Gilly witnessed every part of the squid's life cycle. He watched a male and female in a mating embrace, collected tiny newly hatched squid among the plankton, caught small juvenile squid in a dip net, and saw adults hunting in a group. At night, small fish swarmed under a light hung off the boat, feasting on plankton. Squid gathered at the edge of the circle of light and every few minutes rushed the swarm of fish all at once, each grabbing a victim or two. The squid have the ability to change color, from white to a dark maroon shade that camouflages them in deep water. "While they were hunting," remembers Gilly, "they'd be setting off a kind of fireworks display by switching their colors. It was like looking at a stadium when people are taking flash pictures, and you see lots of scattered pops of light." For Gilly, these new discoveries of the ways of the squid, more than any other part of the journey, conjured the spirit of Ricketts and Steinbeck.

Many biologists have assumed that Humboldt squid are expanding into niches left vacant by the overharvest of large predatory fish like tuna and marlin. Gilly believes that is only part of the story. In studies at sea and in the laboratory, he's shown that Humboldt squid can spend long periods of time in waters that are almost devoid of oxygen, happily feeding in an environment that would kill most large fish.

Large swaths of the eastern Pacific contain midwater hypoxic zones at depths varying from 200 to 600 meters or more. These zones are created by the microbial metabolism of organic material sinking down from areas of high surface productivity. Unlike pollution-induced "dead zones" of low oxygen in some parts of the world's oceans, the midwater hypoxic zone of the eastern Pacific is a vital part of a rich ecosystem.

Squid are muscular creatures with high respiration rates, so Gilly's initial discovery that Humboldt squid hunt in hypoxic waters came as a surprise. But Una Markaida, one of Gilly's Mexican collaborators, has shown that in the Sea of Cortez, the squid's prime prey are small lanternfish that make daily migrations

The tiny squid in the box were caught by dip net off the coast of Santa Rosalia; the larger specimen, an adolescent, was caught with a jig. All have been identified on the basis of genetic techniques as Humboldt squid, Dosidicus gigas. *Ricketts and Steinbeck never mentioned sighting Humboldt squid during their 1940 expedition. "It seems that all life stages of the squid are now prominent over a wide region of the central Sea of Cortez," says William Gilly. Photograph: Clayton Gilly. Field research supported by National Science Foundation, Packard Foundation, and Tagging of Pacific Pelagics.*

to the deep-water hypoxic zone. The squid follow the same pattern. In the lab, the squid are capable of lowering their aerobic metabolic rates to cope with very low levels of oxygen, by means that remain unknown. "The squid's ability to hunt in an area where there's very little oxygen gives it a great advantage over large pelagic fish," says Gilly. "They've got a vast swath of the ocean to themselves as top predator, except for the marine mammals that are chasing them."

Shifting ocean currents and patterns of upwelling can change the shape of the hypoxic zone over time. Gilly believes that the distribution of Humboldt squid follows those shifts, exploiting access to low-oxygen environments whenever they become available. This may explain the recent invasion of the squid into the north Pacific, which seems to have begun during an El Niño event in the late 1990s. In 1998, researchers using an unmanned deep-water submarine glimpsed big squid in Monterey Bay for the first time in decades. It wasn't until 2005, when the giant mollusks started washing up in great numbers on shores from southern California to Alaska, that scientists realized how far their range had expanded.

The squid had not visited Monterey in force since Ed Ricketts walked the shoreline. In the mid-1930s, Monterey Bay's booming rock cod fishery was suddenly plagued by an attack of these foreign sea monsters, which devoured fish before the lines could be reeled in. Commercial fisherman asked the state to place a bounty on the squid, which they considered a pestilence. Ricketts bought some specimens from a sardine purse seiner whose nets had come in cluttered with squid. There is a 1935 photograph of him standing in front of his lab, wearing a look of awe while he holds a squid whose body was nearly as long as his own.

In terms of relative numbers of jumbo squid and big, predatory fish like yellowfin tuna, today's Sea of Cortez is the opposite of the sea that Steinbeck and Ricketts visited. In 1940, there were abundant tuna and few squid. Now tuna are scarce and squid are booming. Something has changed to make these waters welcoming to squid, especially in the Guaymas Basin, which is now the focus of Mexico's squid fishery. Gilly believes the change may be caused by humans, at least in part.

