

San Francisco Estuary Partnership

**Bay Swimmers Revel in Experience
Despite Traffic, Bites, and Pathogens**

Slot Limits for Sevensills?

**Cocktail of Six Antibiotics,
Three Anti-Depressants, and
One Anti-Diabetic Medicating our Bay**

**Estuary Managers Confront
Coastal Challenges**

Green Cement Blues

Sierra to Sea Reflowed

SCIENCE • RESTORATION • WATERSHED • POLITICS • SPECIES • BAY

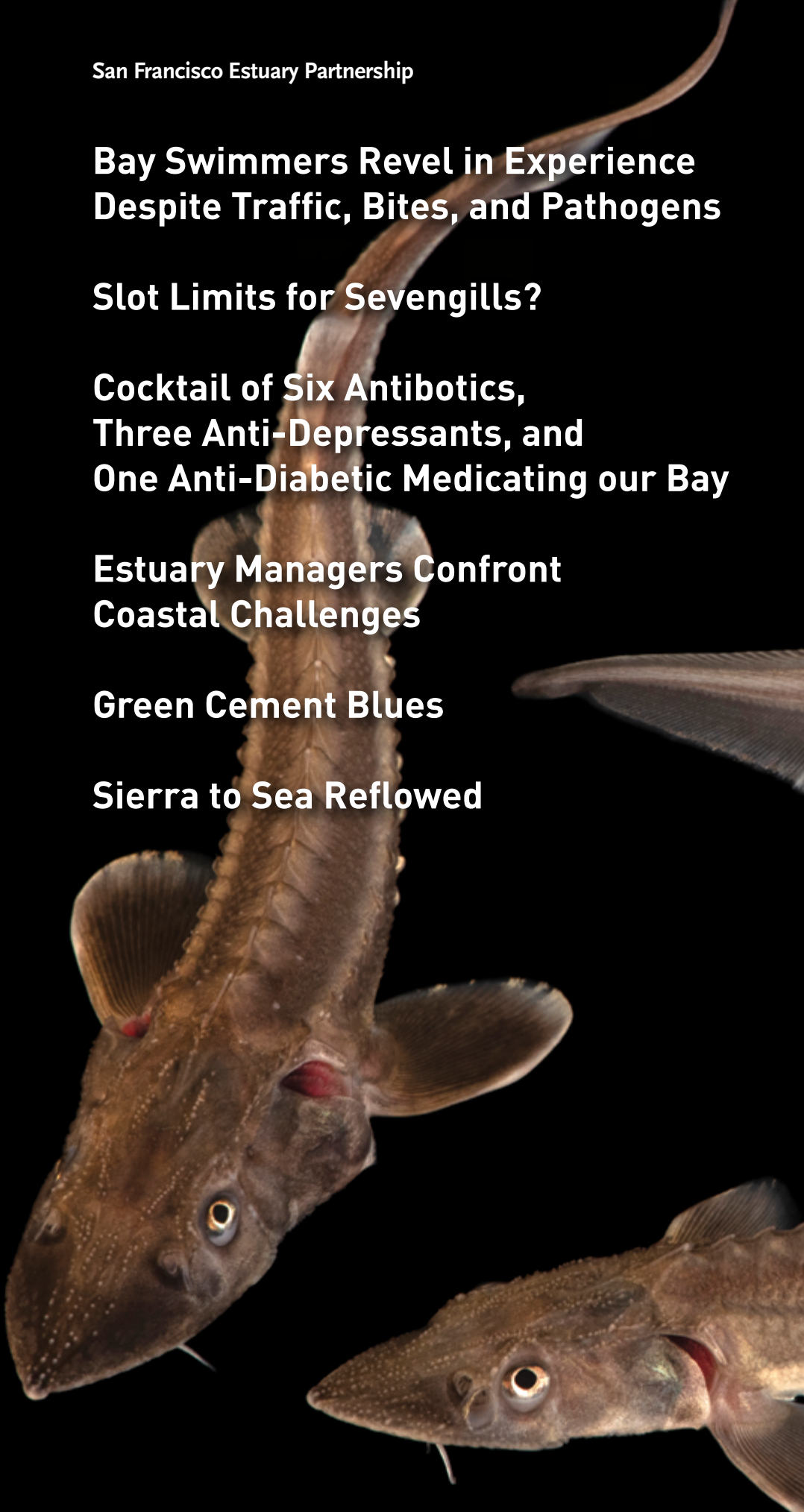
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M O N I T O R I N G

Medicating the Bay

NATE SELTENRICH, REPORTER

Pharmaceuticals are pouring into the Bay, even if we never flush pills. Compounds in painkillers and other common oral drugs are still excreted from our bodies, routed through wastewater treatment plants that can't remove them completely, then discharged to the Bay where they may harm marine life.

The problem isn't unique to the Bay Area, affecting waterways worldwide. It's also not going away — and likely to get worse, says Diana Lin, an environmental scientist with the San Francisco Estuary Institute (SFEI), which recently published a report on pharmaceutical pollution as part of its Regional Monitoring Program for Water Quality in San Francisco Bay. Some common drugs are already more prevalent in wastewater than caffeine.

"The population in the Bay Area is continuing to increase, as well as age, so this means an expected increased use of pharmaceuticals," says Lin, who coauthored the report. "We want to be vigilant in monitoring these contaminants."

In 2016 and 2017, seven Bay Area treatment plants tested incoming and outgoing wastewater for 104 pharmaceutical compounds. This provided a measure of not only which drugs were entering the Bay, but also how well they were cleaned from incoming sewage. Removal efficiency varied widely from plant to plant and compound to compound.

Among the seven plants, two employ what's known in the industry as tertiary treatment. The other five stop at secondary treatment, designed primarily to degrade the biological content of the sewage. Tertiary treatment further cleans the water prior to discharge, but does not target pharmaceutical compounds — and, Lin notes, did not always outperform secondary treatment in the study.

Palo Alto's 46-year-old wastewater facility, which discharges to an unnamed slough, is among those using tertiary treatment. "[As a] last step we basically put it through a

large Brita filter of activated carbon with sand and gravel," explains Karin North, watershed protection manager for the city of Palo Alto. "It just gets those small particles out, and since a lot of these contaminants like to sorb onto the solids, that's where you might find them."

In order to fully remove pharmaceuticals, says North, the plant would need to purify wastewater to drinking-water standards through processes known as reverse osmosis and ozonation. But these technologies are costly and thus unlikely to be used on any water discharged to the Bay, she says.

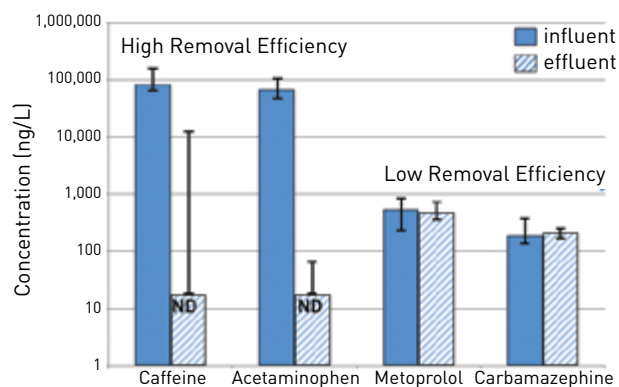
A better option, suggests Sejal Choksi-Chugh, executive director of advocacy group San Francisco Baykeeper, may be the use of treatment wetlands such as at Petaluma's Ellis Creek plant or San Lorenzo's Oro Loma. Also known as constructed wetlands, these facilities use natural processes involving wetland vegetation, soils, and their associated microbes to slowly clean and filter water. "Some of the emerging science shows that they can help remove pharmaceuticals from the waste stream," she says, all at a fraction of the cost of upgrading to reverse osmosis.

Source reduction is important, too, North stresses, like prioritizing diet and exercise over pharmaceuticals, ensuring doctors prescribe the right dose for the right body, designing drugs that break down in the environment, and requiring that manufacturers take back unused medications — which California recently became the first state in the nation to do.

Among the 104 pharmaceuticals tested in the SFEI study, 17 merit further evaluation because concentrations in Bay water could exceed protective thresholds for toxicity to marine life, the authors write. These include six antibiotics, whose release into the environment can contribute to the growing problem of antibiotic resistance, among other

ill effects. Also on the list are three antidepressants, a class that has been shown to have physiological effects on mollusks, crustaceans, algae, and protozoans, and to impact fish survival and reproduction.

REMOVAL EFFICIENCY FOR FOUR DRUGS



Source: SFEI

Then there is the anti-diabetic drug metformin, poorly metabolized by the human body and found in high concentrations in wastewater effluent and surface waters across the U.S. and Europe. It's also estrogenic and appears to feminize the reproductive organs of male fish. In the SFEI study, median concentrations of metformin and the sum of the top three over-the-counter painkillers (acetaminophen/Tylenol, naproxen/Aleve, and ibuprofen/Advil) exceeded median concentrations of caffeine in effluent.

Emma Rosi, an aquatic ecologist with the Cary Institute of Ecosystem Studies in New York and a renowned expert on pharmaceuticals in freshwater environments, says she's particularly concerned about how mixtures of compounds may affect aquatic and marine life. A study she coauthored whose results were published last month in *Nature* detected 69 different pharmaceutical compounds in caddisfly larvae along a creek in Australia receiving effluent from a sewage plant with tertiary treatment.

"Pharmaceuticals are getting into aquatic ecosystems and then moving through food webs with unknown ecological consequences," Rosi says. "If you went to the doctor and told them that you were taking 69 different pharmaceuticals, they would be very concerned for your well being."

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R E C R E A T I O N

Saltwater Revival

ALETA GEORGE, REPORTER

An hour before sunrise on a cool October morning, a small group of swimmers (what they call a pod) meets on the beach of the South End Rowing Club in San Francisco's Aquatic Park. For safety they strap waterproof blinking lights to the back of their goggles, but wetsuits are conspicuously absent. The temperature of the water is around 60 degrees Fahrenheit, warm for San Francisco Bay open-water swimmers. In winter, when the water plunges down to the high 40s, they still swim — though not as far or for as long.

"Swimming sustains me," says Fran Hegeler, vice president of the South End Rowing Club. "It is what gets me up every day. It revives my spirit."

That's the kind of enthusiastic language some Bay swimmers express. Those who have been doing it for a while don't seem to dwell on the dangers like catching hypothermia, being swept out to sea on a tide, getting hit by ships or small boats, exposing themselves to pathogens and pollutants, or having a run-in with a wild animal. While they are aware of these risks, they are more likely to focus on the fact that, as one swimmer says about the activity, "It's awesome!"

