



Photograph by Flickr user Stonebird.

RAFE SAGARIN

On Observation

Notes from a field course on the California coast

In *The Log From the Sea of Cortez*, John Steinbeck and Ed Ricketts wrote, “We determined to go doubly open so that in the end we could, if we wished, describe the sierra thus: ‘D.XVII-15-IX; A.II-15-IX,’ but also we could see the fish alive and swimming, feel it plunge against the lines, drag it threshing over the rail, and even finally eat it. And there is no reason why either approach should be inaccurate.”

A few years ago in the fall, I led a coastal field course from Los Angeles to San Francisco with thirteen undergraduates and graduate students from Duke University. Like John Steinbeck and Ed Ricketts in preparing for their expedition to the Gulf of California, I wanted us to go “doubly open,” knowing that this approach entails a whole spectrum of observation between the coldly scientific and the deeply experiential poles that Steinbeck and Ricketts staked out for their expansive interpretation of field

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One student became known as “The Octopus Whisperer” for her uncanny ability to spot secretive octopuses wherever they roamed.

science. I wanted my students to see California with reverence and awe, while not ignoring its flaws and internal contradictions. I wanted us to get immersed in its cold Pacific waters, to cover our hands in octopus ink and the slime of stranded drift mats of giant kelp. I also wanted to walk in its cement rivers and inhale the stink of its refineries. I wanted us to savor its delicious doughnuts, uncover the secrets of its wines, and gorge ourselves on enormous burritos. I wanted to share it all with the eclectic mix of artists and activists, scientists and stewards who make California their home.

Coastal California presents many possibilities for observation. Because the lessons we learned on our last day in San Francisco might also apply to our first day on Catalina island, and the cement-lined LA River is an excellent lens with which to understand a redwood studded creek near Santa Cruz, I want to break the constraints of time and space here and try—as biologist Ricketts and Steinbeck did throughout their fruitful collaborative years—to recount this story of our journey as a holistic, ecological account of what we saw and what we did. What follows, then, is not a linear diary of our trip, but observations that I hope might coalesce in the reader’s mind to define the whole of what it means to travel the California coast with eyes wide open to all its possibilities.

Observation is not just the task of looking at stuff. It is also the concept and process that paleobiologist Geerat Vermeij calls “the role of sensation—of observation with the brain in gear,” and it has been a little irritant in the mantle of my mind since I first started serious scientific observation of the California coast a few decades ago. I’ve come to see science as a shifting, evolving thing. It doesn’t really shift around the astounding new discoveries that make headlines, as we often are led to believe. Instead, like all evolutions, it shifts holistically in system-wide modifications of simple, ancient processes. Those simple and ancient processes are driven by observation—how we observe and how we use the products of our observation—and observation

has become more powerful than at any previous point in scientific history.

Observation, hyper-accelerated by new technologies and hyper-expanded by greater openness to nonprofessional, noninstitutional, and even nonhuman observers, is the catalyst of the latest evolutionary shift in science. Observation is no longer just the first step in the well-codified, and too often mythologized, “scientific method” that we were all taught in high school, but the driving force in a recursive process of understanding our rapidly changing world at the smallest and largest scales imaginable. In this recent evolution of science—where we have bigger questions to answer and vastly bigger observational data sets to contend with—correlation *can* indicate causation, experiments and controls may be neither necessary nor possible, and mere fishing expeditions can and often do yield profound catches.

For my generation and those before me, this kind of talk is still dangerous, even as my colleagues begrudgingly begin to admit that all science can’t be controlled and all scientists don’t have letters after their names. But I wonder about the generation following me. My students grew up hearing about “the” scientific method, too, but the most exciting and troubling stories of their time—whole sequenced genomes and planetary-wide disturbances such as climate change—have been based on observations, not experiments or theory.

A field course is a good way to observe how students observe. On a field course, passive listening and lab exercises and reading and writing give way to observation. And field courses, obviously more so than lecture halls, reveal the individual behind the observations. We all observe in different ways, based on our personal skills and past experiences. Good birders observe with their ears. The first thing I observe when I came to the California coast is the smell. It’s a mix of kelpy iodine and guano and salt spray and the oily compounds of chaparral. Geerat Vermeij, who is one of the most skilled naturalists I know, has been blind since childhood, so he observes with his fingers.



