





**NATURAL HISTORY OF  
SAN FRANCISCO BAY**

# California Natural History Guides

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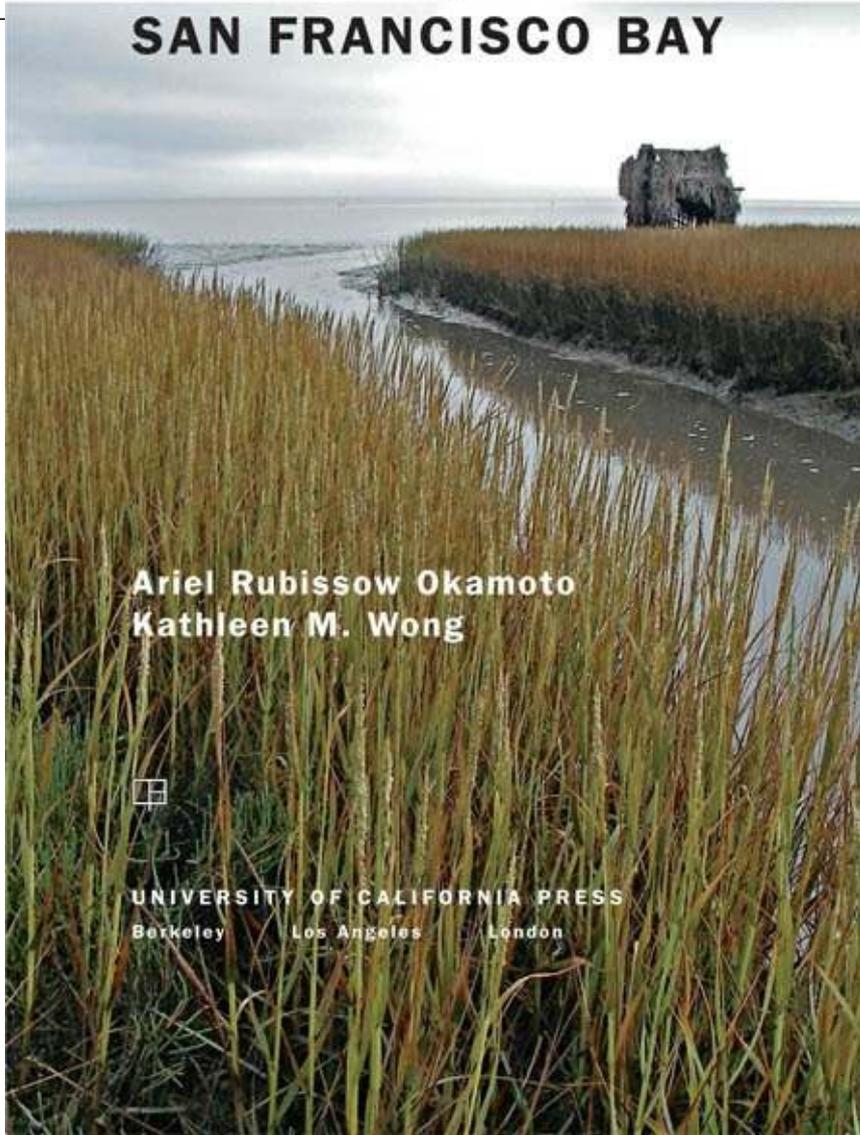
Phyllis M. Faber and Bruce M. Pavlik, General Editors

