

SAN FRANCISCO

ESTUARY

Marathon Eradication Program Working Through Cramp at the Finish Line

Camp Fire Runoff into Butte Creek Doesn't Deter Spawners

Basking Sharks Needle in Pacific Haystack

Group Walks Half 500-Mile Bay Trail

Bigwigs and Bug Science Behind Floodplain Reactivation

Bay Not BPA-Free

**WATER
ENVIRONMENT
CLIMATE
EQUITY**

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E D I T O R ' S D E S K

When the news gets too chaotic, and you know the whole story isn't getting reported (has Congress really done nothing on our payroll these last three years except agree to disagree?), and you feel like the things you believe in – science, equality, humility, Nature – are being overlooked so everyone can make the last available buck at the expense of everyone else, my answer is always go to what's real, local, and personal.

So this fall I'm taking a time out to update the book I co-wrote with Kathleen Wong called the *Natural History of San Francisco Bay*, UC Press, 2011. Now many of you may have read the book, used it to teach an environmental science class, or even contributed your insights or research to its 220 pages. It's really your book, about our Estuary, and all the work

you are all doing to understand how it works and what we need to do to restore it to a functional ecosystem.

So let me invite you now to find a copy and send us ideas for the update. Maybe there are newer numbers to report? Different species to highlight? Changes in the system since 2011? Lessons learned? New frontiers of resilience?



Kathleen and I are negotiating with UC Press on the update, looking for new co-publishers and grants, and also hoping to make more of the book available online as a quick research resource.

So don't be shy. Take a moment and share with us any thoughts on what the update should include, and how we can make the book more riveting and relevant.

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WHAT IS THE STATE OF YOUR ESTUARY?

CONFERENCE 2019 OAKLAND, CALIFORNIA OCTOBER 21-22

This October, the San Francisco Estuary Partnership will host the 14th biennial State of the Estuary Conference at Oakland's stunning Scottish Rite Temple. In addition to plenary and breakout sessions on habitats, living resources, water quality, climate resilience, and environmental stewardship, participants will also enjoy an interactive arts showcase created by the Exploratorium, a drone demonstration, and a walking tour of Oakland's green infrastructure.

Program & Registration:

www.sfestuary.org/state-of-the-estuary-conference/

Monday, October 21

Morning plenary sessions on climate change and the future of California's water; an overview of the 2019 *State of the Estuary Report*; and efforts to create equitable and inclusive solutions to environmental problems.

Afternoon breakout sessions:

- Wetland monitoring, including new technologies;
- Climate resilience science and policy;
- Nutrients and emerging contaminants;
- Resilient design and social infrastructure, including approaches to the environmental challenges of homelessness.

Tuesday, October 22

Morning plenary sessions on nature-based infrastructure and a big-picture view of the Estuary.

Afternoon breakout sessions:

- How species connect the Estuary to the ocean, and fish and wildlife as indicators;
- Science, decision-making and governance for climate adaptation;
- Green stormwater infrastructure and working lands;
- Urban biodiversity and human health, and environmental education and the humanities.

I N T E R V E N T I O N

Just Shy of Splendor in the Grass

JACOBA CHARLES, REPORTER

A tall, slim man dressed in a straw hat and a white Tyvek suit scrambles halfway down the muddy slope of a channel in Hayward's Cogswell Marsh. A second man in spattered waders stands nearby, consulting a GPS device. This is Tobias Rohmer, monitoring program manager of the San Francisco Estuary Invasive Spartina Project (ISP), and the device contains a detailed map showing the locations of the plants targeted for removal.

Applicator Ben Chen directs the wand of his backpack sprayer to apply small amounts of the herbicide Imazapyr to an individual clump of highly invasive cordgrass, a *Spartina* species, that sprouts from the bank. Then he clambers back up, and the pair high-step through pickleweed and gumplant toward another patch of the rhizomatous invasive. Elsewhere in the marsh, an egret stabs for a fish.

This pair's careful work represents one small moment in the massive, nearly 20-year-old Invasive Spartina Project. Experts describe

it as one of the most ambitious, technologically complicated, and—so far—successful invasive-species eradication programs in the world. To date an initial total of 805 acres of non-native cordgrass, spread across 70,000 acres of the San Francisco Bay's marshlands, has been reduced to less than 40 net acres. The project has an annual budget of \$2.8 million, and a total cost of roughly \$45 million to date. However, the long-term success of the program faces unresolved threats in the form of federal closures of certain infested areas.

On this day in late summer, in this particular place, only a two-person team is needed to treat the few spiky clumps of invasive cordgrass scattered across the plain of native pickleweed and saltgrass, or popping out from channels lined by gumplant's cheerful yellow flowers. However, a different ecological story lies just a few hundred yards away on the southern side of a levee. There, invasive cordgrass dominates: the marsh is blanketed by tall thickets of the spiky grass, rather than low fields of natives.

"This really shows you what the difference is with and without treatment," says Rohmer. "The levees were breached [in the 1980s] and it immediately got invaded by the cordgrass. It said, 'ooh, fresh mud!' and nothing else had a chance to get in."