Photograph by NOAA Fisheries West Coast.

Vermeij once said that observing is the most important skill a scientist can have, and he argued that it must be taught and honed. The students on my trip with the best eyes or noses or ears or fingers were not necessarily those who had spent much, if any, time in California, but the ones who had spent the most time observing nature. The ones who walked muddy creeks with a fishing pole throughout their childhood, or trapped and domesticated raccoons, or spent every summer on their grandfather's farm. One student became known as "The Octopus Whisperer" for her uncanny ability to spot secretive octopuses wherever they roamed. It suggested to me that "search images"—which we are told on countless nature programs are how predators identify prey—are not necessarily specific images at all, but rather a way of observationally parsing patterns and relationships in the environment that transcends a particular place.

Freshwater

I can't think of an observation of California life that isn't profoundly shaped, distorted, and clarified through the lens of water. Its presence and absence are felt everywhere. This was well illustrated during a hot hike into the inauspiciously named Garapata ("The Tick") at the north end of the Big Sur coast. I had promised redwoods, but all we saw for a mile or so were forbidding hillsides of prickly pear and poison oak and a scattering of tough wildflowers—Indian paintbrush, lupine, and, my favorite, sticky monkey flower—baking in the sun. Finally, though, we reached the spot where the steep hills of Garapata trap the coastal fog, and the hard dusty trail falls into a shady oasis of ferns and towering redwoods.

In Los Angeles, even a tiny gap in the cement channel of the LA River bursts forth with life, forming an unexpected



Photograph by Flickr user Pinkishkaty.

urban oasis in the middle of miles of freeways and strip malls. As Joe Linton—artist, planner, dreamer, and lover of the LA River—explained to us, LA was transformed from a city born out of its river, to a city in fear of its river, to a city that forgot it even had a river. As a result, a place that is chronically short of water has created the most efficient system for ensuring that rainwater rushes right through the heart of the city and out into the ocean as fast as possible. Except for direct rainfall, barely a drop quenches dry gardens, feeds kayak streams, supports fish, or recharges aquifers. But a new transformation is taking place. Angelenos are reacquainting themselves with the river through bike paths and pocket parks that were once uninviting dead ends and vacant lots. The more adventurous take tours like the one we took, straight into the confluence of the LA River and the Arroyo Seco.

LA became a city of such great size and diversity only by taming its unpredictable river, and now the diverse energy of a great city is engaged in trying to bring the river back to LA. There are scientists and politicians, landscape architects and artists, movie stars and former gangsters all working on the problem of bringing a waterway cast in cement and surrounded by development back from near dead.

Meanwhile, every time it rains the cemented rivers of LA deliver thousands of tons of trash, bacteria, and virus-laced water out to the coast. We visited one such river, Ballona Creek, as it empties into Santa Monica Bay. For its last quarter mile or so the cement Ballona Creek is hopefully called “Ballona Estuary,” but its only resemblance to a real estuary is the tidal influence that gives it brackish water. Off to the side of the channelized “estuary” are the Ballona Wetlands, once a vast waterfowl playground for wealthy hunters,

now a 600-acre patch of vegetation, mud flats, and stalled developments that were recently purchased by the state. It is scattered with beautiful native plants and over 200 bird species including the endangered Belding's savannah sparrow.

Hundreds of miles up the coast and a universe away, a small network of streams in a redwood forest is facing its own water problems. Led by watershed activist Mat Rowley, we went out with a handful of dedicated local citizens, state, federal, and university employees who are working to protect one small watershed and the Coho salmon and cut-throat trout that are barely holding on to their stronghold here. Historical photos from the early twentieth century reveal entire basins here stripped of all redwoods, barren hillsides looking ready to slide at any moment. Luckily, the combination of California heat and coastal fog make ideal conditions for growing the giant trees, and they grow fast, prompting local agricultural scientists to imagine a future sustainable redwood forest industry.