Natural History of  
**SAN FRANCISCO BAY**

Ariel Rubissow Okamoto  
Kathleen M. Wong



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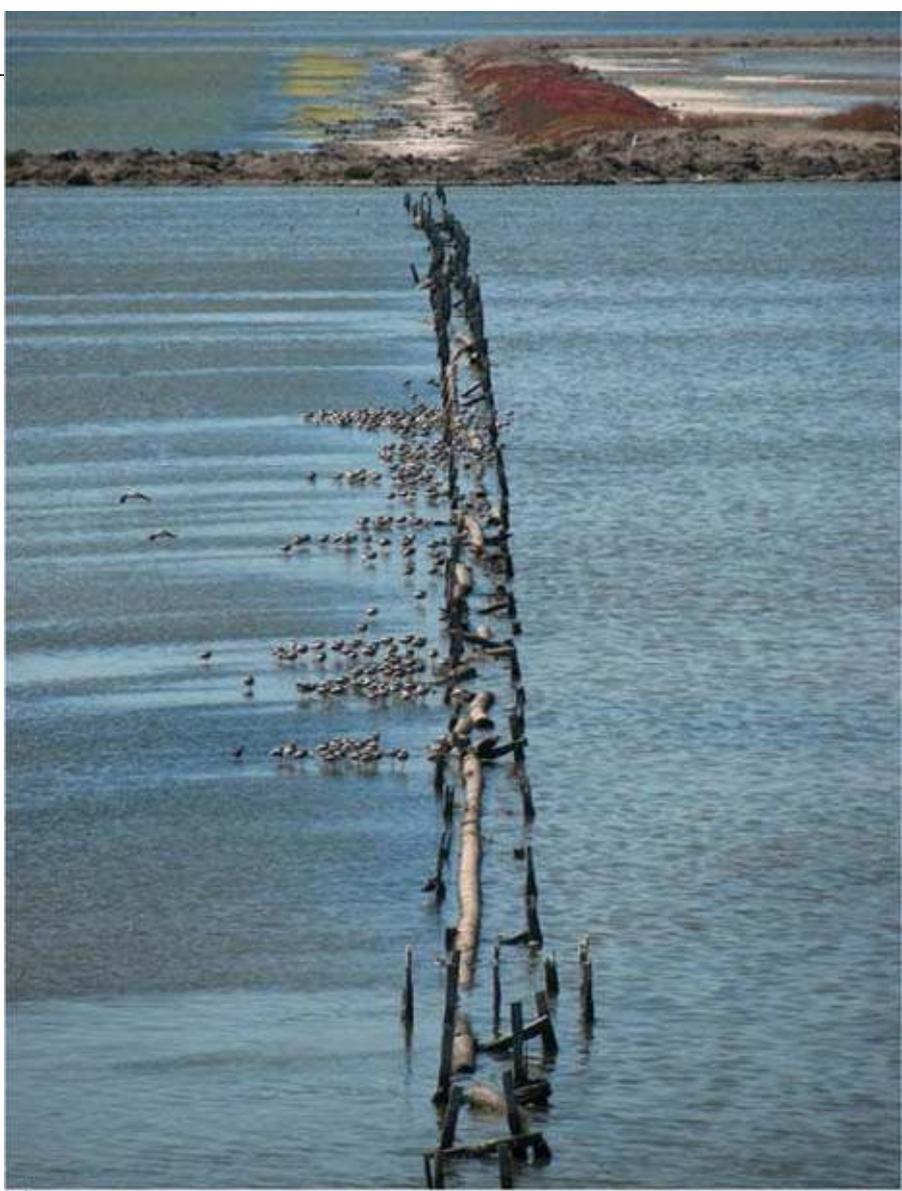
*Cover photographs:* large photo, author Ariel Okamoto and scientist Katharyn Boyer explore herring egg deposits on an eelgrass bed off Keller Beach in Richmond (John Karachewski); left photo, container ships (Port of Oakland); middle photo, pickleweed (Kathleen M. Wong); right photo, juvenile Black-crowned Night Heron (Edward M. Nguyen).

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# PROLOGUE

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This book is unusual among the California Natural History Guides. It explores not only the natural history of San Francisco Bay but also its human history and how each affects the other. It may be the first in the series to describe a place so urbanized and to focus on a body of water rather than a piece of land, though land and water here are inextricably linked in their destiny.

This guide may also be the first to have so many voices in it. As a journalist who has researched and reported on water issues for over 20 years, I have come to know dozens of scientists, agency staffers, activists, teachers, engineers, and businesspeople with a passion for the bay and its watershed. By including so many quotes and memories from diverse people, I hope I've captured here the intensity with which people view the bay and the amount of energy they pour into studying, understanding it, and caring for it.