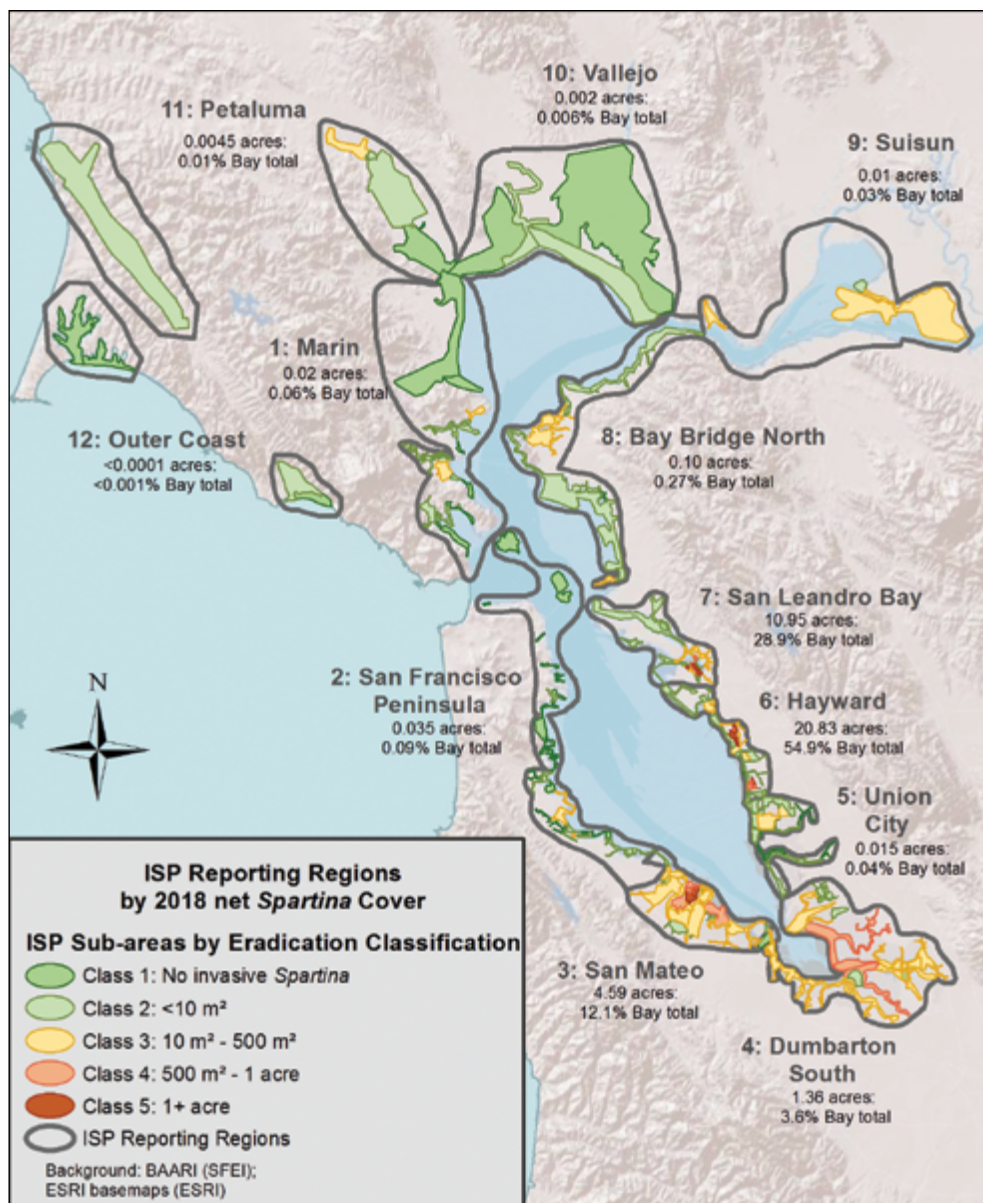
Treatment of the southern section of Cogswell marsh was halted in 2011, due to federal concerns about impacts to the endangered California Ridgway's rail. Though the Invasive Spartina Project staff hope to resume their eradication program in the future, at the moment the site serves as an example of both how far they have come and what they hope to avoid.

"Complete eradication has been and still is our goal," says project manager Marilyn Latta of the California State Coastal Conservancy, which manages the Invasive Spartina Project in partnership with the US Fish and Wildlife Service (USFWS). "It's important that we fully eradicate it from the Bay, and that takes a constant pressure. We can't let up, we can't take a year off, we can't not monitor or treat for very long."

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Photo: Jacoba Charles



Spread of an Ecosystem Engineer

When the project was launched in 2000, its leaders were motivated by the fact that doing nothing would mean losing our familiar marshscapes, and many of the marsh's native species, throughout the San Francisco Estuary. If left unchecked, invasive cordgrass would reshape the tidal wetland habitat of the entire San Francisco Bay—and beyond.

"This is not just an invader within the community. It re-forms the community around it, and creates a new ecosystem," says Peter Baye, a coastal ecologist who coauthored the USFWS Recovery Plan for Tidal Marsh Ecosystems.

There are a handful of invasive cordgrass varieties in the Estuary—all of which are treated by the ISP—but

by far the most problematic is a hybrid between the native species (*Spartina foliosa*) and a species introduced in the early 1970s from the east coast, where it is native, by the US Army Corps of Engineers (*Spartina alterniflora*). Planted experimentally along a flood control channel in Alameda, it spread rapidly throughout the Bay and has been found as far away as Point Reyes and Bolinas. To date all known populations outside the Bay have been successfully eradicated, with the exception of one small population in Bolinas whose removal is underway.

Native cordgrass is an integral part of west coast salt marshes, because it is the most tolerant of saturation. Since it's happy with wet feet, it is the single native species that grows on the lowest parts of the marsh, providing myriad ecosystem services from habitat to flood and erosion control.

Hybrid cordgrass grows more densely, aggressively, and in a much wider range of conditions than its native counterpart. Unchecked, the hybrid can march across virtually all of the salt marsh and out into the mudflat. Able to tolerate even more inundation than our local cordgrass, the hybrid fills in the vibrant, mucky channels that are the lifelines of a tidal marsh and its denizens, such as the endangered Ridgway's rail.

But it also takes over the drier high-marsh habitat, where the salt marsh harvest mouse likes to scamper through pickleweed. Its thickets grow up to seven feet tall and act like fences—they slow high water, snagging sediment and thus building up the marsh itself, raising more and more of the ground above the water line. And in addition to reducing above-ground biodiversity, the invader also reduces biodiversity below-ground, as well as changing the benthic community.

"The main issue is that the invasive cordgrass is able to out-compete a lot of other species and you end up with a monoculture," says Latta. "We don't want this because different plant species provide different biological and physical values."

Eradicating the hybrid cordgrass presents a particular challenge because it is a chimera. It can grow low, indistinguishable from the native except for on a genetic level. It can grow tall and spiky, too, and pretty much any form in between. It reproduces not only via seed, but also vegetatively, as bits of its root-like system of rhizomes break off and float from place to place on the tides.

High-Tech Tools

Eradicating a chimera hiding in 70,000 acres of marsh has demanded that the project leaders continuously experiment and adapt. To hear it described, the operation resembles the ecological version of precision warfare. Ecologists have launched drift cards to identify vulnerable areas; conducted genetic analysis to identify native species lookalikes; sprayed Imazapyr, a short-lived, aquatic-safe herbicide, on highly infested areas from a helicopter; and in other places used a real-time, cloud-based GIS mapping system to selectively target single invasive plants surrounded by native counterparts.



“They have made extraordinary gains,” Baye says. “I don’t think there has been a single estuarine recovery like this one.”