Fish have a much shorter life span than redwoods, and their recovery is much less assured. It is a difficult life, being an anadromous fish, and all the stars must align, even if you are raised, as many are, in the coddled safety of a hatchery. Again, water is the key. There must be adequate water flow to scour creek banks and enough depth to provide deep holes for the fish. When they get to the ocean, those waters must be enriched by upwelling from deep, cold waters carrying enough nutrients to feed the trophic network atop which these predators swim. And when the same fish get back from long ocean migrations to spawn a year or two or three later, there must also be enough water that year to break open the sand berms that form at the beach end of many California streams. Unfortunately, these tiny salmon streams have three thick straws constantly drawing away their water to quench the thirst of some of the most expensive real estate market in the country, the semiconductors and servers of Silicon Valley, and the remnant agriculture that drew farmers to California in search of paradise.

Mat asserted that the ideal political unit is a watershed, and this certainly seems like a logical and more organic way to organize people. It even seems remotely feasible in a place like Santa Cruz. But what about in our massively altered watersheds? What about in Los Angeles? I once saw a tongue-in-cheek "Watershed Map" of LA. It contained nearly the entire state of California as well as much of the

intermountain west, because these are the places LA sucks water from to sustain itself. The original topographic watershed of LA could never support LA as it is, and if whitewater kayakers in Colorado and farmers in California's central valley and Mexican fishermen in the northern Gulf of California had an equal say on some supreme LA Watershed Council, it's doubtful they'd continue to watch helplessly while their water trickled away from them in open air canals, headed for Hollywood.

Saltwater

If California gets any significant new source of freshwater, it will most likely have to come from the sea, but no one has figured out yet how to overcome the huge amount of energy needed to turn ocean water into drinking water through large-scale desalination. For now the salty waters of California have their own unique role in supporting what is likely the most productive ecosystem on Earth—the coastal kelp forest.

On a glorious afternoon we sat on the deck of a long-immobile trailer at the University of California's Rancho Marino Research Reserve. We gazed out at a kelp forest stretching up and down a wild stretch of the coast. Don Canestro, the reserve manager and a true California waterman brought us down to tide pools "ferocious with life," in the words of Steinbeck and Ricketts. Don serenaded us with a tune trumpeted through the massive hollow stipe of bull kelp. Here, in addition to five different types of starfish (the delicate little, blood red *Henricia*, the homely and hermetic six-armed *Leptasterias*, the diversely colored bat star *Patiria*, the hard spiny *Pisaster*, and the ridiculously over-armed *Pycnopodia*), anemones, millions of black turban snails, a few remnants of old California, including abalone, still hung on, as well as more unusual creatures, such as the massive gumboot chiton, the oddly named sea mouse (really a polychaete worm), several types of brightly colored sea slugs, and the diabolically clever octopus. Offshore, otter dipped through the kelp and sea lions brayed from a distant islet.

A few days earlier on Catalina Island, we broke free of the thin intertidal zone, slipping out to sea on borrowed kayaks. We could look down twenty feet into the kelp forest past sparkling jeweled top snails, and look up to cactus-covered cliffs stretched and folded in the most improbable geologic

Abundant Garibaldi, the state fish of California, floated like orange lanterns among the kelp fronds.

contortions. Some of those contortions made grottoes in the cliffs, with the light reflecting in twisting, shimmering bands on the roof.

Later that day, we snorkeled through cobble fields and rich kelp forests. It was a stunning wilderness, just twenty miles from the urban expanse of Los Angeles. Abundant Garibaldi, the state fish of California, floated like orange lanterns among the kelp fronds. We did not see many starfish urchins and rockfish, however. These extremely long-lived fish have been virtually wiped out from many of the more accessible reefs in California. Because of their long lives (several live well over 100 years), late maturation, and low reproductive rates, it will take a long time for this diverse group of fish to recover. It raised an important question, of both scientific and personal value: “Do I focus my observations on what’s there, or what isn’t there?”