In March 2005, Michael Beman and his colleagues at Stanford published a report in *Nature* showing that artificial nitrogen fertilizer runoff from wheat fields in Sonora's Yaqui Valley, which drains into the Sea of Cortez, was creating massive algal blooms offshore. Beman tracked the blooms using satellite imagery. The wheat fields are heavily irrigated about four times each year, he explains, and each time heavy loads of nitrogen are washed into the sea. Then a phytoplankton bloom appears within a matter of days. These explosions of algal growth, which cover up to 577 square kilometers of sea, can lead to hypoxic conditions in the waters below.

"The area affected by the fertilizers is where the squid fishing is," says Gilly. "When *Dosidicus* find these productive zones with low oxygen associated, they invade like ants at a picnic table. It's possible that artificial fertilizers have altered the ecological balance of the entire Guaymas basin over the last 50 years."

Shifting tides

None of this would have shocked Ed Ricketts, but all of it would have fascinated him. He was philosophical about the human tendency to warp the world of nature. In 1948, as Monterey's sardine population and the industry that depended on it collapsed, Ricketts wrote a

Visit *www.seaofcortez.org* for more information, or read

- *The Log from the Sea of Cortez* and *Cannery Row*, by John Steinbeck
- *Breaking Through: Essays, Journals, and Travelogues of Edward F. Ricketts*, edited by Katharine Rodger
- *Renaissance Man of Cannery Row: The Life and Letters of Edward F. Ricketts*, edited by Katharine Rodger

piece for the *Monterey Peninsula Herald* explaining what he knew about the causes of the disaster.

He pointed out that sardine landings had been in decline since 1937, while the fishing fleet had continued to grow. The industry had dug its own grave, and he grieved for long-time friends and neighbors who were now out of work. But he did not fear for the sardine. "Probably we couldn't exterminate the sardine even if we tried," he wrote. People had driven the dodo, the Carolina parakeet, and the passenger pigeon to extinction, "but all we can hope to do with the sea-going forms as the whale and the sardine is to reduce their numbers to the point of commercial extinction, so as to make the industries unprofitable. By continuing to take undersized specimens and by concentrating our fishing in the areas where the animals gather to spawn in southern California, we can come pretty close to accomplishing this objective."

Ricketts also understood that shifting ocean temperatures and levels of plankton growth affected the number and distribution of sardines, but in his time no one had recognized or named El Niño or discovered the now well-established evidence that sardine numbers in the Pacific fluctuate in a predictable 50- to 60-year cycle, driven by shifting ocean currents.

He was poring over sardine statistics on the evening of 7 May 1948 when he decided to take a dinner break, drove off in his dilapidated car, and was hit by a freight train coming around a blind curve. He lingered for two days in the hospital while a legion of his Monterey friends stood vigil. "Ed hung on so long," Steinbeck later wrote, "that some people from the waiting room dared to go home to get some sleep. And then, as happens so often with men of large vitality, the energy and the color and the pulse and the breathing went away silently and quickly, and he died." A few months later, the last of the sardine packing plants closed down, and the Cannery Row Ricketts had known ceased to exist. Today the former cannery buildings are crowded with tourist shops, including a Steinbeck Wax Museum with tableaux of Doc.

William Gilly uses pop-up satellite archival transmitting tags to study the movements of Humboldt squid. The device samples temperature, depth, and light level and transmits the data to a satellite. Using this technique, Gilly has shown that squid migrate to deep-water hypoxic zones in the Sea of Cortez, following the daily movements of lanternfish, their primary prey. The ability to hunt in oxygen-deprived waters gives squid a big advantage over most large predatory fish. Photograph: William Gilly.

More than a half-century after Ricketts's death, sardines have at last returned to the northeastern Pacific. "The Monterey fishery was built on some good year classes that came in the early 1930s, when sea surface temperatures were warm enough for sardines to reach high productivity zones off of California, Oregon, and Washington," explains Richard Parrish, a fisheries biologist who helped build the model that is now used to manage the reborn sardine industry. The model sets harvest quotas based on estimates of existing sardine biomass and on sea surface temperatures known to affect sardine reproduction and survival. It's an updated version of a concept advocated by Ricketts and by California Department of Fish and Game biologists in the 1930s, which was never implemented before the sardine crash.

The little fish are back, but when they returned this time, says Parrish, they congregated off the coasts of Oregon, Washington, and southern California. For reasons that remain mysterious, there are still few sardines off Monterey's coast.

Sharon Levy (e-mail: levyscan@sbcglobal.net) is a freelance writer based in Arcata, California. On a recent visit to Monterey, she rediscovered Ed "Doc" Ricketts as a real person whose life stretched far beyond the limits of Steinbeck's fictionalized hero.

doi:10.1641/B570103
Include this information when citing this material.