The six swimmers step into the inky water and swim with long, strong strokes alongside the Hyde Street Pier and the *C.A. Thayer*, a wooden-hulled, three-masted schooner built in 1895, twelve years after the formation of the South End Rowing Club. Each swimmer finds their own pace. Brad Robinson, a longtime pool swimmer new to open-water in the Bay, says he always swims hard in the beginning to warm up. "It usually takes me 200 meters before I stop questioning why I'm doing it!" he says.

They head towards the opening of Aquatic Park Cove about 400 meters away, with the dim but familiar hulk of Alcatraz in the distance. The pod stops at the cove entrance to clump together before turning west towards Fort Mason against the flood tide. A full Hunter's Moon slips below the south pillar of the Golden Gate Bridge.

The scene may be picturesque, but the dangers of swimming in the Bay are real. Sharing the water with wild animals means sharing it in sickness and in health — theirs, that is. Right now, Sausalito's Marine Mammal Center is dealing with a large outbreak of leptospirosis, a bacterial infection that can cause fatal kidney damage in California sea lions. As of early November, the center was treating 220 rescued sea lions that had tested positive for leptospirosis, and according to the Marine Mammal Center website, about two-thirds of them will die. The bacteria are transmitted via urine while the mammals are hauled out and piled atop each other. Those being treated at the center are acute cases, and it is believed that many more have mild cases and survive infection.



Photo: Clay Schmitz, San Francisco Baykeeper

While leptospirosis is dangerous for sea lions, it isn't likely to affect swimmers. The Center's Director of veterinary science Shawn Johnson says that the bacteria is not known to survive for long in saltwater. "The chance is pretty low of a human contracting the disease unless you're interacting with the animals. We have never had a human case in the decades we've been treating it."

What is of concern is the possibility of a bite from either of the two pinnipeds that live in the Bay, California sea lions and harbor seals (see p.15). Last December three swimmers were bit in one week, and the San Francisco Maritime National Historic Park closed Aquatic Park Cove for several days. "It's not uncommon for swimmers to occasionally get bitten or scratched by sea lions or harbor seals," Johnson says. "But given the number of people swimming and the number of pinnipeds in the water, it's rare."

Robinson thinks it would be more likely for him to get hit by a car than bitten by a sea lion, though he admits he can be startled by encountering one in the water.

"We are lucky to live in California where we can swim in the Bay," says Johnson. "We also have a great population of wild marine animals that live with us. They can get scared and defend themselves, especially in the water. Or, a younger animal can

see you as something to play with." Johnson encourages swimmers to visit the Marine Mammal Center where they can learn more about the animals they swim with.

Hegeler, who has been swimming in the Bay for 10 years, admits she was terrified at first. She felt panicked about not being able to see, and was nervous about sharks

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TURNINGPOINT

River Flows on the Brink

JOHN HART, REPORTER

It was a rare decisive moment in California water. On December 12, the State Water Resources Control Board resolved, at the close of a marathon meeting, to require more water to be left in the Tuolumne, Merced, Stanislaus, and lower San Joaquin Rivers. In the first of three planned amendments to the Bay-Delta Water Quality Plan, the board set early season flows in the three mountain streams at 40 percent of “unimpaired” levels (actually a range of 30-50 percent). These targets are well below the 60 percent of unimpaired that the ecosystem really needs, as determined in 2010 by the board itself (see also pp. 9-12). But they are much more than the meager flows the streams have in fact been getting, and much more than agricultural and urban diverters would willingly let go.

During the nine years the board has been working up to this moment, a parallel process has been dragging along: negotiations among water suppliers, state agencies, and some environmental groups to produce Voluntary Settlement Agreements that could help fish while minimizing legal and political battles. On the 12th, the directors of the state’s Departments of Water Resources and Fish and Wildlife showed evidence of recent rapid progress and asked the board to defer its own action. Some novel and promising ideas were sketched, which the board promised to study as it turns its attention to the Sacramento drainage and the Delta itself. In the end, though, the long-awaited plan for the southern rivers passed, on a vote of four to one. Next stop, if history is a guide: the courts.



Photo: Robin Meadows

SALTWATER, *cont'd from page 3*

and sea lions. She swam in a wetsuit and stayed in the cove for years, and eventually her fears subsided. “I’m not that worried about sea life now. They’re interested in other things,” she says.

The South End Rowing Club and the similarly minded Dolphin Club, founded four years later in 1877, share a beach in Aquatic Park for their clubhouses and docks. Both clubs lease their buildings from the San Francisco Recreation and Parks Department and are open to the public Tuesday through Saturday for \$10 a day.

Popularity in Bay swimming and in the clubs has increased in recent years, reflecting a surge in recreational and competitive open-water swimming worldwide. When Hegeler joined the South End Rowing Club about five years ago there were 800 members, and today there are 1,400, she says. Members swim in pods or solo, and join group swims supported by pilot boats when the route crosses a boating channel, such as a recent South End Rowing Club swim to Alcatraz and back.

Swimmers in the Bay can feel good about water quality, says Sejal Choksi-Chugh, director of the San Francisco Baykeeper, a nonprofit that works to protect and improve the health of the Bay. Choksi-Chugh says that before the federal Clean Water Act was enacted in 1972 and began to be enforced, there was a higher chance of getting sick.

“It’s much cleaner and safer than it used to be, and as long as you don’t swim within three days of a big rain runoff, you’re generally safe,” she says, adding that there still are outlying incidents. “Swimmers should be cautious about going into the water if they smell oil. Instead, they should report it. There’s a chance we can do something about an oil spill if it’s reported early.”

The water at Aquatic Park Cove, and 15 other beach sites around San Francisco, is tested weekly for indicator bacteria by San Francisco’s Public Utilities Commission and Department of Public Health. If water samples are found to exceed state standards, water contact could possibly expose people to a pathogen. In that case, the SFPUC will warn people with

signs at beaches, on their website, by email, and on a hotline. In the last three years the agency has only posted these kinds of warnings at Aquatic Park four times, says SFPUC supervising biologist Ross Duggan.

What may prove to be more problematic for swimmers are contaminants of emerging concern (CECs). Baykeeper notes that while 91 contaminants are regulated by the Clean Water Act, about 100,000 chemicals have been registered or approved in the U.S. over the last 30 years. CECs include microplastics, pharmaceuticals (see p. 2), personal care products, and other endocrine disruptors. Choksi-Chugh says that studies have found microplastics in high levels in the surface waters of the Bay, suggesting that swimmers could accidentally swallow them.

Baykeeper is working with and encouraging the 42 water treatment plants that discharge water into the San Francisco Bay to upgrade their treatment plants to ones that treat these types of pollutants.

Mostly though, Bay swimmers report that they feel healthier. Hegeler says she never gets sick. Robinson says he doesn’t have a constant runny nose like he did the 12 years he swam in a pool. “When people ask me the difference between swimming in a pool and the Bay, I tell them that the water in the Bay is alive. Every day is different. It’s interactive, and not swimming in a bowl of soup.”

Back on the water, the moon setting behind the Golden Gate Bridge, the swimmers reach Fort Mason after about 45 minutes and turn around. On their way back to the club, the sun rises over the Bay Bridge, splashing color and light on the water. “It was a celestial sandwich,” says Hegeler. “It’s an amazing experience. You feel the water on your skin. You taste it. You share it with other animals. It is spiritual and connects you to the earth.”

Report Sick Seals & Sea Lions

415-289-SEAL (7325)

Marine Mammal Center Hospital,
2000 Bunker Rd, Sausalito

F I S H I N G

Shark Hunt Stand Off

ALASTAIR BLAND, REPORTER

They frequent the deepest holes and shipping channels of San Francisco Bay, and few people ever see them. A handful of local fishing guides, however, have become skilled at finding and catching broadnose sevengill sharks.

These large, bullheaded predators live in coastal waters across much of the globe. In the spring and summer months, they enter shallow estuaries, including San Francisco Bay, to give birth to their pups, and it's during these seasonal aggregations that sport fishermen target them. Armed with heavy line, large hooks, and fish heads for bait, these anglers often drop anchor in the murky, current-torn waters between Alcatraz and the Golden Gate Bridge.

It was there, in August of 2013, that an angler fishing on the Berkeley-based charter boat *California Dawn* caught and kept a 322-pound sevengill. The catch, described in a story in *Western Outdoor News*, was reported to be a record at the time, though it didn't last. On July 9, 2017, a fisherman caught and killed a 342-pound sevengill, according to the records archive of the International Game Fish Association. An article at FishSniffer.com reported that the angler was fishing with Legal Limit Sportfishing, a charter service also in Berkeley.

Now, as social-media hype and the prospect of Facebook fame stokes up excitement among trophy seekers, some other fishermen and conservationists want to see the pursuit ended before it depletes shark numbers.

"These guys are trying to catch the biggest females out there to set a record," says David McGuire, founder of Shark Stewards, a Berkeley conservation group that focuses largely on protecting open-ocean species from the devastating shark-fin trade. "It's unfortunate, because these bigger fish are the most important ones in the population, and they're in the Bay to reproduce."

Catching and keeping these sharks is not illegal. Licensed anglers in

California are allowed one sevengill shark, one sixgill shark, and one soupfin shark per day. There are no size restrictions. John Ugoretz, a marine biologist with the California Department of Fish and Wildlife, says fishing restrictions on sevengills — first implemented in the early 1990s — could be cinched up if it becomes clear that fishermen are increasingly targeting and killing them. "Because sharks are slow-growing, slow-reproducing and long-lived, we know we have to be cautious," he says.

Department of Fish and Wildlife catch records, in fact, already show a steady increase in sevengill landings over the past two decades. From 2001 to 2005, recreational anglers on local charter boats — officially regulated as "commercial passenger fishing vessels" — caught and killed an average total of 28 sevengills per year. From 2006 to 2010, they took 57 each year, and from 2011 to 2015, 84. In 2016 and 2017, anglers on these fishing boats caught and kept 102 and 77 sevengills, respectively. These numbers do not include sharks caught on privately owned boats.

Stockton-based recreational fisherman Dave Hurley, who writes and distributes an online fishing newsletter several times each week and closely follows the fishing

activities of dozens of charter boats, says he has seen interest in catching the largest sevengills spike in the past five or six years, primarily among a small handful of charter boat companies. He estimates that anglers caught and kept 180 large sharks in 2018 in San Francisco Bay.

"Is that kind of harvest something the population can withstand?" Hurley says. Fishery managers have no idea — primarily because they don't know, not even approximately, how many sevengills are out there.

"There hasn't been any long-term monitoring study of the population, so we have no baseline estimate," says Sean Van Sommeran, founder of the Santa Cruz-based Pelagic Shark Research Foundation.

At the global level, the International Union for the Conservation of Nature, which assesses the conservation status of the Earth's plants and animals, designates the broadnose sevengill shark as "data deficient." In 2017, scientists from U.C. Davis, the Aquarium of the Bay, and the University of San Diego published findings that San Francisco Bay sevengills migrate hundreds of miles along the coast — behavior that can make it difficult to accurately track population changes. Another paper, published in the journal *PLOS One* in 2015, found San Francisco Bay sevengills to be a genetically distinct population, with about 40 percent of

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Sample Facebook post image of sevengill catch.