Something else that may be different in this guide, in comparison to others, is the way in which I explore my own particular interest in science and scientists, and the extraordinary ways in which they test their theories in a medium—water, waves, tides, mud—that is relatively challenging for humans to work in. I am personally fascinated by the lengths to which humans will go to learn, and I marvel at the inventions they create to enable them to measure and track the subtle changes in the estuarine environment and all that lives in it.

As I observe our millennial battle for control of nature, I am encouraged that we humans continue to seek our proper place within it. I am heartened that we can not only build a dam but also take it down, as well as by the fact that we can spend hours counting weeds, sifting bay mud for tiny forms of life, following a plastic drifter downriver, or trying to mimic nature so that we can better balance our relationship with the ecosystem.

Perhaps the human race is destined to find the meaning of life on-screen, but I, for one, am all for getting hands dirty and feet wet.

Ariel Rubissow Okamoto

# ACKNOWLEDGMENTS

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## Ariel Rubissow Okamoto

In the two decades that I have been writing about the waters that run down from the Sierra into San Francisco Bay and the Pacific, three people in particular helped me find my voice as an environmental writer: Marcia Brockbank, Tim Ramirez, and Kim Taylor. As they worked to push the envelopes of estuarine science and ecosystem management—often within cumbersome bureaucracies steeped in convoluted water politics—they remained unfailingly inspiring and supportive of my work and my voice.

Thanks also to those who have consistently helped me to think big across disciplines and see the connections: Gary Bobker, Jim Cloern, Bruce Herbold, and Phil Williams. They were critical to my being able to pull together a book of such broad scope.

I also appreciate those who always return my calls and emails, and who have made the time to explain complicated science and politics to me throughout my water-writing life: Jon Burau, Jack Davis, Kathy Heib, Rainer Hoenicke, Jim Kuwabara, Wim Kimmerer, Sam Luoma, Peggy Olofson, Steve Ritchie, Dave Schoellhamer, Stuart Siegel, Tina Swanson, Jan Thompson, and Will Travis.

In addition, much of my work over the last few decades has involved writing documents conveying the work of government science to stakeholders and the interested public. I drew heavily in this book on my earlier work on the annual San Francisco Estuary Project *State of the Estuary* reports, the project's *ESTUARY* newsletter, and CALFED *Science Action* publications. I also found invaluable such bibles as Andy Cohen's *An Introduction to the San Francisco Estuary*, The Bay Institute's *From the Sierra to the Sea* report, the *Baylands Ecosystem Habitat Goals* report and *Species Profiles*, and the annual *Pulse of the Estuary* from the San Francisco Estuary Institute. To remind me how to tell a good bay story, I used Harold Gilliam's *San Francisco Bay*. And I will always be grateful to my professor, Annie Dillard, who told me I was no good, which made me work to prove her wrong.

Thanks also to my wonderful cowriter, Kathleen Wong, and the other writers who helped me complete the book: Cariad Hayes, Lisa Owens Viani, and Susan Zakin.

Particular thanks to everyone whom I interviewed for the book (see the References); to those who read the book back to front for me: Bruce Herbold, Rainer Hoenicke, Jim McGrath, and Peter Moyl; and to my editors, Phyllis Faber and Jenny Wapner, for engaging me in such a unique project. I also was enchanted by how the book communicated a whole new level of information about the bay via the wonderful photography donated by Max Eissler, Francis Parchaso, and Jude Stalker, among others.

Special thanks to the Bay Area Clean Water Agencies for providing critical gap funding for the book's production. BACWA is a joint powers agency whose members own and operate municipal sewer systems in the nine county San Francisco Bay Area. BACWA and its members are public agencies governed by elected officials and managed by professionals charged with and committed to protecting public health and the San Francisco Bay environment.