These days, the project has a year-round schedule that includes monitoring, treatment, and restoration. While some hybrids are identifiable in the field, genetic analysis is also essential in order to identify the location of hybrids that are otherwise indistinguishable from native species—until they spread to a degree where they begin to cause ecological problems. To preempt this, leaf samples are collected and shipped to a commercial laboratory in southern California for extraction and analysis. The ISP then reviews the data from the lab to determine, for every sampled plant, the likelihood of it being descended from

S. alterniflora ancestry; these results are then fed into the program’s GIS layers, so the plants can be located in the field during future treatment and inventory events.

Access is another hurdle for the program. While some marshes can be treated on foot by a small team, a few are still so large and densely infested that they are sprayed from helicopter. Still others require access by an airboat, or the “marshmaster,” an amphibious vehicle that can float or roll on tracks. Additionally, access must be carefully timed in coordination with the tides — not only to permit access, but also to leave enough time for the herbicide to dry and take effect.

One major challenge for the restoration arm of the project was obtaining a reliable source of native cordgrass. To accomplish this, the ISP partnered with The Watershed Nursery in Point Richmond to grow genetically tested, native clonal plants. At one point the nursery had 40 beds of the plants; to date, more than 450,000 seedlings have been planted at more than 40 sites, once they were deemed clear of invasive cordgrass — a key step to prevent more hybrids.

While plantings — of the cordgrass seedlings, and other native species such as gumplant — are a vital part of the restoration, the team has also constructed more than 130 islands

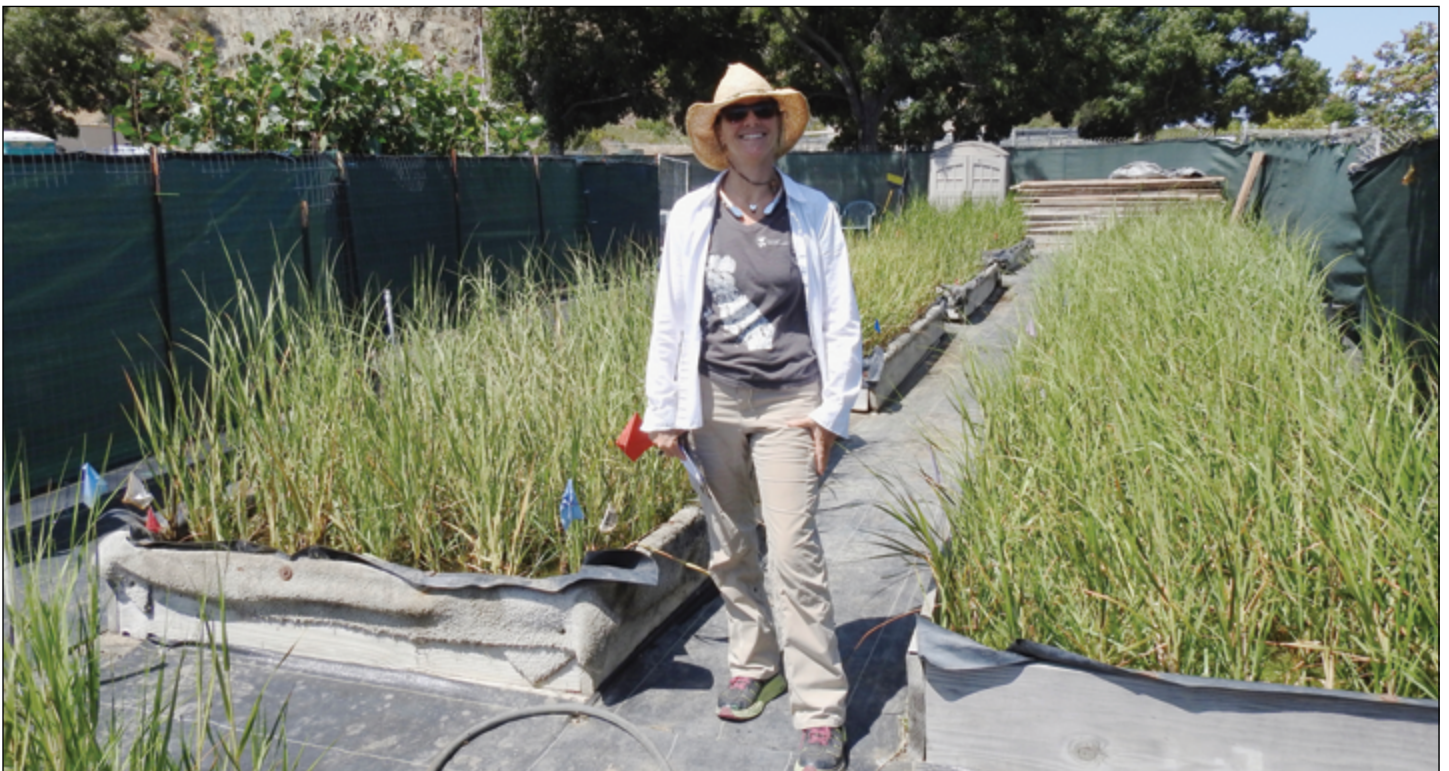
to serve as additional habitat for rails and other species. This includes 75 temporary “floating islands” made from a PVC mesh and raffia, and 62 permanent high-tide refuge islands constructed of on-site sediment and planted with native vegetation.

“These are important because a lot of young restored marshes might be fully submerged at very high tides, so there is really high predation during those events — rails are more visible and available for predators to pick off,” says restoration manager Jeanne Hammond.

In addition to overcoming these logistical and technical constraints, the ISP has collaborated with more than 150 landowners, including private homeowners and public agencies such as the East Bay Regional Park District.

“It would just be a losing battle if we didn’t have all the landowners engaged,” Latta said. “One site that is fascinating on that front is Corte Madera Creek. Our lead local partners Olofson Environmental, Friends of Corte Madera Creek, and the Marin County Department of Agriculture had to coordinate with 108 landowners; it took years of hard work to reach and gain permission from everyone.”

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Diana Benner, co-owner of The Watershed Nursery, which grows native *Spartina* for the restoration arm of the Invasive *Spartina* Project.
Photo: Jacoba Charles

Unplanned Hurdles

Although the ISP set an initial goal of eradication by the year 2016, it met an unexpected hurdle in 2011 in the form of a biological opinion from the Fish and Wildlife Service. One of the project's unavoidable impacts, as predicted in the project's 2003 Environmental Impact Statement, was initial loss of habitat for the Ridgway's rail. These small, shy birds thrive in scattered clumps of vegetation, which is created in abundance when the invasive cordgrass first begins to spread. However, as the infestation progresses the clumps will turn into dense stands, and eventually eliminate mudflats entirely—which will harm the rails and other species that depend on these habitats.