SPECIES SPOT

Sleuthing Sturgeon Snags

KATHLEEN WONG, REPORTER

The green sturgeon looks like a fish that's swum directly out of the ancient ocean. With the flattened snout of a dragon, and sides armored with bony scutes, *Acipenser medirostris* looks capable of weathering anything nature could throw at it. But in fact local sturgeon are struggling; the population that spawns in the Sacramento Bay-Delta was declared federally threatened in 2006. UC Davis researchers are now trying to figure out why the fish is in trouble.

The campus is home to the world's only green sturgeon rearing program. Scientists in professor Nann Fangue's lab study the captive-spawned progeny of traditionally harvested fish donated by the Yurok tribe of northwestern California. With funding from partners including the California Department of Water Resources, the Delta Science Program, and the National Oceanic and Atmospheric Administration, the program is designed explicitly to help save the species.

"If we knew how large they are when they're moving through each portion of the system, we'd know a lot more about the threats they face at each life stage, and where we need to put our energy," says postdoctoral fellow Anna Steel. "But the Delta is a black box now."

In a system teeming with introduced species, sturgeon might be consumed by non-native fishes. Graduate student Sarah Baird examines how tempting green sturgeon are as meals with the aquatic equivalent of gladiator fights: she places sturgeon of the same size in tanks containing largemouth or striped bass. Video cameras follow the action.

Apparently, not even small green sturgeon are preferred prey. "Often the bass shake their head, and — ptui! Spit them out," Baird says. "The scutes are extra sharp when sturgeon are young. I can only imagine how they feel in a bass's mouth." Sturgeon more than about 20 cm long rarely got eaten, possibly because they were too big to fit into the predators' mouths.



The Tracy pumps, which grind up fish venturing too near their inlets, could also pose a threat. Louvers resembling shutter slats were installed in front of the pumps to create eddies that direct fish toward a bypass channel. "Sturgeon are very different" from the salmon and bass the louvers were designed for, says Steel. "They live on the bottom, have a triangular body shape, and a different evolutionary history."

Steel has been observing how sturgeon fare against the louvers at the campus' J. Amorcho Hydraulics Laboratory. There, she's been swimming sturgeon of various sizes in a flume outfitted with louvers retired from the Tracy pumps. While sturgeon between 6 and 12 cm long often slipped between the lab's test louvers, fish longer than 16 cm were more likely to bypass. Faster water speeds, Steel found, improved bypass success for these larger fish, but put smaller fish at greater risk.

Green sturgeon arriving at the real bypass are generally greater than 18 cm long. So young fish have likely outgrown the danger by the time they've reached that section of the Delta. "It's great news," says Steel.

As reassuring as the researchers' findings have been thus far, they don't pinpoint the cause of the sturgeon's demise. A combination of factors that have been changing or intensifying over time may be to blame. And so the UC Davis team will continue to illuminate these gaps by studying the green sturgeon they rear from tiny egg to primeval river prowler.

Earlier Sturgeon Stories ESTUARY

Surgeons: www.sfestuary.org/estuary-news-sturgeon-surgeons/

Intakes: www.sfestuary.org/wp-content/uploads/2017/08/EstNews-Jun2014-final-v3.pdf

SHARK, *cont'd from page 5*

individuals born to the same parents. This could indicate a population especially susceptible to overfishing.

Berkeley fishing-boat owner Steven Mitchell feels quite sure the local sevengill population has already declined. "It's not as easy to catch the big sharks as it once was," says Mitchell, owner of the San Francisco charter boat *Top Gun*. Mitchell takes paying customers fishing for a variety of local species, including halibut, salmon, and sharks. "But I tell them before the trip, if we catch a big shark, that fish is not coming into the boat, because these are the breeders," he says.

Conservationists think the time has come to rewrite the laws on catching sevengills. Hurley and McGuire want to see officials place both minimum and maximum size limits on sevengills. This system of regulating catch, known as a slot limit, protects immature juveniles as well as the largest, most fecund adults. Van Sommeran says he would support a change to the law but doubts there is enough population data "to make a case for protecting the bigger fish."

Indeed, state officials tend to implement new fishing regulations only after research shows that a species has been impacted or depleted. With sevengills, McGuire feels that in the absence of better population data, it would be prudent to act cautiously and implement a slot limit now to protect the juveniles and the largest adults, both for sevengills and their larger cousin, the sixgill. The Bay's sevengill population, he says, is already being impacted — not just by fishing but also pollution and loss of prey and habitat. "We need better science," he says, "but science takes time, and there is never enough convincing data until it is too late for many species."

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Records Archive: <http://wrec.igfa.org/WRecDetail.aspx?uid=66871&cn=Shark,%20sevengill#.W8pXHWKhPY>

Bay Nature 2010: <https://baynature.org/article/saving-the-bays-sharks/>

E Q U I T Y

Toxic Soup Strains Silos

AUDREY MEI YI BROWN, REPORTER

Theo Ellington remembers biking through the Hunters Point shipyard as a kid, before there was a road. He grew up in nearby Bayview, and that lifelong relationship comes through in the way he talks about his home. He is now a resident of the shipyard's Parcel A development, a set of luxury condominiums overlooking an active Superfund site. In November he ran for a local Supervisor spot. Although he did not win the seat, it's clear he knows District 10 intimately — its people, its pollution, its trouble getting the Navy, the U.S. Environmental Protection Agency, and cleanup contractor Tetra Tech to address the toxic soup in this gentrifying corner of San Francisco. "People are sick and tired of being sick and tired," he says.

Recent headlines about falsified soil-contamination tests are just the latest development in a longer history of failures and frustrations for the neighborhood. Residents say they want honest answers and consistent attention from regulators who, from a local perspective, often seem mired in siloed decision-making and unable to think holistically enough to create a safe environment for these San Franciscans to live in.

Ellington's voice on the phone seems to come with a thousand-mile stare. He tells stories passed down from community elders about what has happened in the shipyard over the decades, from human and animal testing in the Navy's Radiological Defense Lab to the more recent landfill fire in 2007. The shipyard has "been a fixture in community since '70s," a toxic ghost the community can't shake.

To enter Hunters Point, one crosses a short bridge and passes by the Restaurant Supply Depot and Greyhound bus lot, the citywide wastewater treatment plant, and the Port of San Francisco, crisscrossing freeways, a trucking depot, and the site where a proposed PG&E power plant was shut down by community resistance — all without seeing a grocery store. To enter this place is

to experience a supersaturation of overlapping pollution sources.

Roots run deep in Hunters Point. For many residents, family histories weave in and out of the shipyard. Black workers were recruited from the American South to work in Bay Area shipyards during World War II. Although the demographics of Bayview and Hunters Point are now changing — "there's a segment of the population that feels like it's being pushed out," says Ellington — this corner of the city remains around 30 percent Black, with growing Asian and Latinx populations.

Recently, Hunters Point has appeared regularly in the mainstream news cycle due to fraud in the cleanup of the Navy shipyard, which was contaminated with radioactive waste from nuclear research. Many sources have documented myriad problems with the cleanup effort, performed by the contractor Tetra Tech and overseen by the Navy and EPA. In what is now called by some the biggest case of eco-fraud in U.S. history, test results from at least 90 percent of shipyard soil samples have been called into question, and two radiation control supervisors have been sentenced to prison.

"What happened with Tetra Tech is really unprecedented," says Tina Low, a water resources engineer with the San Francisco Bay Regional Water Quality Control Board. "It's not normal by any stretch."

From a local perspective, trust in Tetrattech, the Navy, and the EPA has been compromised time and time again. According to Ellington, "there's a disconnect right now between the people affected by disaster and people in charge overseeing the cleanup."

Low notes that "radiological issues have gotten most media coverage," but that there's a "whole array of contaminants that are not radiological in nature" also present in the area. Off the top of her head she lists petroleum, mercury, PCBs, lead, metals, and intrusive vapors. .

Dr. Ahimsa Porter Sumchai, a local physician and activist, says she wasn't shocked by the data falsification. Sumchai has worked on environmental-justice issues in Hunters Point for more than 20 years, and that experience, in addition to her time on the Remediation Advisory Board supervising the cleanup, has shown her that regulatory safeguards and oversight continue to fail in protecting Hunters Point residents, she says. The shipyard's legacy is just one component of the neighborhood's "environmental toxic soup."



Hunters Point residents assemble at a protest near the new Lennar/FivePoint condominium development overlooking the contaminated Navy shipyard. Photos: Audrey Mei Yi Brown

Regulators and local residents tend to have different ways of thinking about toxicity in Hunters Point. Sheridan Enomoto, an organizer with the San Francisco-based environmental nonprofit Greenaction, says she approaches toxicity from the perspective of place, and the connection between people and land. She takes a holistic view on contamination, considering how various sources add up to cumulative health impacts that locals have to live with.

Regulatory agencies like the water board approach contamination problems differently: "We just break it apart into pieces that are manageable," says Low.

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TOXIC, *cont'd from page 7*

But by constructing a conceptual site model, Low and her colleagues now aim to “get a very clear picture of how these things are interacting — what are your sources and where are they going?”

Enomoto has long observed government agencies “working in silos,” isolated from each other and separate from the communities they serve. In her view, the result is a fragmented understanding of how contamination plays out upon the community, which in turn yields incomplete solutions.



As an alternative, Greenaction spearheaded a program called IVAN (Identifying Violations Affecting Neighborhoods), which registers reported health impacts from community members and works backwards to locate pollution sources. IVAN is a grassroots model; individual residents’ experiences add up to complete a collective toxic map. A new community-led air-quality monitoring project is also underway at Greenaction, with funding from the California Air Resources Board. Ten air monitors will be placed around Hunters Point, with a community advisory group overseeing the program.

According to Greenaction executive director and longtime activist Bradley Angel, his organization is “not really doing this for the grant money. It’s actually kind of a pain, it’s a lot of work,” he says. However, the data from the air monitors is invaluable because it will make local pollution legible and “validate what the community has known for a long time.”

Low has experienced the frustrations of regulatory silos firsthand, when issues have gotten segmented depending on the program or regulation. “The people you’re talking to might not have the right expertise or access to particular funds you need to address it,” and these mismatches of expertise or funding access are “not uncommon,” she says.

In Low’s view, the best way to tackle silos is to create a multidisciplinary team. Additionally, it’s essential that regulators recognize “even if a [problem]

doesn’t fit into an [obvious] program box, that doesn’t mean you don’t have to address it,” she says. “You have to be a little creative.”

Looking to the future, the urgency of bridging regulatory silos is mounting in the face of climate change. Given the shipyard’s proximity to the shoreline, local residents wonder about the rising level of the Bay and the increasing likelihood of extreme storms and floods — what will happen when toxic waste is exposed to water?