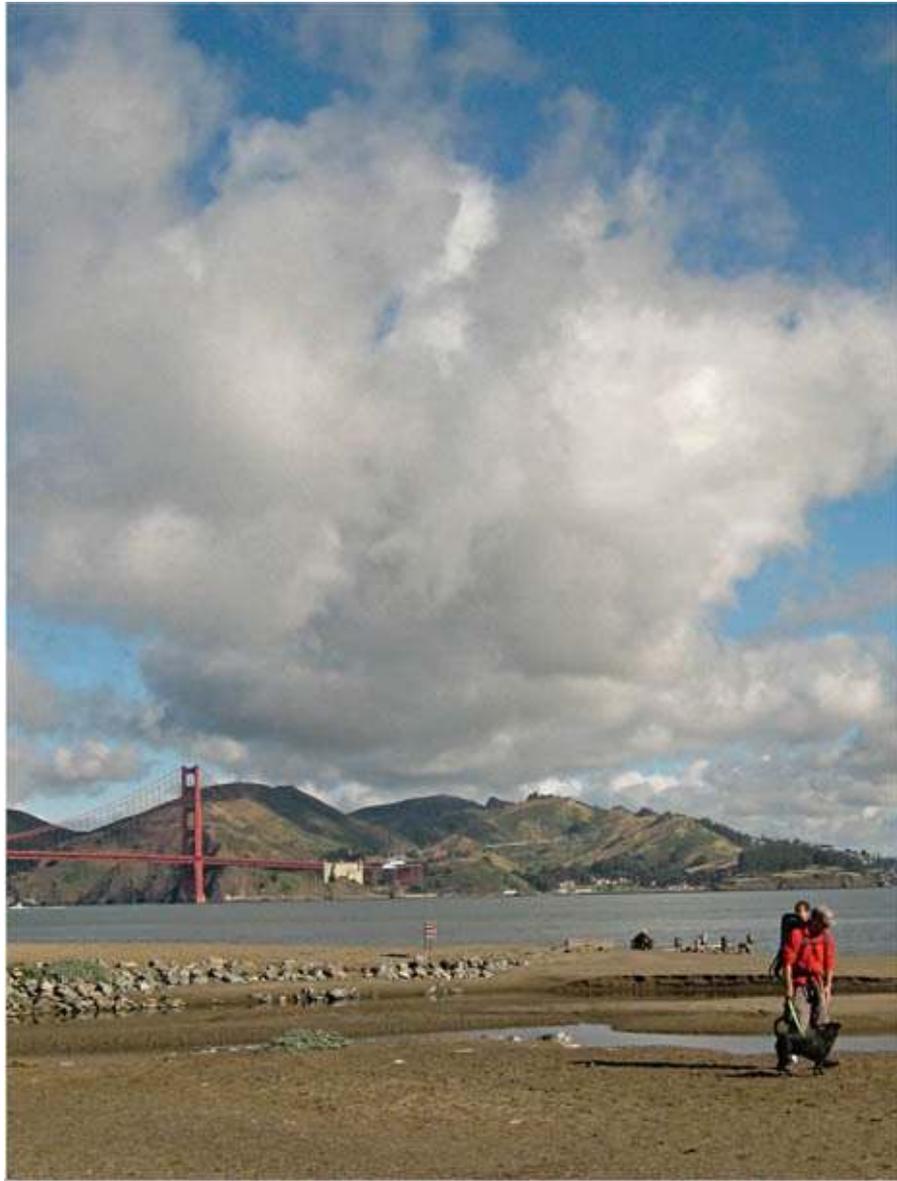
Last, I could not have written this book without the faith and love of my family—Paul, Tira, Mikko, and my mother, Joyce Carlyle. Thank you for sticking with me through my werewolf moments.

Kathleen M. Wong

First and foremost, I am indebted to my coauthor, Ariel Rubissow Okamoto, for making my long-standing dream to write a book come true. Her strong relationships with bay scientists and broad knowledge of California water issues have shaped my reporting and sparked a whole new appreciation for the wonders of the bay.

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The one I have leaned upon most during this journey, however, is my husband, Max Eissler. His enthusiasm for exploring strange corners of the bay and his zeal to capture better photos for the book never waned. I couldn't ask for a better companion in life or love.