"If you run the clock forward, this [treatment restriction] is not a good thing for rails," Baye says.

When the Ridgway's rail population dropped throughout the Bay from 2008 to 2010, the USFWS blocked invasive cordgrass removal at 14 sites, totaling 585 acres, where the rails were determined to be too vulnerable, or their populations too important, to risk any decline.

"I don't think we were expecting to have treatment restricted completely," says Hammond. "A lot of the sites were really far along into treatment."

At the time of the closure in 2011, the total acreage of invasive cordgrass throughout the Bay was 49 acres and estimated to be on track for full eradication at most sites by 2016. In the intervening years, treatment continued where allowed and the regional total continued to decrease, to a low of 27 acres in 2016, with 22 of those acres (80%) in sites with treatment restrictions.

However, with a source of invasive seeds and rhizomes protected, the acreage has now climbed to nearly 40 acres, with 26 acres (70%) in sites restricting treatment. Not all of the spread can be attributed solely to the restrictions, Latta says—a series of wet years also gave the invasive population a boost. Nonetheless, the closures remain the most pressing threat.

"My concern is that a leaky refuge for hybrids will be maintained in place without a definite endpoint," Baye says. "The invasive hybrid is hard to keep fully controlled, and needs to be eradicated in order for repopulation of the native species to occur en masse, and for large-scale tidal marsh restoration to proceed."

Baye says that his particular concern is the proximity of the treatment-restricted zones to the South Bay salt ponds. "That project is moving ahead, and if thousands of acres become receptive, while at the

same time there is a new population center for generating the hybrids, I think there is a risk that it could go back to being unmanageable."

"The nexus between these two projects is an ambitious effort to restore native salt marsh for rails, mice, and other Estuary species — and we can't move forward on one without the other," says Anne Morkill, USFWS Refuge Complex Manager.

Forging on

Latta is hopeful that the ground lost to the closures will be regained over time. Last year, some of the closed sites were reopened to treatment, after rail numbers increased and the ISP requested a re-consultation from the Fish and Wildlife Service. Six of those sites (35 acres) are open to full treatment, while two sites totaling 146 acres, which also support high numbers of Ridgway's rails, are currently treated for seed suppression only. Seed suppression is accomplished by low-dose, broadcast treatments of non-glyphosate herbicide by helicopter, which aims to prevent seeds from forming. However, this treatment does not address spread from rhizomes, or the habitat changes that occur as the existing stands mature.

Although some rails may be lost due to the treatment, the reopened areas—all located in Hayward, San Leandro, and San Leandro Bay—are part of a regional network of marshes that are fairly well connected, with connected clusters of high-quality habitat that the rails may take refuge in as the treated areas recover. Rail habitat is sensitive in less than 150 acres of the project area, out of 70,000 acres of marsh and mudflats throughout the Bay.

Latta hopes that the remaining four sites closed to treatment will also be reopened in the future. She says that the ISP plans to ask the Fish and Wildlife Service to review them in the next year or two, once they have evidence that the methods being used on the seven re-opened sites are working. "We have made so much collective progress with our dedicated partners, and we've built all of the tools to finish the job," she says. "We are looking forward to reaching this milestone and we need everyone to keep working together until it's done!"

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Invasive Spartina stalk among natives. Photo: Jacoba Charles

F I R E

Tire Melt in Salmon Stream?

LISA OWENS VIANI, REPORTER

On the morning of November 8, 2018, Allen Harthorn, a farmer who lives about two miles from the town of Paradise, watched a dark cloud of smoke forming in the east and began to worry about the safety of his and his neighbors' homes. He also began to worry about some other residents of the Butte Creek watershed—the largest run of naturally spawned spring Chinook salmon in California.

The fire missed Harthorn's home, but grew into the deadliest wildfire in California history, blazing through 153,000 acres, killing at least 86 people, wiping out over 18,000 structures, and devastating the foothill town of Paradise. Because this fire was such a new breed—one that burned forests and wildlands as well as cars, appliances, homes, and even septic tanks—scientists, fish advocates, and resource managers are unsure of exactly what the impacts on the salmon will be or how well they will recover.

Harthorn, who also heads up the Friends of Butte Creek and has worked for 20 years to support recovery of the fish, was thrilled to see plenty of adult salmon in the creek this summer. But he wonders about the fate of the juveniles that had just emerged from the stream's gravel to make their way downstream (and ultimately to the Sacramento River, estuary, and ocean) when the fire struck. "They would have had an 80- or 90-mile journey through various degrees of toxicity," says Harthorn. "[Plus] they were eating invertebrates and other microorganisms; they very well could have been picking up toxic compounds."

Those compounds were a result of the unusual nature of the wildfire, says Jackson Webster, assistant professor of civil engineering at California State University Chico. Jackson, along with several state agencies, began sampling water quality in the creek as soon as the first rains began in late November, shortly after the fire was contained. "This was an urban firestorm with building after building igniting, but it wasn't burning the tops of the trees. It was driven by rolling embers pushed by wind on the ground," says Webster.



Winter flows in Butte Creek after the 2018 Camp Fire. Photo: Jackson Webster

It appeared as if many of the burned homes' concrete foundations captured a lot of potentially contaminated sediment, he says, but the mobile home parks that burned were a different story, with runoff from those homes, which just sit on slabs, heading directly for storm drains and the creek. Webster says as many as 30,000 cars burned as well—and their tires. "Many of those cars were sitting on asphalt and draining into the storm drain," says Webster, who saw the creek's waters running black, smelling of smoke.

The Department of Water Resources and the Central Valley Regional Water Quality Control Board also monitored water quality

in Butte Creek, which is not a source of drinking water for humans, during peak storms from December of last year through May 2019. Those results show elevated concentrations of heavy metals and PAHs (polycyclic aromatic hydrocarbons), a byproduct of combustion that can be toxic. Webster says levels of aluminum in particular were initially high enough to affect the health of fish and aquatic life. But Clint Snyder, assistant executive officer with the Central Valley Water Board, says the system is continuing to flush itself out. "By May of this year those concentrations had decreased quite a bit," says Snyder.