On a scientific level, dealing with negative observations is problematic. Maybe we happened to snorkel on a day the rockfish were mating on the other side of the island. The best way to sharpen the outline of that negative space is to get more basic observations—dive around the island, dive throughout the year, learn when and where the fish mate, set up well-enforced reserves, and see if the fish come back. On a personal level, it can be disheartening to always observe the negative space. It takes some of the unbridled joy out of floating in a kelp forest or hiking up a canyon. However, it does give a sense of direction for a conservation pathway, which always starts with that missing element or altered state, winds its way through trophic webs, habitats, climate, and history all the way back down to one important driver of change: people.

People

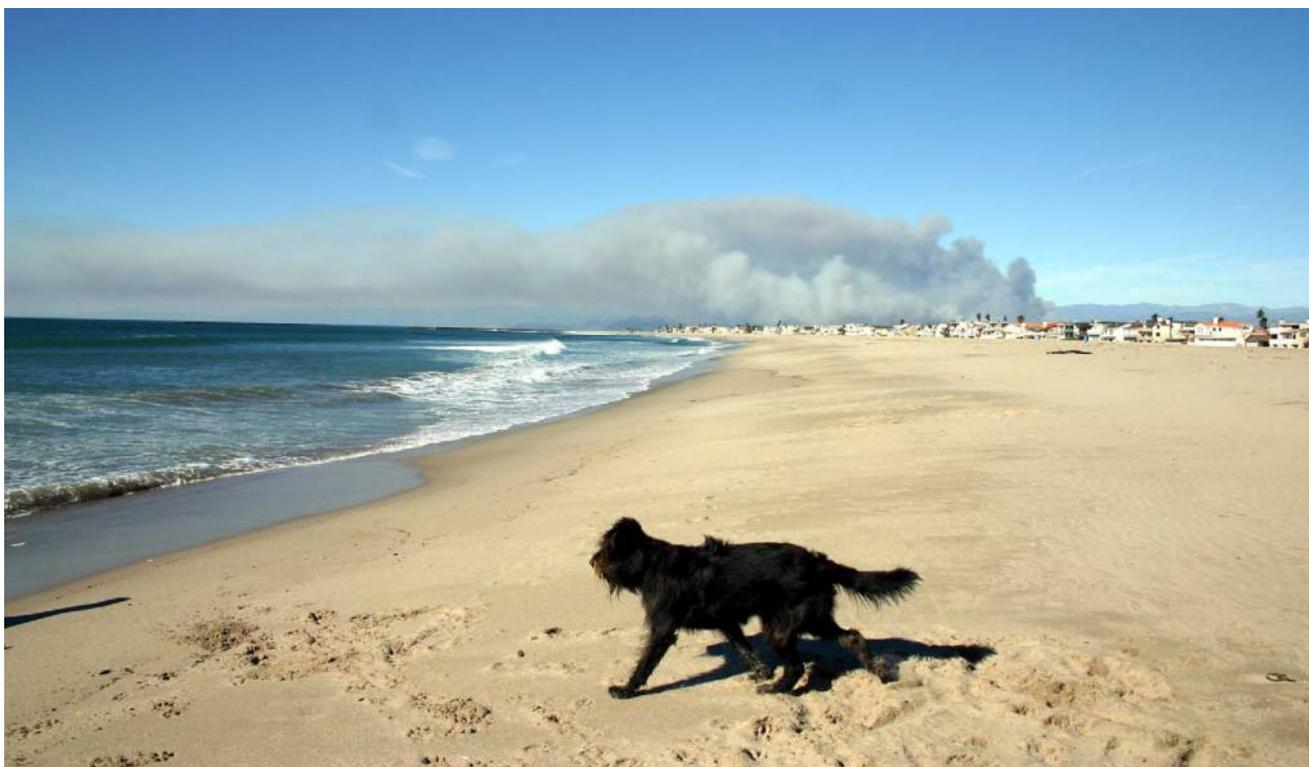
Ecologists such as myself, who were once content studying gorgeous ecological systems in the semi-pristine comfort of scientific reserves, are increasingly recognizing the obvious: all ecological systems are profoundly influenced by human beings who are themselves shaped by complex economic and social behaviors. California is a fabulous living laboratory for

these “social-ecological systems.” In a state of thirty-six million people, it is pretty hard to separate nature from humans. That separation becomes even more difficult when you consider California’s role as the sixth largest economy in the world as well as its location as a gateway to the entire Pacific.