Enomoto points to the proposed shoreline sea wall as an example of an inadequate solution to sea-level rise built from a fragmented rather than holistic perspective. The sea wall is not continuous, and it therefore offers incomplete and inequitable protection. Moreover, even a continuous sea wall would not prevent contaminants from getting into groundwater.

One of the other major regional regulatory agencies, the Bay Conservation and Development Commission, acknowledged similar concerns in its 2016 Policies for a *Rising Bay* report, noting that future flooding from sea-level rise could exacerbate

Hunters Point’s site-specific risk of exposure and “cause pollutants to mobilize” in communities close to brownfields and industrial sites. The Commission also noted that unequal quality of shoreline protection structures (like a sea wall) could lead to disproportionate damage in disadvantaged communities. Areas with lower-quality shoreline protection could be hit harder by flooding because of amplified wave reflection off of protective structures.

As the Commission observes, and as local residents know well, the impacts of climate change will not fall on everyone’s shoulders equally. In Hunters Point, existing problems will likely be made worse. At the same time, people outside of Hunters Point should care about this potential flooding. “What’s happening in the shipyard affects the Bay, what’s happening in the Bay affects the state, and what’s happening in the state affects the country,” says Enomoto. Our world is not siloed, and as Enomoto speaks to me, smoke from wildfires 150 miles away chokes San Francisco.

Local resident Theo Ellington believes he was sold a false dream when he bought his home on Parcel A of the shipyard. The condominiums on Parcel A indeed look part of a dream: up on a hill with manicured expanses of lawn and a clear view of the waterfront. The idyllic picture is only missing its white picket fence. After Ellington moved his family there, the dream crumbled as the basic safety of the picturesque property was called into question. It felt personal to homeowners and the community as a whole. “This would not happen in the Marina,” says Angel, referring to San Francisco’s northern waterfronts.

“All these hazards were shipped to this side of town,” says Ellington, who nonetheless remains hopeful about the area’s future. He concludes, with a break in his voice, “We deserve to be a vibrant community.”

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Hazard Sandwich Story, June 2018 ESTUARY News

www.sfestuary.org/estuary-news-rbd-islais-creek-hyper-creek-mediates-hazard-sandwich/

B A S E L I N E

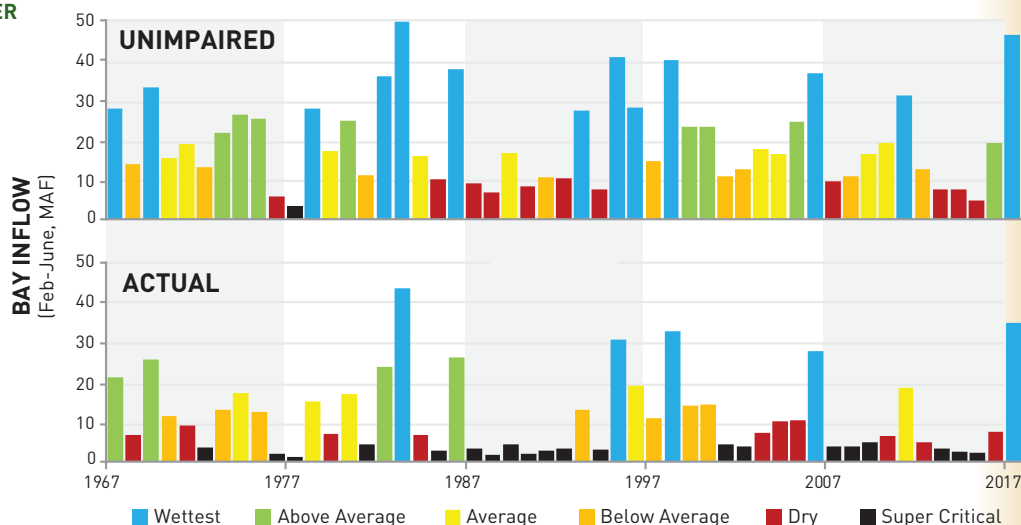
Reflowing the Sierra to the Sea

Bay Institute Releases 20th Anniversary Edition of 1998 Report

ARIEL RUBISSOW OKAMOTO, REPORTER

A fall flight over the Mexican coast where the Colorado River meets the Sea of Cortez offered me a gut-punching, eye-screwing, visual on the results of impaired flow. The semantics of 'unimpaired' and 'impaired' flow have laced the language of California water management debates since some engineer invented these politically 'neutral' terms long ago. The terms refer to our alteration of freshwater flows from snowmelt and runoff by dams and diversions. But whatever the labels, or which estuary you're referring to, keeping these flows from reaching the sea via rivers can starve these aquatic ecosystems of their liquid life force. Whether it's the vast yellowing salt flats that are all that remain of the mighty marshes of the pre-dam Colorado River delta, or our own estuary at the mouth of the Sacramento and San Joaquin Rivers, when we "impair" the flow from the mountains to sea, the result is ecological trauma.

Twenty years ago, the Bay Institute released its own drill-down into this impairment, writing the first ecological history of the vast Central Valley and San Francisco Bay watershed stretching "From the Sierra to the Sea," as the report is called. A variety of water users, stakeholders, and well-known engineers weighed in on



The Estuary's fish and wildlife have experienced near-permanent drought.

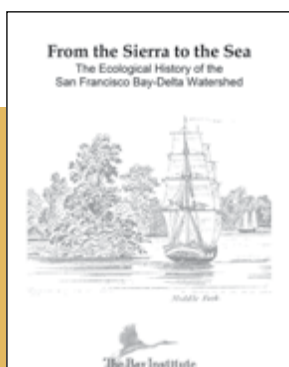
Figure A: In the last 20 years, Bay inflow has been increasingly impaired, as a result of high levels of water diversion. The driest conditions (the Dry plus Super Critical year types), which occurred naturally in 20% of years, are now experienced in the estuary 70% of the time. Summarized from 2018 Sierra to the Sea, p. 283.

the conclusions, making it more like an early attempt at water community consensus on baseline conditions than an environmental manifesto. In December 2018, the Institute released a 20th anniversary edition — hardbound, and glossy — that includes both a faithful reproduction of the original maps and history, as well as a data-packed, 18-page Afterword summarizing more recent trends.

"For the last twenty years we have been trying to think our way around the central problem of flows," writes environmental

journalist John Hart in his foreword to the new edition. "Maybe, just maybe, if we do a great many things right, we can bring the ecosystem back partway without giving back any meaningful fraction of the water we are taking. On the evidence, this approach has failed."

The evidence presented in the new edition's Afterword is a record of continuing collapse. Four more native fish populations (and orcas that feed on Central Valley salmon) have been added to the list of endangered species. Three listed species — winter run Chinook salmon, and longfin and delta smelt — declined by more than 97 percent between the environmentally-proactive late 1990s and 2017. Salinity from ocean tides continues to creep up estuary. Exotic fish are happily ensconced in an altered food web. Extremely high levels of water diversion combined with reduced snowpack, low inputs of sediment from upstream, pollution, and rising sea levels are all exacerbating ecological effects.



1998 & 2018 Editions

New 2018 Report at www.bayecotarium.org/sierra-to-the-sea

continued on next page

REFLOWING, *cont'd from page 9*

"We are in that once-in-a-generation place where we take stock and consider making major changes to how we manage the Estuary ecosystem," says the Bay Institute's program director, Gary Bobker, who oversaw production of both the original edition and the 2018 update. The last time, he says, was in the mid-1990s, when Congress and the state adopted major water management reforms, and when big new programs aimed at balancing water use and ecosystem health such as CalFED got off the ground. "That was a decisive time for determining our future, and we're in that kind of time again."

Even though the Bay Institute published *From the Sierra to the Sea* in 1998, its authors contend that it is still the only effort to date to look at the historical ecology of the entire system. Bruce Herbold agrees. "It still sits on my shelf and it still drives the science and management of California's aquatic resources," says this former U.S. Environmental Protection Agency biologist who spent decades helping endangered fish up and downstream. "When I started working in this field thirty years ago, one might have expected to see walls, or at least different colored ground, between the Bay, the Delta, and each of the tributary rivers. The divisions still exist, but as witnessed by the State Water Board's recent controversial plan to regulate streamflows in order to promote better conditions in the Estuary, people are now more likely to view the watershed as connected."

For any reviewer, the ups, downs and slices of the bar and pie charts presented in the Afterword of the 2018 *From the Sierra to the Sea* require time and reading glasses to appreciate. "Reality is complex," writes Hart. "Yet complexity can also serve as a refuge, sparing us the job of distinguishing between more important things and less important things. The big thing sometimes obscured by the length of the "multiple stressor" list is the first thing on it, the historic and ongoing reduction of flows through the Delta and Bay. The harm done by many of [these stressors] dwindles whenever flows are strong."

Laser Like Focus on Last 20 Years**Flows Down, Fish Down, Salinity Up, Collapse Closing**

The 18-pages and twenty years (1998-2017) spanned by the Afterword cover changes in inflows, outflows and reverse flows; Central Valley water use; tree crop acreage; native and non-native fish abundance; as well as rising temperatures and water levels due to global warming. More charts and maps fill the pages than words, a mere sampling of which is presented in this article. In some cases, the authors pulled together data from multiple sources to show the interactions between different parts of the estuary and its watershed; in other cases they built on analyses from other well-respected sources and worked to place them in context or extend their scope.

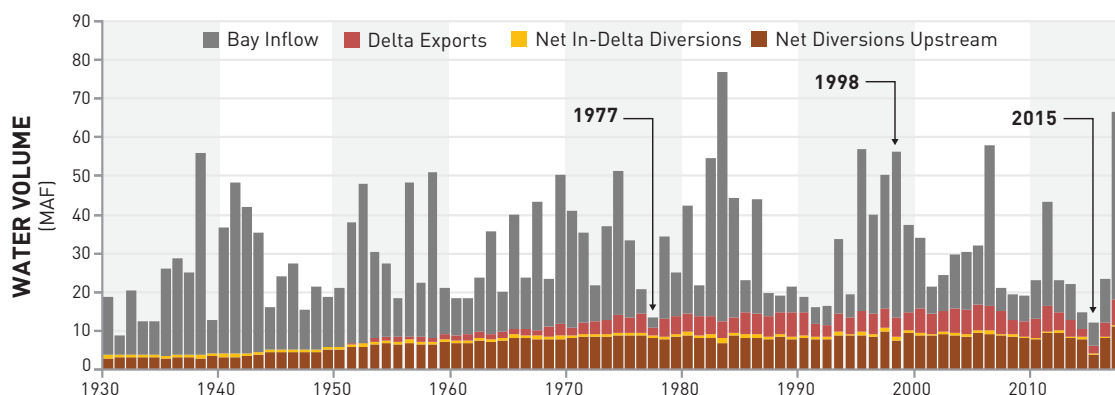
Pulling it all together, the authors come to a variety of conclusions. For one, they counter the argument that major improvements in flow have resulted from the last three decades of policy change. Actual fresh water flowing from the Sierra and Central Valley rivers to the Bay and ocean is now so diminished that the driest Bay inflow conditions, those that would naturally occur 20 percent of the time, now occur 70 percent of the time (see Figures A and B). Without significant flow reinstated to buoy ecosystem processes and habitats, native fish are sure to collapse.