The state agencies and Chico State researchers will monitor water quality again this fall and into next spring. "We're still trying to figure

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Spring run Chinook passing over Durham Mutual Springer Dam. Photo: Scott McReynolds

out how to measure any contaminants in the stream bed material that could be released into the food web," says Webster. In addition to collecting soil samples, he and colleague Sandrine Matiasek, assistant professor of geological and environmental sciences, collected some of the straw wattles that were placed to control erosion, and will be analyzing any toxins they contain.

They'll also be examining char, or burned wood, says Matiasek. "This char can act as a sponge for contaminants that are not very soluble in water, so we're interested in understanding the role it plays and how it might filter contaminants, [as well as] what happens if salmon are spawning in an environment rich in char."

Follow-up after the fire was tricky. The California Department of Fish and Wildlife was unable to monitor benthic invertebrates, which sustain young salmon, or stream gravels after the fire because so many staff members lost their homes during the event and were scrambling to cope.

Robert Gresswell, an emeritus research biologist with the United States Geological Survey in Bozeman, Montana, who has studied the impact of wildfire on streams for many years—albeit not this new kind of wildfire with a town burning in the midst of a forest—says wildfires undoubtedly have an effect on invertebrates, at least in the short term. "You might lose mayflies and caddisflies for a while but different species

come in and overall biomass remains the same."

Another potential challenge for fish after wildfires is the loss of riparian vegetation, which can lead to a lack of shade and elevated water temperatures. But Clint Garman, an environmental scientist with Cal Fish and Wildlife, says much of the riparian vegetation on Butte Creek did not burn or is starting to rejuvenate. "Some of the trees that burned are contributing to large woody debris that the juvenile fish will use as habitat," he adds. The Friends of Butte Creek have applied for a grant to prepare a restoration guide for landowners that will include native and non-native plant identification and management, and funds for tree planting, primarily in the riparian areas.

Scientists and fish advocates won't know exactly how well the juvenile salmon survived the fire's impacts on the stream for a few years. The juveniles that out-migrated last fall will come back as two-, three-, and four-year-old fish, Garman explains. "Butte Creek adult fish are predominately three years old, so 2021 will be the year to look at adult returns."

He hopes that last winter's heavy rains after the fire helped the juveniles that survived make their way to the estuary and ocean. He acted conservatively in monitoring the juvenile fish this year — by not trapping them — to give them the best chance to survive. "Especially under last fall's circumstances, I felt it best to leave them alone and let nature do what

it does, without us adding additional stress on them. I'm sure [the fire] didn't help matters, but other than the heavy metals, [these fish] have co-evolved with wildfire and turbid water conditions throughout their life history," says Garman.

The adult salmon, which are resting in the stream right now, getting ready to spawn, are probably helping the stream recover, Gresswell says. "Those salmon will be working the substrate as they rebuild their redds, which helps mobilize fine sediment and flush it downstream." These adult fish do not eat for months and rely on stored body fat to survive, from the time they migrate upstream from the estuary and ocean until spawning, Garman explains. That means their risk of consuming contaminated invertebrates is much lower than that of juveniles.

For now, the effort to clean up fire debris continues, activities that could have their own impacts on the Butte Creek watershed. "There's a massive amount of construction, truck traffic, dust, erosion, that could have a secondary effect," says Webster. He and his colleagues continue to collect sediment samples and are seeking funding to focus more on the sediments and potential effects of contaminants on juvenile salmon.

They'll continue to monitor the watershed this winter. Webster says he wants to better understand not only how the stream environment is changing but also how long it takes to recover. While recovery from the devastation continues, he sums up the concerns of many: "What are the sources of contaminants? Is it the cars, is it the trailer parks, houses, and how should we respond in the future? What should our priorities be?"

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DEEPER DIVE

www.sfestuary.org/estuary-news-tire-melt-butte-creek-salmon/

Bay Not BPA-Free

ARIEL RUBISSOW OKAMOTO, REPORTER

Even though your big bottle of artesian spring water says “BPA-FREE” on it, that doesn’t mean it’s better for you than your tap water, especially if the bottle contains “a regrettable substitution” or has sat out in the sun in a local parking lot or shipping yard.

“BPA is globally detected in human urine,” says scientist Ila Shimabuku of the San Francisco Estuary Institute. She is not surprised, because bisphenols are produced in such massive quantities and used in plastics, papers, and many other consumer goods. “It’s in pretty much everything you’d find at Target.”

BPA, one of a chemical group called bisphenols, is a clear, stable, durable ingredient in plastic bottles, can liners, cash register receipts and many other things we use and touch every day. In fact, bisphenols are so widely used by the industry that trying to identify the sources and points of entry into our water supplies and waterways is a major challenge. New research from the Bay Area’s Regional Monitoring Program does confirm, however, that bisphenols are ending up in Estuary waters in amounts whose order of magnitude isn’t that far off thresholds for ecotoxicity.

In 2017, the RMP collected and analyzed 16 bisphenols (including bisphenol A, or BPA) in 22 water samples from around San Francisco Bay. Concentrations of BPA found were similar to those found in other marine and estuarine environments and in the range of 1.5-35 nanograms per liter or parts per trillion. The probable “no effect” threshold for BPA alone is 60 ng/L according to the literature.

“It’s an intriguing compound in terms of its mechanism for action on our health,” says the Institute’s lead scientist on emerging contaminants, Dr. Rebecca Sutton, referring to the fact that BPA can disrupt our hormone systems at very, very, very low levels. “A trace of BPA in water can affect wildlife.”

While a well-developed body of research on BPA clearly demonstrates the disruption of endocrine