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*One day when I was at the 1939 World's Fair I watched the sun going down from Treasure Island, reflected in all the windows in Berkeley and Oakland, a blaze of fire over there. The Bay Bridge was new at that time, and I looked up at this bridge in the sky, and the bay reflecting the sunset light, and I thought, "Wow, what a place, I've got to live here someday."*

HAROLD GILLIAM, JOURNALIST & WRITER

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**EMMA MACCHIARINI SWAM** before she walked. On the morning of July 12, 1989, she got up early, dressed in a sparkly swimsuit with a pink bow, smeared herself with Vaseline, and stepped into the bay. Swimming from Fort Point under the southern tower of the Golden Gate Bridge to Lime Point on the opposite shore, she aimed to cross a coastal opening where currents surge with all the force of an entire ocean on one side and the state's mightiest rivers on the other. She recalls thinking while in the water that they'd got the tides all wrong. The swim was much more work, and took much longer, than she'd imagined.

At one point during her swim, Emma feared she wasn't going to make it. But she kept lifting her arms and kicking her feet in the freezing grey water, accompanied by her father swimming beside her and her mother paddling a boogie board. At another point, a container ship cut across her path, and the two bar pilots shadowing her in a Zodiac signaled wildly to both the towering vessel and the slip of a girl to watch out. Eventually she was able to see the beach ahead, but never seemed to get there. Then she remembers her father saying, "Stand up, Emma," as she found her footing on the Marin County shore.

The headline in the *San Francisco Chronicle* the next day read: "Girl, 8, Conquers Gate." The black-and-white photo hid the green algae on her face. Macchiarini was one of the youngest people ever to swim the mile-wide channel under the red bridge. She got fan mail, and television coverage for her feat.

On that foggy day decades ago, Macchiarini swam across the deepest part of San Francisco Bay where the bottom lies 330 feet below sea level. But most of the bay, which encompasses 470 square miles of open water between the narrows of the Golden Gate and the Carquinez Strait, is less than 100 feet deep. From one end to the other, the bay is about 42 miles in length and ranges from 5 to 13 miles in width. Before radar and sonar, ships regularly hit the fog-obscured rocks at its entrance. And gold seekers abandoned so many vessels off the tiny town of San Francisco that new residents built right on top of them. These opportunists became the first in a long line of Bay fillers who saw more dollar signs along the waterfront than up in the mother lode.



Girl dives into the bay in the early 1900s. (Courtesy of The Dolphin Club, Shirley Coleman Collection)

Today, 7 million people live on the shores and hills surrounding San Francisco Bay. Around the

extraordinary natural harbor, they and their predecessors have built 46 cities, 6 ports, 4 airports, and 275 marinas, not to mention myriad industrial centers, oil refineries, and military bases. They have also set aside miles of bayshore for recreation and wildlife in the form of 135 parks, refuges, and reserves.

To locals, the bay is a breathing space, a blue prairie of water outside their windows and beside their communities. To tourists, it's the water under the Golden Gate Bridge, the rippling backdrop to one of the engineering marvels of the West.

## An Ever-Changing Environment

San Francisco Bay is an estuary where rivers draining 40 percent of California's landscape meet and mix with the Pacific Ocean; where coastal and inland ecosystems overlap; where seabirds and songbirds ply the skies; where sharks swim with sardines; and where species both native and alien compete for space and food alongside some equally competitive primates.

Here at the edge of the North American continent, cool ocean water and air encounter their warm inland counterparts, shaping an environment in constant flux. One minute the sun may blaze down from above, whereas the next is wet with fog drip. Tides coming in may suddenly go out; wave trains may collide, encountering a shifting breeze or a change of current; and brown plumes of sediment-laden fresh water from the rivers upstream may dissolve into the bluer bay just west of the Carquinez Bridge or drive a muddy arrow through the Golden Gate and out to the Farallon Islands.

In this coastal zone, the continental and oceanic plates of the planet can shift against one another any moment, sending a bridge or levee collapsing into the water. It can grow hot and dry enough for fire to consume most of Angel Island in one night, and cold enough for snow to stick on Mount Tamalpais. El Niño and La Niña rearrange the water layers every two to seven years, and every few decades the whole North Pacific experiences a change so profound that entirely different types of fish take up residence in the bay.