Nowhere is this interaction more clear than in the ports of LA and Long Beach—the largest shipping port in the United States. Here much of the world’s goods (and, I might argue, crap) are offloaded day and night. The ships idle, burning dirty marine diesel, while cranes pile huge metal containers into tall stacks that build up into ephemeral cities that are taken down as those containers are loaded onto flatbed trucks and long freight trains, which carry the shipments to warehouses and distribution centers where other trucks come to take the goods to Walmarts, Best Buys, and Home Depots near you.

All that movement has an environmental price, which is often concentrated in places where people can barely afford to pay it. Wilmington is a kind of nontown bordering the ports and politically forgotten in the vastness of the mega city of LA to which it belongs. When the ports announced plans to build a wall through the neighborhood to mitigate the local effects of traffic and pollution from all this global trade, Jesse Marquez, a Wilmington resident spoke out. With no college degree, no research training, and no money, Jesse educated himself about pollutants from the diesel ships, cranes, and trucks. He learned to read an environmental impact statement and to demand public hearings. He discovered alternatives, such as electrified ports, that at least don’t concentrate all the pollution in one area. Jesse has no staff and no political power, but he and his collaborators have not only brought several port and refinery projects to a halt, they’ve changed the way all future port projects in LA—and perhaps throughout the world—are likely to be constructed in the years to come.

With so much intense interaction between people and ecosystems, even the shadow of people long gone leaves a lasting impression. A remnant of William Randolph Hearst’s excesses, in the form of a zebra herd, grazed casually on the coastal below Hearst Castle when we visited.



Photograph by Melissa Weise.

Hearst's estate is slowly returning to the public domain, which offers wonderful opportunities to restore lands and riparian areas degraded by grazing (I don't yet know what the plan for zebras is), bring back native plants and pollinators, and provide more public access.

However, the easily exploitable intertidal zones—once protected by gated roads—can often be unintended casualties of this movement. Researchers estimated that one of the last healthy red abalone populations live on a northern California ranch that returned to the public after over 150 years of private ownership. The population lost about twenty years of reproductive potential in the first year of public access, as abalone hunters, with the blessing of the Department of Fish and Wildlife, eagerly plundered a long inaccessible spot.

As we moved up the Big Sur coast, I saw another shadow of human interaction, the invasive pampas grass, which is outcompeting native plants wherever it appears. This grass spread from long fingers running along fissures in steep rock walls to whole fields full in just a few years. Their huge inflorescences full of easily transported seeds are both their source of attraction to landscape gardeners and the reason

they spread so well, even to places like Big Sur, far from manicured California lawns.

How does an ecologist observe a landscape? Should I see the objectively beautiful pampas grass as blight on an otherwise gorgeous coast? The author Henry Miller, who retreated to Big Sur in the mid-twentieth century, asked of the region, "How long will it hold out against the invader?" Miller had people in mind, and there are still not many here, but should I expand his definition of invasion and concede defeat to the pampas grass?

Toward the end of our journey, I got to thinking about the long chains of observations, and scientific knowledge, and the links that are forged in individual relationships, directly between teachers and students, and remotely between strangers across the world and across time. On a wall at Hopkins Marine Station, the oldest marine lab on the west coast in Pacific Grove, California, is a copy of a hastily scrawled note written with a calligraphy brush that was found by a US submarine crew in the closing days of World War II, tacked to the door of a small island laboratory in Japan. It reads:

"This is a marine biological station with her history of over sixty years. If you are from the Eastern Coast some of

you might know Woods Hole or Mt. Desert or Tortagna. If you are from the West Coast you may know Pacific Grove or Puget Sound Biological Station. This place is a place like one of those. Take care of this place and protect the possibility for the continuation of our peaceful research. You can destroy the weapons and the war instruments, but save the civil equipments for Japanese students. When you are through with your job here notify to the University and let us come back to our scientific home.—The last one to go”

I have passed that note thousands of times during the many years I have studied at, worked at, and now visited Hopkins Marine Station. And every time I stop to read it, I’m overcome with emotion. I think of that biologist, alone, fleeing a clash between two enormous forces, putting all his faith in a still larger truth: that the virtue of discovery would be universally acknowledged. The faith of that scientist, Katsuma Dan, who went on to an internationally recognized career in marine ecology and developmental biology, was affirmed. The Misaki Marine Biology Station still stands today.