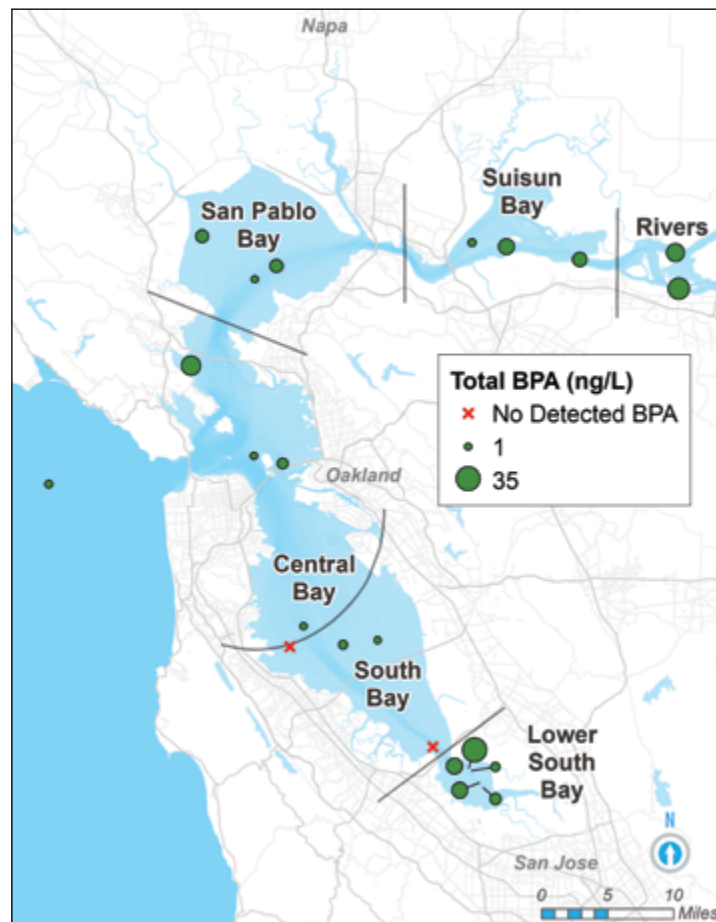
systems in both humans and wildlife, and while bans on BPA in a few items like baby bottles have been in place since 2012, it’s still in the environment. Worse, scientists suspect replacements, such as bisphenol S [BPS], may just be another version of the same thing.

“We have no information to say that BPS is safer than BPA, and we’re finding both in the Bay,” says Sutton. Manufacturers are not required to tell anyone what’s in plastics or other products and Sutton suspects they may have made “a regrettable substitution” of one toxic chemical with another from the same class of compounds.

In the Bay samples, the RMP discovered comparable levels of BPS and BPA. “It worries me that we found similar concentrations side-by-side, but that BPA is used, imported and manufactured 1,000 times more than BPS,” says Shimabuku. Bisphenol S may last longer in the environment, she suspects. “All the BPS we found was in the dissolved, water soluble form,” she says, which means it can be most easily absorbed into the estuarine food chain of fish, birds, seals, and eventually humans.

If a substitute is roughly the same chemical structure, it’s likely to act in a similar way in terms of environmental effects, says Dr. Liz Miller, SFEI’s new toxicologist. “Toxicity studies take a lot of time, money, and organisms, so it’s ethically somewhat questionable that we should now have to study BPS. It’d

be better to spend the money researching an alternate with a different chemical structure. But the industry and the regulations don’t work that way.”



RMP Monitoring Results . Source: SFEI

“When I read this new RMP research, the first thing that struck me is we should be reversing the burden of proof here,” says Andria Ventura, an activist with Clean Water Action. “We should not treat the Bay, wildlife, or the people that live around the Bay, as lab rats for the chemical industry.”

Industry has fought BPA-limiting legislation for years. In the early days, they even had advertising campaigns suggesting those on food stamps would lose their canned goods if passed, according to Ventura.

Clean Water Action is involved in three state bills in various stages of approval related to bisphenols. AB161 (Ting), in the suspense file at press

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T E C H N O L O G Y

Drones Pilot Vegetation Mapping

MICHAEL HUNTER ADAMSON, REPORTER

From aerial photography to package delivery, few technological innovations in the last decade have captured the public imagination like drones have. In the world of conservation, as attested to by multiple speakers at a late-summer UC Davis workshop, they may be the vehicle of choice for mapping the future of invasive plant management in the Delta.

Industry insiders that have adopted the technology prefer the acronym UAV (unmanned aerial vehicle) over “drone” to avoid connoting parallels to the military weapon. While the vehicles are still controlled by an FAA-certified pilot operating from the ground, the term “unmanned” separates them from a host of other pilot-present aircraft like helicopters, planes, and balloons.

The California Department of Water Resources began using UAVs in earnest after the Oroville dam failure in the winter of 2017. Harry Spanglet, a program manager with the Department, says UAVs were “critical” to the post-incident mapping effort. “They could access areas that were unsafe to get close to, particularly at the break.”

Stillwater Sciences, a company that consults for organizations like DWR, has been using UAVs since

as early as 2014. Rob Thoms, plant ecologist with Stillwater, has seen the technology improve markedly in the five years since. He recalls an early project in the Delta: “Our pilot needed to bring four backup batteries. It could fly for half an hour to 45 minutes and we needed four hours of flight time.” He can’t recall any need for recharging in more recent efforts.

Resolution of the accompanying sensors also helped bring UAVs up to speed. The greater the resolution, the higher the altitude at which a UAV can fly to achieve the same image accuracy. “The cool thing about that is the higher up you are, the fewer passes you have to design into the flight pattern, so it goes faster,” says Thoms. “You can cover more ground in the same amount of time, or the same amount of ground in less time.”

The Blacklock Ranch, a leveed island in the Suisun Marsh, offers a typical case example of how drones can be employed at a restoration site. Water Resources is currently managing an infestation of highly invasive common reed at the ranch. “We are using our UAVs and our multispectral sensors [measuring energy in the red, blue, green, and infrared regions of the spectrum] to map and monitor the spread of the weed,” says Spanglet. Once mapped,

treatment plots can be established and UAVs can continue to monitor treatment efficacy.

UAVs “are the wave of the future,” says Spanglet, and improvements to the associated sensors will propel that wave. Hyperspectral imaging (“measuring energy in the entire spectrum in hundreds of discrete bands instead of just the usual 4 or 5 bands,” Spanglet explains) and LiDAR (firing lasers and measuring the time it takes for the reflection to return; a kind of light-based sonar) are capable of providing extremely accurate images but at a steep price. Spanglet expects the costs of these now prohibitively expensive sensors to come down considerably in the next five to ten years. Thoms is interested to see how LiDAR used in driverless cars may help UAVs navigate densely forested riparian corridors. Reactive sensors like those used to help a vehicle begin braking before the driver applies the pedal may help safely navigate these maze-like environments.

“We’d be able to locate and quantify patches of invasive Himalayan blackberry in the understory, for example,” says Thoms.

Technology has historically been a boys’ club, with women underrepresented relative to the overall population. The UC Davis event, however, featured many female presenters. Stillwater, meanwhile, will soon have their first female FAA-certified UAV pilot. Thoms hopes that technological strides in the field will be accompanied by commensurate leaps in parity.

Whatever future advancements are made, Spanglet stresses that UAVs cannot replace on-the-ground field crews, whether they are collecting samples, conducting conservation work, or ground-truthing desired outcomes. It’s better to think of UAVs as a kind of spotter in the sky, searching for signals in the noise. In such a rapidly changing ecological landscape, that’s a valuable tool.