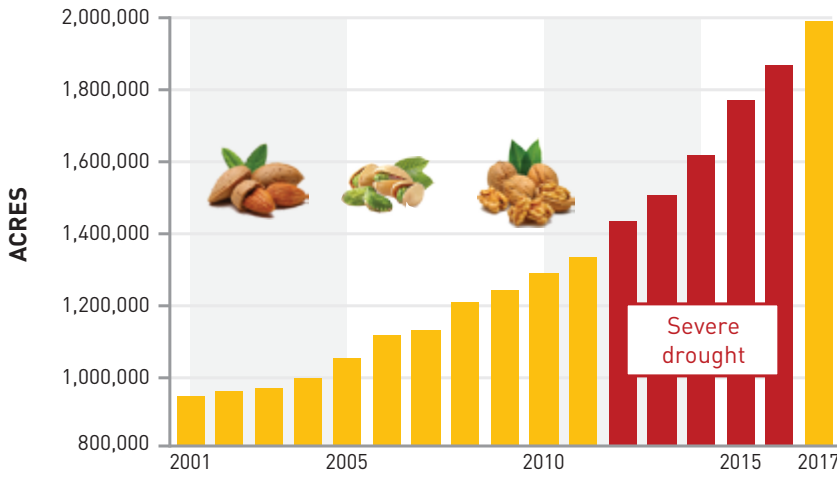
"When populations are near extinction, that's the time we should strengthen protections, but every time we have a drought, all the rules go out the window," says Bobker, citing changes to Sacramento River temperature requirements in 2014 and 2015 that left salmon eggs with a more than 95 percent mortality rate. "When fish rebound and are viable, and when habitats are large enough to be resilient, that's when you have more flexibility. So we need to boost growth when conditions are wetter and then design rules for droughts that take into account multi-year impacts — instead of hammering the resource in wet years and dry."

Another conclusion — something of a surprise — was the lack of obvious links between native and exotic fish assemblages (see Figure D). "We all know that the system is now dominated by non-natives but the narrative that this is what has driven the decline of native species over the past two decades doesn't pan out," says Jon Rosenfield, the Bay Institute's lead scientist. "As a group, natives have held their own in the ecosystem since the original report was published."

Surface runoff in the Bay Estuary's watershed is naturally variable but human water use and exports aren't

Figure B: An increasing fraction of surface water in the Bay's watershed has been diverted or exported over the last 20 years. In dry years, the inflexibility of water demands results in diversion of a large percentage of Central Valley runoff. In some years, more than two-thirds of the winter-spring runoff is diverted from, or stored, upstream of the Estuary or exported South. Summarized from 2018 *Sierra to the Sea*, p. 285.





Acreage devoted to water intensive tree crops has exploded in the Central Valley

Figure C: The area planted with almonds, pistachios, and walnuts (which require lifelong irrigation) more than doubled between 2001 and 2017. The largest expansion (2014-2015) coincided with the recent period of severe drought (red bars), further impacting overdrafted groundwater supplies and accelerating subsidence. Summarized from 2018 *Sierra to the Sea*, p. 286.

Another conclusion is that despite severe drought and depleted aquifers, the acreage of water intensive tree crops in the Central Valley has exploded (see Figure C). “It makes us realize we should be careful what we wish for,” says Bay Institute report co-author Peter Vorster. Vorster admits that environmentalists have long argued that scarce snowmelt shouldn’t be used on low value crops like alfalfa. According to the Afterword, acreage devoted to high value walnuts, almonds, pistachios doubled between 2001-2017 – increasing by more than million acres — mostly in the groundwater — overdrafted San Joaquin Valley.

Trees “harden” water demand — most orchards have to be irrigated every year and can’t be fallowed in times of drought or flood like field crops. “No one wants to dictate what crops people should grow but we have to make choices about how much acreage to irrigate in order to live within our water budgets,” says Peter Vorster. “Otherwise, our already small water budgets for the ecosystem, and our newly mandated budgets for groundwater, will still be at risk.”

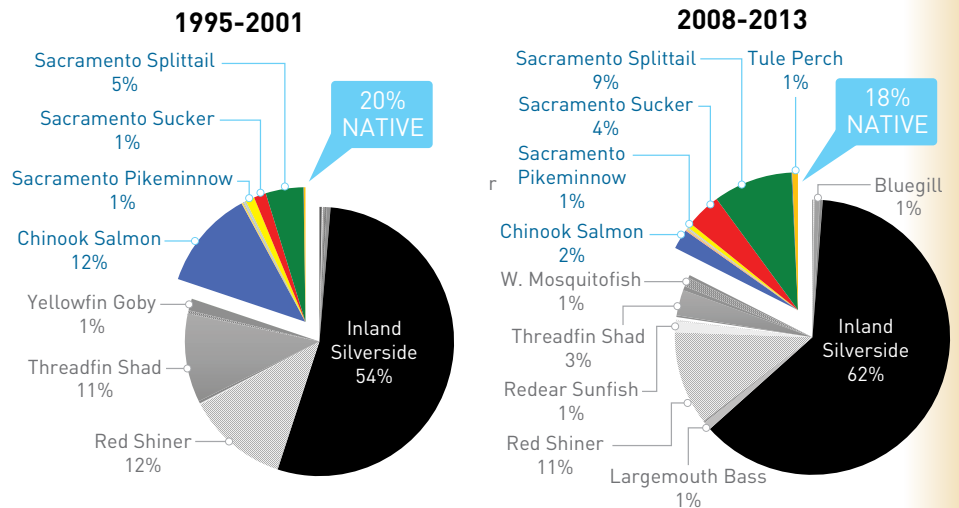
Another surprise emerged as the team cobbled together data from multiple sources spanning 40 years: “The number of days of extreme reverse flows on my spread sheet amazed me,” says Institute scientist Greg Reis. He found that in the record before 1998, reverse flows of -10,000 cubic feet per second (cfs) only occurred in summer on five days.

But between 1998-2017, reverse flows of the same or larger magnitude occurred on 485 days in summer, or an average of over three weeks per year. “This shift in heavy exports to the unprotected part of the year is a change that may exacerbate toxic algal blooms and other problems,” adds Reis. “Water managers and regulators need to pay attention.”

Other conclusions relate to the changes ahead not behind us — as global warming produces hotter temperatures, more extreme weather including flood events like Oroville, and rising sea levels that will inundate low-lying habitats.

As the Afterword notes, at the time of *From the Sierra to the Sea’s* publication in 1998, estuary managers recognized global warming as an emerging environmental threat but little imagined its pace and magnitude. What’s clear now, however, is that change will occur more rapidly than previously thought, with serious implications for ecosystems.

continued on next page



Non-natives continue to dominate the fish fauna, but on the whole, they are not replacing natives

Figure D: A comparison of proportional catch of non-native fish species (black and grey slices) and native fish species (colored slices) caught in the shallow waters of the Delta during the late 1990s and 2000s. While some non-native species increased and some native species decreased, there was no major change in the relative abundance of these two groups over this period. Summarized from the 2018 *Sierra to the Sea*, p. 291.

Where There's A Will, There's Way More Fish

A Window for Real Restoration

Even as early as the 1998 edition, the Bay Institute and all those who contributed to the first *From the Sierra to the Sea* report were recommending landscape scale restoration efforts including support for ecosystem processes such as sediment movement. This early work stimulated a number of further, more detailed, ecological histories and recommendations. The San Francisco Estuary Institute, for example, went on to produce a triumvirate of detailed studies that are now the foundation of Delta conservation management recommendations (Delta Historical Ecology, Delta Transformed, Delta Renewed).

"From the Sierra to the Sea really helped validate the importance of big-picture studies of landscape change, opening the door for more granular analyses like our Delta work," says the organization's senior scientist Robin Grossinger.

The new edition's Afterword restates an obvious conclusion that can now be found in a plethora of scientific and technical documents and management plans, if not political platforms, namely the need to recognize and support processes not just places. And that's where water comes in again: "What binds together any network of pre-existing or restored habitat reserves in this system is fresh water," says the Afterword. This water mobilizes sediments to create and maintain physical habitats like marshes and beaches; creates low salinity habitat when it mixes with salt water from ocean; transports organisms, nutrients and prey between habitats; cues migratory behavior in salmon and other species; and limits

contaminant effects on the ecosystem.

More attention needs to be paid to these ecosystem processes, the Afterword finds, despite the gains made with the addition of hundreds of acres and miles of restoration projects up and downstream in the last 20 years — from gravel augmentation in tributaries to levee setbacks and floodplain expansion in Central Valley rivers to wetland and creek restoration around the Bay. These include one of the largest and most ambitious projects championed by the Bay Institute — restoring fresh water and salmon to 150 miles of the San Joaquin River, once dry down to the sandy river bottom due to "impaired" flows.

Landscape managers are now concerned that all this work to grow species and habitats will be undone, or produce different outcomes, as air and water temperatures rise and the ocean advances upstream. Recent fires, floods and drought have already galvanized the public to consider more ways to support natural resilience. The political will to really reshape land use practices, however, remains weak, as have commitments of more flows to fish.