A scientist samples a square meter of the estuary for invasive plants. White plastic quadrats provide measuring tools for diverse organisms and bay conditions. Some of the longest standing records of bay conditions reside with the U.S. Geological Survey, which set up the very first tide gauge at the Golden Gate more than 100 years ago. (Francis Parchaso)

“The bay is not a static thing,” says aquatic ecologist Jim Cloern of the U.S. Geological Survey. Cloern had been studying the bay for over 20 years when he saw plankton growing in places and times they had never been seen before. His state colleagues surveying fish began pulling in more salmon than halibut and seeing unusual surges in bottom-dwellers. “In terms of these biological communities, it’s almost like the bay flipped from one state to another state. Ecologists call these ‘regime shifts’ or ‘crossing a threshold,’ ” he says.

To survive in such a changeable place, local fish and wildlife must be unusually resilient—able to endure winter floods and summer droughts, as well as times of scarce food between times of plenty. Lately, however, more than a few species have been having a tough time adapting to the most dramatic changes of all: the arrival of people. During the past 150 years, entrepreneurs and engineers have straightened rivers, culverted creeks, drained marshes, and paved coastlines. They have also rerouted the flow of water from land to sea, directing the lion’s share into reservoirs, faucets, and irrigation pipes.

“We have plumbed more of our system and diverted more of our fresh water for longer than anyone, anywhere, on the West Coast,” says the U.S. Geological Survey’s Jan Thompson. Though Thompson has spent most of the last two decades studying an alien clam decimating the bay food web, she remains optimistic. “What better system to prove that you can turn something around than one that has been so manipulated, and one we can still manipulate?”

**TABLE 1. San Francisco Bay through History**

	1700	TODAY
Bay surface area	~800	~580 square miles
Bay Area human population	10,000	8 million
Tidal marsh	190,000	45,000 acres
Freshwater flows through Bay	~30	~20 million acre-feet/year
Salmon returning to spawn	>2 million	<150,000 (only 1/5 wild origin)
Spring shorebird count	millions	hundreds of thousands

Sources: Data from Bay Conservation and Development Commission; Margolin 1978; *Habitat Goals*; Department of Water Resources; California Department of Fish and Game.

## Saving the Bay

Californians are as changeable as the bay itself. Many come to the Golden State expressly to escape their former lives or to experience something new. People arrive ready to fight for a dream, whether gold or freedom or tolerance or redwood trees. And one of the dreams they've fought hardest for is a healthy bay.

By the 1950s, the bay was more stinky and ugly than healthy. For years, locals had been dumping their garbage at shoreline landfills, draining their sewage into creeks and tidelands, and banishing their industries, refineries, and canneries to the waterfront. Fish kills, oil spills, and bay fills—the dumping of dirt into the shallows to create new real estate—were considered a normal part of doing business. The shore was not a place to go for recreation and exercise, as it is for many Bay Area residents today, but a place to avoid.

In 1961, Berkeley's plan to fill several thousand acres of the bay lit a fire under three of its residents. Kay Kerr, Esther Gulick, and Sylvia McLaughlin could see the muddying of the waters and the changes to the shore from their living room windows up in the hills. Investigating the matter, the women heard city council members discussing the removal of all of the coves to achieve tidelands waterfronts, and saw an Army Corps of Engineers map in which the wide waters of the bay had been confined to a narrow channel in the name of progress. The women sent a flyer out to a thousand neighbors and fellow citizens, emblazoned with the words, "Bay or River?" The response was disbelief.

"[Most local citizens] thought the bay belonged to everybody," one of the women, the elegantly dressed Esther Gulick, recalled in a 1987 oral history. "Then, when they found out that a good part of it along the edge belonged to corporations like Sante Fe [railroad], they just couldn't believe it, and they couldn't do enough . . . to help."