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Photo: Stillwater Sciences

R E C R E A T I O N

True to the Trail

ALETA GEORGE, REPORTER

On a clear San Francisco morning, I met Barb Christianson and Sally Jo Dinwoodie, both 64, at a Hunters Point neighborhood with new, multi-storied townhouses that can go for a million dollars. Seven of us headed down the hill towards the Bay with the San Francisco skyline and Bay Bridge sparkling.

Christianson, Dinwoodie, and a small group of friends are walking the entire San Francisco Bay Trail by tackling one segment at a time, in order, once a month. After two years, they have covered more than half the trail, both the finished, and as best they can, the unfinished portions.

At the Hunter's Point Shipyard, we walked past a guard who was fast asleep in the guardhouse. Our plan was to drop down to Crisp Street, the closest street to the water. As we discussed the route, a woman in a Jeep Cherokee drove up to the guard gate and honked her horn to wake up the guard. She yelled at him, and then yelled at us that the area was restricted.

After some disappointed discussion and talk of dissent, we eventually chose to climb back up to the transition area between Hunters Point and Bayview, where cultures and economies are pushing against each other. The condos were tidy and neat, but the neighborhood felt like a ghost town. The older neighborhoods had friendly people and more activity but are in serious need of some love in the form of city dollars.

At the bottom of Ingalls, we turned towards the water and were excited to find an open gate to Yosemite Slough and a trail along the water. A field of pickleweed, an egret, and a killdeer's warning cry were familiar signs of a tidal marsh. Abruptly, the trail ended in an area heaped with trash and clothes. "This is the Bay Trail. One minute we're on the trail and the next it dead ends into a homeless camp," someone said.

The San Francisco Bay Trail is a proposed 500-mile trail that when finished will ring the Bay. This year marks the 30th anniversary of the year the region launched the Bay

Trail. To date, public and private landowners have completed 356 miles of trail. The finished miles appear as solid green lines on the navigation map and the 25 regional map cards, and the yet-to-be completed sections as dashed green lines.

Bay Trail project manager Laura Thompson says that some of the dashed lines "represent a vision of how people will experience the edge of the shoreline in the future." She stresses that the project discourages trespassing, and asks people not to follow the dashed lines. On the ground, only some of the unfinished sections are actually traversable. When they are, the Bay Trail map cards indicate a safe way to navigate those legs.

From the beginning, this group of Bay Trail walkers chose to walk the whole trail. "We stay as close as possible to the Bay. We want to see it. We're on the Bay Trail," says Christianson. "We've only trespassed maybe five times."

Dinwoodie says they draw a clear line. "We've gone through holes in fences and walked through gates that were closed, but we have never climbed a fence and we don't go through residential private property."

On their one-year anniversary, the two women, along with Michelle Dhanak and Adena Kershner, approached a closed gate with a "No Trespassing" sign in Vallejo. The factory inside the fence was shuttered and there was a tempting hole in the fence.

They weighed their options at the gate. The Mare Island Strait lay to their left, and a steep cliff to the right. If they didn't go forward, they would have to backtrack for miles, and that was against one of their three rules: Stay as close to the water as possible; don't take shortcuts; and no back tracking.

Their trek had already proven challenging that morning. They had had to climb over slippery rocks underneath the Carquinez Bridge because of a trail gap. There's a vision for the trail to cross Interstate 80 further north at Sonoma Boulevard, but for now, it's nothing more than a dashed line on the navigation map.

After a brief discussion, the walkers slid through the hole in the gate. What they didn't know was that they were stepping into a red-hot, land-use issue in Vallejo. The shuttered factory was the old General Mills flour plant and the site of a proposed cement plant opposed by many Vallejo citizens. (The Orcem cement plant proposal was withdrawn on May 24, 2019 — see *ESTUARY* 12/18 issue.)

Within minutes, a female caretaker sprang out of an abandoned building with two leashed barking dogs. "You can't go through here. You have to turn around," she snarled.

Without missing a beat, Christianson approached the woman (and the barking dogs) with phone in hand. She was polite, showed the caretaker where they were trying to go, and asked if she had any ideas on how they could get through.

The caretaker softened and escorted them to the gate at the other end of the 39-acre property. "Barb won her over," says Dinwoodie. "We always joke, if there's a problem we'll send Barb."

The walkers celebrated their one-year anniversary that day with beers at the Vallejo Ferry Terminal. Then they called Uber, and returned to their parked cars.

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Photo: Katherine Briccetti

Nitty Gritty

Christianson and Dinwoodie — both working women who are busy with friends and family — met as young moms 30 years ago. They walked the Bay Trail from Emeryville to Albany every Friday night with strollers. The moms kept walking until Dinwoodie's degenerative back pain kept her from the trail. Dinwoodie resisted surgery until her doctor told her she'd be in a wheelchair if she didn't do something. She had the surgery.

Two years later, when she was healing and Christianson had finished the "marathon project" in which she ran a marathon in all 50 states in 10 years, they decided it would be fun to walk the entire Bay Trail. "Just a little bit each month," Christianson told her friend. "You can do it." They sent an email to their other female friends. No regrets or RSVPs needed. Just show up if you want to go.

They started in Emeryville two years ago this June. One month after their two-year anniversary, I met the group on the north side of the Golden Gate Bridge (it was the first of two times I joined them on the trail to research this story). The two friends are the only ones in the group who have walked a segment every month since the beginning. Michelle Dhanak, and Annette Williams have done most of them, and plan to schedule make-up walks. A core group of others come occasionally.

Eight of us set out at 8 a.m. We crossed the fog-shrouded Golden Gate Bridge, and stopped at the south overlook for a snack. I asked the group if they knew of anybody else who had done the entire trail. "By the time we finish, maybe there'll be somebody," said Dhanak, and everyone laughed.

"We don't have a day deadline, or a number of miles that we have to go each day," says Dinwoodie. "We like to do ten miles, but it's whatever works. We also don't have a deadline for when we finish. We figure it will take about two more years."

In fact, several people have walked the finished sections of the trail, according to Thompson. Corinne DeBra has walked around several times, and returned to her car after she walked a section. Kurt Schwabe used public transit to walk all the solid lines in 30 days.