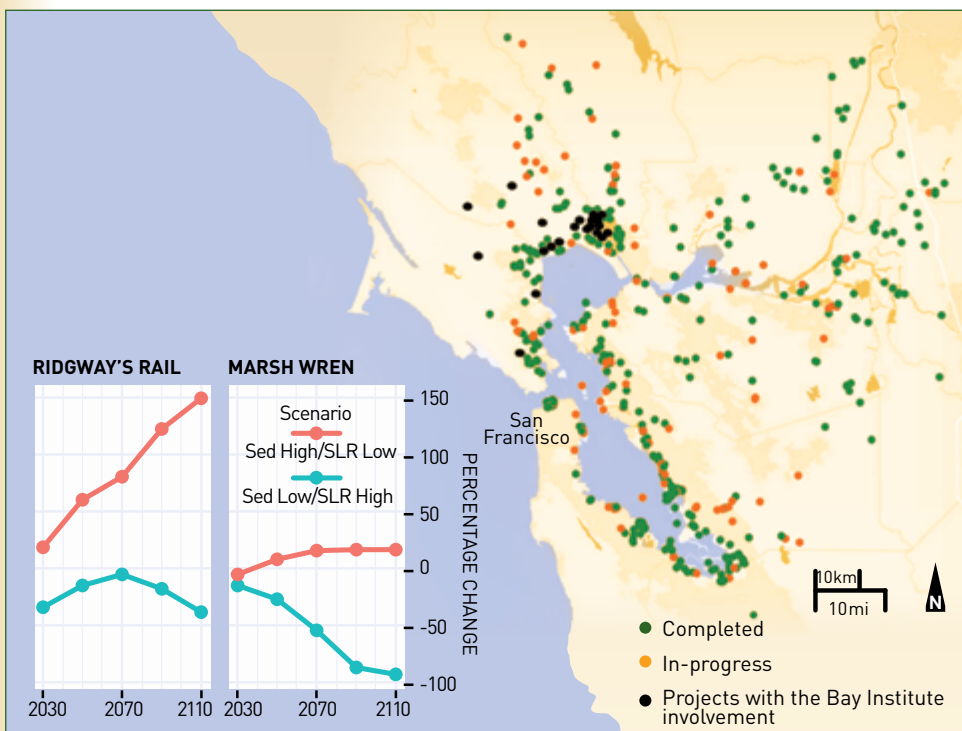
"Governor Schwarzenegger's Delta Vision task force did a great job of highlighting all these emerging threats and how we needed to reconnect and rehabilitate parts of the estuary. Then we got sidetracked. Governor Brown fixated on delta conveyance rather than larger water management changes and California lost a precious decade when we could have been addressing the root causes of the Estuary's decline," says Bobker.

"Now is the time to do the rest of the restoration, to add the critical element of water, if we want our investments to pay off," says Rosenfield.

"Building resilience doesn't require us to stop all human use of California's water, just to do a better job of sharing it," says Bobker.

Public investment in wetland restoration may not produce desired results without adequate sediment inputs from Central Valley rivers.

Figure E (map): Completed and in progress non-mitigation restoration projects from the 2018 EcoAtlas. Figure F (bird charts): Projected habitat availability for two wetland-dependent bird species under two difference scenarios of climate change. Blue lines depict the proportional change in bird density based upon estimated future habitat extent under high rates of sea level rise (1.65 m) and low sedimentation rates (25 mg/L suspended sediment concentration); red lines reflect low rates of sea level rise (0.52 m) and high sedimentation rates (300 mg/L). Increases in river flows influence salinity and sedimentation rates (as well as the species, growth and bulk of wetland plants), sustaining habitats as sea levels rise. Modified from original image by Veloz et al. 2013. Summarized from 2018 *Sierra to the Sea*, pp. 296-7.



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www.sfestuary.org/estuary-news-reflowing-sierra-to-sea/

Estuary Partners Choose Their Battles

JOHN HART, REPORTER

On an early October day, an unusual crowd of tourists filed onto the Red & White Fleet's *Harbor Queen*, paying rather less attention to Alcatraz and the Golden Gate than to each other. In town for the National Estuary Program's annual Tech Transfer Conference, they had come to compare notes and strategies from the 28 varied bays, bights, bayous, and river mouths that benefit from one of the nation's most durable, and efficient, environmental laws.

In 1987 amendments to the Clean Water Act, Congress proclaimed selected tidewater regions to be "estuaries of national significance" and offered money to help local coalitions take on environmental problems there. Through all the political gyrations since, a thin stream of funding, via the Environmental Protection Agency, has continued to flow to place-based programs with tiny core staffs and numerous collaborating partners. These doughty groups have helped work wonders in habitat restoration and pollution cleanup, learning many a lesson along the way. The yearly conference, hosted this time by the San Francisco Estuary Partnership, ensures that that knowledge gets shared.

Listening in on the conversations aboard the *Harbor Queen*, I really "got" how different other estuaries are from our familiar Bay and Delta, and how smart Congress was to pursue national environmental goals through programs developed in, and for, one special region at a time.

Some of these National Estuary Program target areas are urban, some rural. Some are vast, some quite contained. Certain estuaries, like ours, are feeling the effects of prolonged artificial drought as freshwater inflows are diverted for consumptive use. In others, water quality, not quantity, is the worry. Some have too much input of sediment and nutrients, while others struggle with unnatural shortage, as is the case in San Francisco Bay. Some estuary groups are riveted by one big problem — an iconic species in trouble, for example. Others, like ours, comb out priorities from a mat of interlocking issues.

"Our world right now is seen through the lens of the orca," says Sheida Shahandy of the Puget Sound Partnership. Dwindling numbers of the charismatic whale in this region have made national news. What's doing the animals in, most obviously, is starvation: their decline tracks that of their prey species, the Chinook salmon. In this busy harbor and industrial region, food shortage is compounded by pollutants that build up in the animals' fat; drawing on these reserves, hungry whales poison themselves. Swarming ships and whale-watching boats also harass the pods.

Sahandy sits on a governor's emergency task force that has just endorsed cuts in salmon harvest, a boost in hatchery output, and a temporary outright ban on Southern Resident Orca viewing tours. Lined up behind these are steps that could have been taken straight from the Partnership's 2016 Action Agenda: an attack on pollution, notably from stormwater runoff; faster work to restore salmon habitat statewide; and long-term controls on maritime noise and harassment.

Sahandy hopes that the current crisis will shake loose funds. "It's not that we don't know what to do," she says, "but in the last three years, only 30 percent of planned actions could be carried out. I don't want to be managing decline," she adds. "I want to find out how to turn the dial toward actual improvement." Ultimately that depends on confronting climate change and managing galloping regional growth.



Orca sighting on 12/3/18, Iceberg Point, Pacific Ocean offshore of Puget Sound.
Photo: Mark Malleon

The Tillamook Estuaries Partnership in northwest Oregon covers the namesake bay and several others formed where rivers pool behind coastal dunes. Director Kristi Foster is celebrating a huge recent success: the restoration of 443 acres of tidal wetlands at the mouth of the Tillamook River, essential for habitat and to reduce destructive local flooding. Seventeen years in the making, this Southern Flow Corridor project is one of the largest and most complex restorations in the Pacific Northwest. "It's a showcase for all of Tillamook County," Foster says.

It's a very different constellation of problems around Corpus Christi, Texas, where the Coastal Bend Bays & Estuaries Program is at work. As in California, lowered freshwater input is a key factor. However, the main competitor for water in this case is not agriculture — there is little crop irrigation here — or even residential use in a slowly growing region. It is rather the massive petrochemical industry. A 2001 agreement called for releases down the Nueces River mimicking, at a reduced level, the irregular pattern

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Estuary partnerships coast to coast.

of natural flows to Corpus Christi Bay. If not sufficient to restore the habitats that were, this solution promises to maintain what is. "We are dealing with a remnant of what was here naturally," says director Ray Allen. "We have to actively manage for that."

Tides are muted on this coast, but sea-level rise is being subtly felt. In a reversal of the California situation, rising Texas waters tend to expand the marsh band, not erode it, as vegetation colonizes the hypersaline flats that lie upslope. One kind of habitat is replaced by another. Outside its vulnerable urban cores, this region is fairly well positioned to adapt to an encroaching Gulf. Large ranches will make room for the waves, if only because acre-by-acre defense would be too expensive. "Thank God for the big landowners," says Allen.

Sarasota Bay, a fifty-mile-long lagoon on the southwest coast of Florida, is fairly new to the ranks of estuaries, having naturally lacked the freshwater input to qualify as one. In modern times, though, the bay acquired tributaries of a sort due to stream reengineering, urban storm runoff, and wastewater outfalls. With more water from the land came nitrogen and other nutrients, tending to overfertilize the bay. Among other accomplishments, the Sarasota Bay Estuary Partnership has succeeded in reducing nitrogen inflow by two thirds.

But these days all local efforts seem overwhelmed by the devastating regional red tide, an overgrowth of the toxic alga *Karenia brevis*. While the affliction follows natural cycles, director David Mark Alderson suspects that continued cleanup could lessen future pain. "We've done a lot of really good work on reducing nutrient pollution along this coast, but it may not be enough." A new initiative along the bay seeks to naturalize streams and shorelines, creating additional nutrient uptake and improving habitat for fish.

The New York-New Jersey Harbor & Estuary Program oversees one of the nation's most urbanized and polluted meetings of river and sea. It is also unusual in straddling two states; the nonprofit Hudson River Foundation provides the needed framework. Pollution is down in recent decades, but vast stocks of poison lurk in bottom muds,

complicating wetland restoration work. The idea of bringing back oyster beds is popular, but scientists are just beginning to understand how to bring these efforts to scale.



NEP national meeting cruise on San Francisco Bay. Photo: Peter Beeler

For metro dwellers to appreciate their estuary, they must be able to reach it. A number of waterfront parks have been created of late in the region, but access alone isn't enough, says director Rob Pirani. "Activities must be designed to draw people who may think, 'That place is not really for us.'" And the very success of the cleanup effort can push housing prices out of reach of "the people who lived with the degradation all this time," Pirani notes. "Can improvement be done in a manner that doesn't jeopardize these communities?"

I sat in on a kind of New England symposium with staff from MassBays (the Massachusetts Bays National Estuary Program); the Piscataqua Region Estuaries Partnership (centered on the New Hampshire coast); and the Casco Bay Estuary Partnership (Portland, Maine). All three face a challenge peculiar to their corner of the world. For reasons not well understood, relative sea-level rise is greater in the northeastern US than anywhere else on the planet, and stands to happen sooner. While the more typical coastline, like ours, has some three decades left to prepare for the steeper phase of rise, the future in New England is now. "Where will the marshes go?" wonders Pam DiBona of MassBays. In her region, urban development often blocks the way. On up into Maine, rural river valleys have more room for rising tides, with such obstacles as roads, minor development, and a lack of public lands.

The Great Marsh of Massachusetts, the region's largest, has the added

problem of sediment starvation. In New Hampshire's Great Bay, by contrast, mud is all too plentiful; dislodged by upstream development and harsher storms, it smothers valuable oyster beds. All three states worry about the decline of eelgrass stands, now at a fraction of historic levels.

Asked "what keeps you awake at night," Rachel Roulliard of Piscataqua thought for a while and volunteered, "Honestly, it's coordination." It's a perennial challenge everywhere. Estuary partnerships work by persuasion and education, not by exercising direct regulatory power.

Every partnership, it seems, is feeling the need to widen focus beyond the classically "environmental." Many are underlining the economic benefits of what they do, and several are reaching out to urban groups that have too often been left out of the conversation: the disadvantaged communities that have suffered most from past decisions and stand to be hardest hit by future changes like sea-level rise. The San Francisco Estuary Partnership's Caitlin Sweeney sees an analogy with the "legacy" pollutants that lie in bottom muds: "Our estuaries have also inherited a legacy of environmental injustice." Both must be confronted now.