The women proved adept at channeling citizens' outrage through a new organization they founded called the Save San Francisco Bay Association. That first flyer garnered about 2,500 memberships at \$1 a piece—the founders wanted saving the bay to be affordable. By 1970 they had 18,000 members and activist cells in the East Bay, on the peninsula, and in Marin. Known today as Save the Bay, the group was one of the first citizens' organizations formed to save a body of water rather than a rare bird or pretty canyon. With a lot of persuasion and considerable political clout, the association successfully legislated stewardship of the bay through the creation of the San Francisco Bay Conservation and Development Commission (BCDC)—a first in regional governance.

Over the years, many other Bay Area residents have taken up that torch, working to protect the wetlands, clean the water, cap the landfills, and preserve the salmon. Today, more than 200 environmental groups have their headquarters in the San Francisco Bay Area; many focus in some way on the health of the bay. Natural resource managers arriving here from jobs in other parts of the country are always amazed at the forest of hands raised, number of speeches made, and degree of passion expressed at public meetings.



Fishers on a shore of concrete riprap. (Max Eissler)

## ***OWNERSHIP & GOVERNANCE***

- The state was granted ownership of San Francisco Bay, as well as “swamp and overflowed lands” throughout the estuary and delta, in the early 1850s. Since then, the state has granted roughly half the lands in the Central and South bays to local municipalities.
- State records of historic sales suggest that more than 200,000 acres of baylands, floodplain, beach and water lots in the Bay Area may have been sold to other public and private landowners. No specific estimates of total acreage in private ownership are available.
- Nine counties and 46 cities extend underwater into the bay.
- Agencies with regulatory authority to manage land and water uses of the bay include the San Francisco Bay Conservation and Development Commission and the State Lands Commission.
- Other agencies involved in bay shoreline land-use planning include the California Coastal Conservancy and the Association of Bay Area Governments.
- The bay’s environmental quality is protected and overseen by the San Francisco Bay Regional Water Quality Control Board, the California Department of Fish and Game, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, and the National Marine Fisheries Service, among others.

“The [Bay Area] contains a fortuitous assemblage of citizens with a special culture and style of

life, a special environmental awareness and appreciation. There is a heady mixture of international cosmopolitanism, of varied shorelines with the flavor of ships and water, of the free spirit of the frontier, and of youthful and harmonious living,” wrote Rice Odell in a 1972 Conservation Foundation booklet about saving the bay. His words are every bit as valid today.

## Inside and Out

Most people living in the 46 cities that ring the bay know a nearby place for a bayside barbecue, Sunday stroll through the marshes, an afternoon fishing expedition, or a salty swim. Many run and pedal the trails now gracing the levee-tops and waterfronts, or take their city dogs to romp along the wide open spaces of a bay beach.

### *SITTIN’ ON THE DOCK OF THE BAY*

Soul singer Otis Redding and guitarist Steve Cropper wrote what has become the bay’s signature song, and Redding’s best-selling album, in the late 1960s. Redding came up with the first line—“I watch the ships come in and I watch them roll away again”—while staying in a houseboat on the Sausalito waterfront. On radio station playlists ever since, the song strikes a familiar chord for most Bay Area residents.

But the bay attracts more than those in search of exercise or family time. People leap from the Golden Gate in their hour of despair, or sip champagne on a bay cruise in their hour of celebration. Blue Angels zoom over the bay during Fleet Week, fireworks burst over the water on the Fourth of July, and fireboats spew fountains into a crowd of sailboats during April’s Opening Day on the Bay.

Equally riveting can be the natural wonders that appear on San Francisco’s watery doorstep. In 1985, a 36-ton Humpback Whale dubbed “Humphrey” wandered delta waterways for over a month. It took a flotilla of boats banging on steel pipes to make enough noise—a Japanese fishing technique known as *oikami*—to drive him back to sea. In May 2007, the Sacramento River once again beckoned to whales, this time an injured mother and her calf.