That chain of knowledge can be seen and felt in the new clean basement of the California Academy of Sciences in San Francisco, too. There we saw rows and rows of preserved specimens entrusted to the academy by naturalists and scientists hoping to pass something on—even the most simple “this lived here then”—to a future observer. The specimens are long dead. More than a century has passed since some were plucked from a tide pool or a forest stream. But there is power in them still. More than one student noted that touching a dry starfish that was placed in a jar years ago by Ed Ricketts and labeled in his own hand was one of the highlights of our journey.

Fire

Fire seems to bring out the best and the worst of people in California. As we motored up the Pacific Coast Highway, we passed dozens of boxy CAL FIRE trucks packed with men and women who, laden with gear, would soon be stomping up hot dry hillsides into probably the most terrifying of California natural disasters—wildfire. Wildfires can be just as unpredictable as earthquakes, and rather than being over in seconds, they linger and tease and strike over the course of many agonizingly fearful days. On the chaparral hillsides, wildfires are stoked in steep narrow canyons that concentrate the wind, spurring them into wicked fronts of destructive force.

It was like watching soldiers marching off to war. We slowed to a rubbernecking crawl when we saw the war zone unfold right in front of us on the north end of the Malibu coast. A huge air tanker swooped down low over a ridge and opened its bomb bay doors, dousing the hillside in red flame retardant. Just a few hundred yards offshore, helicopters scooped up water and circled over the burning canyon to drop a Pacific wave on the flames.

The ecological reality is that the Malibu coast, the canyons of Orange County, and the Hollywood hills will burn, fire suppression or no. It doesn’t take a buildup of understorey to turn these places into tinderboxes, because they are already set to burn. Even the smallest chaparral plants burn. All it takes is a long dry season, a careless match or lightning strike, and a fierce hot Santa Ana wind. The land will come back quickly, however. Within weeks, new plants—some whose seeds have been dormant for years and have been released to germinate by the heat—will grow. Within months, black barren hillsides will be covered in wildflowers. Maybe this is why so many Californians forget. How can such stunningly lush hills, so close to an endless expanse of water, destroy themselves so often?

But fire brought out the best moments of our trip, as well. On cold coastal nights after long drives and long days of activities, we had excellent fires. They raised our primordial subconscious memories, and we became a clan. On the last night of the trip, we gathered by the fire one more time and we shared our best moments with each other. Some were simple things unique to our small group, such as making pasta dinner in a windswept shack on a coastal bluff. Some were grand things that have been commonly felt with reverence and awe by millions of people across generations, such as a quiet sunset walk in Muir Woods. Some were very personal memories that we were grateful to be invited to share. Some moments took place in specific places, and when we heard of them we all remembered how that place looked and smelled and sounded. Afterward, we sat by the fire quietly and listened to the waves crashing on the rocks and watched the flickering embers rising to meet the flickering stars, and I thought how everyone’s favorite moment had become my favorite moment, too. So in that moment I was finally taken to that place that existed only on paper when we started the trip, a place mapped out in prose by Ed Ricketts and John Steinbeck on one of their own leisurely journeys of travel and research:



Photograph by Ed Bierman.

“And it is a strange thing that most of the feeling we call religious, most of the mystical outcry which is one of the most prized and used and desired reactions of our species, is really the understanding and the attempt to say that man is related to the whole thing, related inextricably to all reality, known and unknowable. This is a simple thing to say, but the profound feeling of it made a Jesus, a St. Augustine, a St. Francis, a Roger Bacon, a Charles

Darwin, and an Einstein. Each of them in his own tempo and with his own voice discovered and reaffirmed with astonishment the knowledge that all things are one thing and that one thing is all things—plankton, a shimmering phosphorescence on the sea and the spinning planets and an expanding universe, all bound together by the elastic string of time. It is advisable to look from the tide pool to the stars and then back to the tide pool again.” **B**