Amid the smiles and professional optimism aboard the *Harbor Queen*, a certain grimness was apparent in this crowd. Like the god of Old Norse legend who tried to drain a drinking horn connected to the sea, our estuary advocates are fighting the local expression of changes on a planetary scale — changes that, even in the best scenario, have only begun to be felt. The task is to repair and strengthen estuarine ecosystems — now — against unstoppable disturbances to come. "Just make sure the system is as healthy as you can make it," says Curtis Bohlen of the Casco Bay Estuary Partnership. "That's all we can do."

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Hauling Out on Higher Ground

ASHLEIGH PAPP, REPORTER

For centuries, the harbor seal has thrived in the waters of the San Francisco Bay. The Pacific herring and salmon available during spawning seasons represent an alluring feast, but it's the 20 or so resting places sprinkled around the Bay that offer a perfect year-round home to the region's sole resident marine mammal. The availability and location of these onshore and island "haul-out" sites could change dramatically with sea-level rise, however.

National Park Service ecologist Sarah Allen has been studying local harbor seals for decades. "They have this dual existence," says Allen, who serves as science program lead for the park service's Pacific West Region. "They're tied to the land physiologically and tied to the bay waters for food and travel, but they have to follow the tidal cycles of the water because that's when the haul-out spaces become available." From rocky islets to tidal marshes, the bay shoreline offers respite to these native marine mammals — not only to rest and molt, but also to breed and raise their young.

"Harbor seals are amazingly resilient to changes in their habitat," Allen says. "Nevertheless, they require resting places onshore where they feel safe." But as the landscape



Female with pup at Castro Rocks. Photo: Suzanne Manugian

of the Bay is projected to change as sea levels rise, haul-out sites for harbor seals, most often low-lying rocks and marshes, are increasingly threatened. What will happen to seal populations as their vital habitat changes or disappears entirely?

Rocky islets like the Castro Rocks, located near the Richmond-San Rafael Bridge and among the Bay's more popular haul-out sites, are a particularly important refuge. Representing about half of the total haul-outs available to seals in the Bay, they offer less risk of human disturbance and quick access to schooling fish below. As the tide shifts from high to low, more of the rock is exposed and the seals hoist themselves up onto the surface.

"It's quite entertaining to watch," says Tori Seher, a National Park Service biologist whose office is based on Alcatraz Island. "Some of the seals have it down: they time it perfectly and the wave pushes them up onto the rock and they land in the right place. Others, usually the smaller ones, take a while to get up onto a rock that doesn't have another harbor seal already on it."

Due to the very nature of these rocky haul-out habitats, little can be done to protect or preserve them as sea levels rise. Of the rocky haul-out areas that currently exist throughout the Bay, more than half are likely

to be erased this century. "Eventually [the seals] will lose this habitat because it's fixed. When the sea level rises the smaller, little rocky islets will blink out," Allen says.

Meanwhile, the ability of tidal marsh habitats to naturally respond to rising seas offers hope to concerned researchers in the field. The gentler slopes and calmer

waters found in tidal marsh areas make these haul-outs particularly attractive during pupping season and thus invaluable to preserve.



Seals at Mowry Slough. Photo: Lyman Fancher

Rachel Tertes, a U.S. Fish and Wildlife Service biologist at the Don Edwards San Francisco Bay National Wildlife Refuge, is monitoring a nearly complete restoration effort at Redwood City's Bair Island geared in part toward seal habitat. "We're working to restore tidal marsh areas now, before the pace of sea-level rise increases, so that tidal marsh can keep up with rising water," she says.

To get ahead they've restored diked farmland and salt ponds back to tidal marsh and re-leveled it with future tides in mind. Tertes is optimistic about harbor seals' future there. "The South Bay numbers have been staying high," she says. "Not only have they been using the historic haul-out sites, but we're seeing them explore the new channels throughout the recently restored Bair Island."

To Allen, the next chapter for this resilient marine mammal looks similarly hopeful. "While the remote rocky islands may be lost to seals with sea-level rise, newly created intertidal marshes may help to accommodate the loss of rocky habitats in the Bay," she explains. "If we protect spaces along the shore, seals in the Bay may not only adapt to the changes but even expand."

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R E S T O R A T I O N

Greening Dickson's Heights

JACOBA CHARLES, REPORTER

Looking east from the levee-top trail, a silvery swath of bay is dotted with low islands — some tufted with plants, others mere muddy humps that barely break the surface.

This is low tide at the nearly 1,000-acre Sears Point wetland restoration project on the western side of San Pablo Bay. The islands, 500 in all, are actually man-made mounds, scattered across the mudflat as an integral part of the restoration design. Each is roughly 60 feet across and was carefully sculpted so its wide, flat top would submerge at high tide, creating habitat for a specific group of marsh plants. This in turn provides an important suite of ecological functions central to the project's success.

"Without the mounds, you would just have a big area of open water," says Julian Meisler, a program manager with Sonoma Land Trust. The organization once owned and now oversees monitoring of the property, which was recently added to the San Pablo Bay National Wildlife Refuge and renamed the Dickson Unit. "We are eagerly watching the success of the vegetation on the mounds."

A few years ago, that success appeared to be in jeopardy. After project managers breached the levee separating the restoration site from San Pablo Bay in October 2015, the mounds eroded much more than expected. However, researchers later found that experimental plantings of native Pacific cordgrass stabilized the mounds. San Francisco State University graduate student Margot Buchbinder carried out the experiments in collaboration with staff from the Sonoma Land Trust and the nonprofit Invasive Spartina Project.

"The timeline on these projects is really decades," says Meisler.

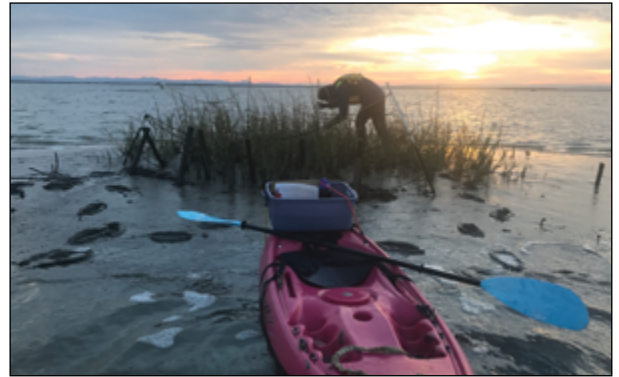
As with many bayside properties throughout the region, a levee kept the restoration site's soils dry for more than a century. While farmers worked the former marshland, it subsided about six feet — too low for tidal marsh to grow after a simple levee breach. The waters would be too deep, and

instead of an intermittently submerged mudflat, there would simply be an extension of San Pablo Bay.

But how could nearly 1,000 acres — more than 700 football fields — be raised by six feet in elevation? The mounds were part of the solution. They would not only provide immediate patches of marsh, but also help dissipate wave and tidal energy and settle sediment already in Bay waters to the bottom.

Though mounds can be seen as a feature in other restoration projects in the Bay Area, they have previously been installed as high-tide refuges. Sears Point was the first project, and is still the only example, aiming to influence ecosystem-level process such as sedimentation.

Originally the raw earthen mounds, constructed with bulldozers in 2014, were intended to revegetate naturally



before being exposed to Bay waters, says ecologist Peter Baye, who helped develop the design. The plan called for them to be left in place for up to five years, protected by the old bayside levee and a vast new, inland levee constructed as part of the same project. This would have allowed mature root and plant growth to stabilize both the mounds and the new levee before being exposed to by waves and tides from the Bay.

continued to back page



Marsh mounds at Sears Point (pre-breach, so the water is stormwater, not saltwater). Photo: Stephen Joseph, courtesy Sonoma Land Trust. Above: Margot Buchbinder collects samples.

Calculating the Cost of Adaptation

ISAAC PEARLMAN, REPORTER

Two decades ago, the San Francisco Public Utilities Commission (SFPUC) faced a rather big problem: its massive and aging water network, spanning the Sierra foothills to the Pacific Ocean, was in dire need of a makeover. The Hetch Hetchy water system crosses three major faults and needed seismic retrofitting. The city's 100-year-old combined sewer and stormwater pipes faced major repairs and upgrades. And the SFPUC needed billions of dollars to do it all.

So the commission did what many municipalities facing hefty infrastructure pricetags do: issue bonds, to the tune of \$4.8 billion. But in order to finance a subset of these projects, the SFPUC did something new. It went green.

"Green bonds provide a great way to finance climate adaptation and mitigation projects, but they are like any other bond," explains Mike Brown, the SFPUC environmental finance manager who oversees the \$1.4 billion in green bonds that the commission has issued since 2015.

So what makes a bond green? When the debt is issued specifically to bankroll projects with tangible environmental benefits, such as a new pump station that reduces energy use, public transportation projects cutting carbon emissions, or even rain gardens to capture and treat stormwater. By being labeled or certified as green, these bonds appeal to so-called impact or "ESG" (environmental, social, and governance) investors seeking a larger societal benefit to their investment — in addition to their personal profit, of course.

Certification costs and increased reporting requirements can be barriers for issuing green bonds, but Brown and the SFPUC are banking on that changing. That's because the green bond market is currently exploding, going from essentially zero when the first green bond was issued in 2007 to about \$170 billion delivered globally in 2017.

"The goal is to get to \$1 trillion in annual green bond issuances

by 2020," says Brown. "That's the United Nations' target to finance the low-carbon economy transition and meet the 1.5- to 2-degree limit outlined in the Paris Agreement."

Brown notes that although the SFPUC's first green bonds didn't receive any pricing benefits from municipal bond investors in the form of lower interest rates, a recent \$300 million taxable green bond issued by the agency did. Another benefit is the significant publicity received by the SFPUC. "We've expanded our investor base and have been recognized as one of the leaders in this area," Brown says.

But can green bonds finance the Bay Area's massive sea-level-rise bill, or is it only a drop in the ocean? Mark Northcross, a principal at NHA Advisors and financial advisor for the recent Resilient by Design



Rain garden in San Francisco's Mission District funded by an SFPUC green bond. In November 2018, Los Angeles County approved another innovative financing mechanism: Measure W. Starting in 2019, property owners will pay 2.5 cents for each square foot of impermeable surface on their parcels. The tax will raise an estimated \$300 million per year to fund rain gardens, parks, and watershed restoration designed to capture and clean the precious rainwater running off the county's concrete and asphalt surfaces. Photo: SFPUC

challenge, has been thinking lately about the cost of protecting the Bay Area from sea-level rise. Assuming \$175 million per linear mile of levee (about what the Hamilton Wetlands restoration project in Novato cost), and that half of the San Francisco Bay, or 200 miles, will need a levee or seawall for protection, Norcross gets a total of \$35 billion — which he calls "definitely low."

"A \$35 billion bond issue secured by a tax on all two million parcels in the nine-county Bay Area would equal \$1,100 per household per year for 30 years," he says, adding that for planning purposes a better target might be \$50 billion.