Avocets showing off the orange plumage of breeding season. (Robert M. Chilvers)



Central Bay kiteboarders. (Max Eissler)

Signs of nature abound in the bay for those ready to see them. Most locals have admired flocks of ducks paddling air as they lift off the water and the glistening domes of seal heads noodling offshore. Tourists come to marvel at the sea lion colony lolling on San Francisco's Pier 39 and to visit the Aquarium of the Bay. Here, a walk through an underwater tube reveals the Armored Sturgeon, Skeveyed Halibut, and flashing schools of herring that live below the bay's blue surface. In the region

shoreline parks, visitors can see curlews and peeps poke their beaks into the mud for goodies, and pelicans and terns dive-bomb for fish.

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Of course there are many more up-close and personal ways to experience the bay. Emma Macchiarini's father belongs to the South End Rowing Club, one of several thousand residents who have joined open water swimming clubs in San Francisco. Just as many enjoy catching bay waves and winds with kiteboards, ketches, catamarans, and boogie boards, or indulging in the age-old pastime of fishing.

Jim McGrath races formula boards, the latest and lightest type of windsurfing rig. In a good race under the right conditions, this retired port environmental manager can skim from Berkeley to San Francisco and back again in an hour and a half. He has raced in the confines of Washington's Columbia River and through what he calls the "organized" waves off Hawaii, as well as in the bay's warm swells off Florida. To him, the bay is rougher, bigger, more unpredictable than those locales. Experienced though he is, McGrath has lost his gear and had to be rescued more than once from bay waters.

Anthony Mirkovich likes working in an urban fishery. "You can eat a fancy lunch in the best restaurant on the Wharf and be out fishing that night," he says. Mirkovich fishes for herring in the bay, helps a friend crab outside the Golden Gate, and heads to Alaska for salmon. Doing all three jobs is the only way to make a living fishing on this coast now, he says. Yet in the 1900s, every Bay town had a fisherman's wharf, and every other a sardine cannery; the shallows grew oysters, and the cove was teemed with shrimp.

Mirkovich's grandfather used to fish out of Seattle, but Anthony didn't inherit his boat and gear from family. His pride and joy is a 32-foot bow-picker called the *Masterpiece*—a herring boat. More than 100 years the herring fleet is not allowed to bring in more than a few thousand tons of the tiny, silvery bay fish. It's a quota set by the state to protect the fishery. In 2007, Mirkovich brought in 72 tons, his most recent big catch.

Mirkovich started fishing when he was 12 years old, when 130 herring boats worked the bay. Today, the local fleet numbers around 30. But the handful of guys Mirkovich fishes and barbecues with all help each other out, and he enjoys the camaraderie. "In the early morning, there's the smell of diesel on the docks, with the boats warming up, the guys slinging gear back and forth, seagulls cawing, and radio chatter. That's when bay fishing comes alive," he says.



Herring fishery research vessel tied up on San Francisco's Embarcadero. Seagulls often follow fishing expeditions looking for easy pickings. (Ryan Bartling)

Apart from the last few fishermen, some residents still know the ways of the bay with the intimacy of the past, when more of the local populace relied on the bay for food, transport, and a living. Boat pilots guide the wallowing tankers and top-heavy container ships in and out of the Golden Gate. Miners claw and suck sand from the bay bottom to fill freeway beds, and dredgers do the same to keep shipping lanes and port berths safe for marine navigation. Ferry operators still zip to and fro in busy white boats, powered by the jet engines that have replaced the early paddlewheels. Their wake is so powerful it sometimes erodes the mud from bayshore marshes. Engineers still make salt by trapping sheets of bay water in the sun. And builders still negotiate with the shifting elements to raise bridges and anchor waterfront seafood joints over and around the water.

But most people only cross the bay or admire it from afar. They may not know the bay intimately, but its bridges and freeways keep them apprised of its moods and colors. Almost everyone smiles at the sight.

“The bay gives our region its name and creates a sense of place which defines the community where we live,” says Will Travis, 20-year leader of BCDC, the government agency in charge of preserving this watery regional treasure. “The bay is our Eiffel Tower, our El Capitan, our Big Ben. It is a visual icon which gives our region its identity as a place different from everywhere else.”

But to all those who live or visit here, perhaps the most amazing quality of the bay is its proximity. “To me, the bay is direct access to wild nature—unmanaged, unmanicured nature,” says swimmer Emma Macchiarini.

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