Northcross acknowledges it's a very rough estimate. But the point is the Bay Area is going to need a lot of money — and that creative funding sources are needed. "Green bonds are great for projects that have already passed the years-long pre-planning and CEQA process," he says. "But we need grants to fund projects through this early, high-risk phase."

To Brown, however, the rise of green bonds presents a larger opportunity. "The municipal bond market is massive — about \$400 billion dollars annually," he says. "But think about all the projects that municipalities finance: electric rail, water projects, wastewater treatment — maybe 75 percent or more could be labeled green. I want to get to the point where every dollar of debt issued is green."

And if the market for green bonds grows the way he expects, it soon may pay to go green.

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I N D U S T R Y

Green Cement Blues

JOE EATON, REPORTER

For the last three years, an environmental storm has been brewing in the North Bay city of Vallejo. An Irish cement company and its local partners want to build a processing plant and a marine terminal at the site of a long-closed flour mill on the east bank of the Napa River. But a broad spectrum of community groups has come together as Fresh Air Vallejo to oppose the project.



The historic Sperry Mill on the Napa River and proposed site of the Vallejo Marine Terminal and cement plant. Photo: Omnific Pictures/TJ Walkup, from Riverfront Ruckus & White Washed Tombs film in production.

Citing concerns over air quality and other impacts, the Vallejo Planning Commission rejected the applicants' permit in 2017, a decision that the cement company appealed. City Council members postponed action on the appeal pending completion of what the city calls a Draft Final Environmental Impact Report (EIR). Then on November 7, the state Department of Justice weighed in with a scathing analysis of the deficiencies of the EIR, as well as the Environmental Justice and Air Quality analyses prepared for the project. This reset the clock for the city's next action.

Vallejo already bears a heavy pollution burden. The former Mare Island Naval shipyard is a Superfund site, and the city lies in the middle of the refinery corridor that extends from Richmond to Martinez and Benicia. South Vallejo, where the plant and proposed Vallejo Marine Terminal would be located, is a predominantly African-American community whose residents, according to the California

Environmental Protection Agency, have extremely high rates of asthma and cardiovascular disease and a high incidence of low-weight births.

Enter Orcem, the Texas-based subsidiary of "green-cement" manufacturer Ecocem, headquartered in Dublin with operations in Ireland, France, and the Netherlands. On a web page describing the Vallejo project, Orcem claims its process involves a "near-zero carbon dioxide footprint" and

zero mercury emissions as well as up to 80 percent fewer emissions of air pollutants such as nitrogen and sulfur oxides compared with "traditional" cement production methods.

At Vallejo, the Orcem plant would use granulated blast furnace slag, a waste product from iron and steel mills, to produce cement. The slag and other cement ingredients would be unloaded at the new terminal. Orcem would take over the site of the Sperry flour mill, operated by General Mills until 1992 and subsequently designated a city and state historic landmark. Despite that status, the existing mill structures, where ospreys — formerly endangered birds making a recent comeback in the area — have nested in recent years, would be demolished.

Peter Brooks says he first became aware of the plans when a draft EIR for the project appeared on the city's web site in the fall of 2015. He and allies pressured the city to schedule additional public meetings on the EIR and helped generate a deluge of

citizen comments. Fresh Air Vallejo, an organization of which Brooks is now president, grew out of that effort. Its current supporters include not just environmental nonprofits and environmental-justice advocates but also unions, civil-rights groups, businesses, and student organizations.

The group found disturbing anomalies in the EIR's air quality analysis. Jay Gunkelman, formerly with the Bay Area Air Quality Management District (BAAQMD), says the report's emissions analysis inappropriately applied rural monitoring methodology to an urban setting, and understated the impact of cement dust releases and the emission of carcinogenic and otherwise toxic chemicals. Earlier this year, BAAQMD advised the city of 17 areas of concern with the project's Health Risk Analysis, including data discrepancies and failure to identify specific emissions sources. Other concerns raised by Fresh Air Vallejo include almost round-the-clock truck traffic, continuous lighting at the plant, and the potential that the marine terminal could be used to handle coal shipments.

Backing the Orcem venture is the Mare Island Straits Economic Development Committee, chaired by city council member Jess Malgapo and aligned with the JumpStart Vallejo Political Action Committee. According to the *Vallejo Times-Herald*, Orcem and its partners have contributed to the JumpStart PAC, funding the campaigns of Malgapo and fellow council members Pippin Dew, Hermie Sunga, and Rozzana Verder-Aliga in 2016 and 2018. The four of them made up the majority that voted in 2017 to override the Planning Commission's rejection of the companies' permit applications.

With recent elections, however, the make up of the City Council has changed. But before the new Council had a chance to meet, the Department of Justice issued a 13-page letter signed by Deputy Attorney General Erin Ganahl, warning of potential violations of the California Environmental Quality Act. The document, citing a report from independent air quality analyst Camille Sears that focused on emissions from vessels using the marine terminal, stated that the EIR "fails to adequately disclose, analyze, and mitigate the significant environmental impacts of

WETLANDWATCH

State Could Step Up

CARIAD HAYES THRONSON, REPORTER

California environmentalists hope to see an end to the years-long wait for a state wetlands protection policy in early 2019. Despite an official policy that calls for “no net loss” of wetlands in place since 1992, the lack of a specific wetlands definition, along with a patchwork of mitigation procedures, has led to the loss of many thousands of acres of ecologically important lands. As the Trump administration moves to roll back federal wetland protections, some environmentalists believe the new state policy may soon be all that stands between many of California’s remaining wetlands and destruction.

The State Water Resources Control Board’s new policy, given the wordy title State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State, has been in the works since 2008, and has undergone several drafts and rounds of public comment. However, enviros like Defenders of Wildlife’s Rachel Zwillinger are optimistic that the next release will be similar enough to the draft released last year that it can move quickly toward adoption by the state board early in 2019.

If the next version of the plan does resemble the prior one, Zwillinger says there will be a lot to like in it. “It’s an essential regulatory element for efforts to achieve the no-net-loss policy,” she says. “It creates statewide clarity about which landscape features are wetlands entitled to protection under state law, and a uniform set of procedures [for] first avoiding, then minimizing, then mitigating impacts so really rigorous protections

[exist] for our few remaining wetlands.” As landscapes where both aquatic and terrestrial ecosystems overlap, wetlands support complex communities of plants and animals. They also trap carbon, filter pollution, absorb runoff, and buffer surrounding areas from flooding.

The Trump administration’s rollback of the Waters of the U.S. (WOTUS) rule has given new urgency to the matter. Adopted by the Obama administration in 2015, WOTUS established a broad definition of lands entitled to wetland protections under the Clean Water Act. The current administration is working to repeal the rule.

If successful, it’s likely to replace the rule with something that restricts federal jurisdiction and is much less protective of a variety of wetland types that occur in California, Zwillinger says. “By enacting this policy, California can protect all of its wetlands, including the ones that would lose protections otherwise because of the federal rollback.”

The 2017 document uses a modified three-parameter definition of wetlands that provides more chances to protect them than the federal definition, and also safeguards unvegetated areas such as playas and tidal flats. A fall 2017 comment letter to the state board from 11 environmental organizations including Save the Bay, the Center for Biological Diversity, and Defenders of Wildlife described this as an improvement over previous definitions, while continuing to recommend an even more protective one-parameter definition.

Some agricultural interests, on the other hand, would prefer that the state definition mirror the one used by the Army Corps of Engineers. “You might have a property where the Corps does not consider a wetland to be present but the Water Board does,” says Kari Fisher of the California Farm Bureau Federation, one of more than two dozen ag-industry associations that also submitted a joint comment letter on the 2017 draft. “That creates conflicting procedures, alternatives analysis, and mitigation analysis that a landowner would have to do to comply. Those are not simple or easy processes to begin with, and if you’re going to have to do differing ones depending on different definitions, that just adds time and money.”

Both the environmental and agricultural letters raised concerns about the treatment of previously converted croplands under the policy. Fisher says the Federation is concerned about differences between the state and federal definition of these lands, and has suggested language changes that would match that used by the Army Corps. Zwillinger, however, worries that the draft’s guidance might allow for incremental changes that would eventually lead to such land being converted to urban uses.

Despite reservations, Zwillinger describes the current draft as “a very necessary step in the right direction.”

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Draft Policy:

www.waterboards.ca.gov/water_issues/programs/cwa401/docs/official_Doc_timeline/procedures_clean.pdf

the project.” Ganahl also wrote that the Environmental Justice Analysis also fell short of the mark: “Where a project’s impact area plainly has a high proportion of minority residents—in this case roughly 76% minority—it strains logic to state that there is not a minority community that will be disproportionately impacted.”

Brooks, who says Fresh Air Vallejo had not engaged with the Department of Justice beyond an

initial letter, adds that “it’s very encouraging to have fresh eyes on the situation.” Although not legally binding, the letter prompted a swift reaction from city manager Greg Nyhoff, who delayed the release of the EIR until January.

With the ball back in the city’s court, Brooks and Fresh Air Vallejo are looking at the long game. Beyond the city, the project would be subject to review by the BAAQMD, the Bay

Conservation and Development Commission, and likely other state and federal agencies.

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COVER IMAGE: White Sturgeon from UC Davis lab (see p. 6).
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GREENING, cont'd from page 16

"The theory was that those first plants would have essentially been sacrificial," Meisler says. "Once the levee breached, the salt water would kill them — but the roots would hold the mounds in place, and the dead vegetation would act as a comb, pulling sediment out of the water."

However, that theory was never put to the test. Time limits on funding meant the project needed to be completed sooner, and didn't allow the years necessary for the mounds to lie fallow or grow vegetation, Meisler says. In the first year post-breach, the mounds lost an average of 1.5 feet in elevation.

While about one-third of that loss resulted from subsidence of the mounds under their own weight, it was still far greater than expected. "The wave erosion of the mounds was extreme after the breach, especially during the spring of 2016," says Mike Vasey, director of the San Francisco Bay National Estuarine Research Reserve, a partner on the project.

Triage for the mounds began that spring, when Buchbinder installed experimental plots of Pacific cordgrass, *Spartina foliosa*, which is the only

native species suited to the lowest or most inundated marshland. Since Buchbinder's first round of plantings coincided with the most rapid period of erosion, many plots did not have a chance to take root. But she replanted that fall, and erosion of all the mounds slowed. By 2017, planted mounds — 18 in all — had stopped their rapid erosion. Some have since regained elevation.

"I don't want to imply that the plants are responsible for stopping all the erosion," Buchbinder says. "The massive erosion stopped on its own — but [while] the control mounds continued to erode, the *Spartina* mounds were stabilized."

And that stabilization means the mounds will stay in place for the future, where they can do the good work of trapping sediment. Already the Bay floor within the Dickson Unit has gained an average of three feet of new mud, according to Vasey.

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Photo: Robin Meadows

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