The trail through San Francisco brought us to Crissy Field with a stop at the Warming Hut; through a busy Farmer's Market at Fort Mason; along the scalloped-shaped Aquatic Cove with swimmers doing their

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Photos: Annette Williams, Aleta George, Barbara Christianson and Katherine Briccetti.

laps; and into the bustle of Fisherman's Wharf and the Embarcadero. We took pictures, patted dogs, and after nine miles of walking boarded a ferry bound for Sausalito and our cars.

"Walking once a month doesn't get you more fit," says Dhanak. "Psychologically you get used to walking longer. Your feet hurt, your legs hurt, but you find out you can do it anyway."

To hear more stories, I met Christianson and Dinwoodie at a café in Berkeley to look at their pictures and the navigation map. As we did, I felt like I was going through a family album with a married couple who had been together for years. They corrected each other and helped one another remember details. And both of them laughed a lot.

"Remember that time in San Rafael when we had to get under the bridge, and that young man on his bicycle helped us?" said Dinwoodie. The only route the walkers saw was on a freeway ramp, but the kid led them down a ravine, through some branches, and onto a trail they never would have seen without his help.

On the same day, they had argued about whether or not to try and walk through San Quentin State Prison grounds, or if they should follow the dashed line that skirted it. According to the map, there was a road closer to the water (remember that rule?) that went through prison grounds.

At the northern edge of San Quentin, the naysayers won the debate and the group walked around the prison. But as they walked, they wondered, "If we had called ahead would the prison have let us go through on the road?" Curious, they stopped to ask the guard at the gate on the south end.

Apparently, his jaw dropped. "Are you kidding me? It's a prison!" he said.

"He was so cute," says Dinwoodie. "He thought we were so dorky."

Napa was difficult; it took them four months of Sundays to get through. A draw bridge that never lowered stymied their progress, and they walked for miles on railroad tracks in the hot sun. One day they had no choice but to walk on the highway because they couldn't get through an airport, a sanitation plant, and a state wildlife refuge that is open to permitted hunting and fishing, but not through-walkers.



They also had fun in Napa. They walked alongside vineyards in the morning sun, went wine tasting, and had a spa day in Calistoga. "We've gone wine tasting four times," says Christianson. "But who's counting?"

Unfinished Business

Back in Bayview at Yosemite Slough, we exited the marsh and walked through an industrial area with people living in RVs until we found our way back to the water's edge at Candlestick Point State Recreation Area. The sky was blue, and a picnic table beneath a coast live oak tree offered a place for a shared snack.

We walked out to Candlestick Point on the designated trail and found campers (with tents and a permit), dog walkers, and picnickers setting up colorful tablecloths and balloons for a special celebration. "I love seeing how many people love the Bay and are using the trail," says Dinwoodie, who attributes her good health to walking and a weekly dance date with Christianson at Berkeley's Ashkenaz.

Upon leaving Candlestick Point, we came to more dashed lines and the need to decide on a route. "We are trying to be faithful to the Bay Trail idea by figuring out the most traversable close-to-the-bay route," says Sally.

"These women's mission appears to be a natural reaction to an unfinished Bay Trail," says Bay Trail's Thompson. "Seventy-one percent complete is enough to motivate people to will it to completion by walking its imagined entirety. It gives me hope."

The two women trail blazers are looking forward to the second half of their adventure in the South Bay, where there are long stretches of completed trail. "We always look for Bay Trail signs. When we find one, we take a picture of it because we're so proud we're on the trail. A lot of the time we're not sure," says Dinwoodie.

"We've always had our stretch of trail that we've felt ownership of from Richmond to Oakland. We have that allegiance, and there's people north of us and south of us who have their allegiances. The Bay Trail is really raising consciousness of the Bay," she adds.

Of course, one can't help but wonder what will happen to the Bay Trail as sea levels continue to rise. Thompson says they are working with other regional and local interests to address unavoidable inundation in some locations. "The Bay Area as a region and individual cities are starting to tackle this," she says. "It's important for us to preserve continuity of the Bay Trail as sea levels rise."

Next month, the conversation, the walk, and the friendships continue.

MORE INFO?

www.baytrail.org

DEEPER DIVE

Check out more photos from the two-year adventure.

www.sfestuary.org/estuary-news-true-to-bay-trail

P O L I C Y

State Plan Doubles Down on Alignment

CARIAD HAYES THRONSON, REPORTER

Integration, alignment, and collaboration are the watchwords of a new blueprint for a sustainable California water future, released as the state faces critical challenges ranging from extreme weather events to contaminated drinking water. The document will help inform the water resilience portfolio ordered by Governor Gavin Newsom earlier this year, and calls for effectively doubling current water-related expenditures by state government.

The California Water Plan Update 2018—released by the Department of Water Resources (DWR) in July—is meant to guide state policy and investment over the next 50 years to maximize the benefits squeezed out of every drop of the water supply.

The update identifies four societal values associated with water and calls for 19 specific actions, each linked to one of six goals. The update—required by law every five years—builds on information incorporated in the 2013 update, including 12 regional reports and 30 resource management strategies, as well as 49 supporting documents developed for the current update.

The timing of Update 2018 is fortuitous. In April, Governor Newsom ordered the California Natural Resources Agency, California Environmental Protection Agency, and California Department of Food and Agriculture to develop a portfolio of water resilience strategies. “There’s a great deal of information in the plan and supporting documents that

covers many of the things that the governor asked for, including an inventory and analysis of water supply and demand, and projected regional and statewide demand,” says the Resource Agency’s Nancy Vogel, director of the portfolio program.

The plan emphasizes a regional approach to water and calls for increased state support for Integrated Regional Water Management programs. “The plan really hits home that with climate change, and with more extreme and consequential events such as droughts and floods, we really have to make a more concerted effort to work together,” says DWR’s Kamyar Guivetchi. “We have to encourage and support the different management sectors — water

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The state’s commitment to funding integrated regional water management is revealed in projects like this under construction in San Mateo County and along San Francisquito Creek in 2018. The SF Estuary Partnership is a key partner, as grant manager and regional collaborator, in achieving the multi-partner, multi-benefit “alignment” supported by DWR’s IRWM and the State Water Plan Update.



Wildlife-friendly hedgerow adjacent to agricultural drainage ditch and orchard near Davis, a multi-benefit project. Photo: Amber Manfree

supply, flood management, water quality, ecosystem, waste water—to work together in what I would consider co-management for multi-benefit projects.” Guivetchi adds that this approach would also enable co-funding of projects.

Improving agency alignment and addressing persistent regulatory inconsistencies will be crucial to such a multi-sector approach. “Our agencies are siloed and their regulations are not always aligned, so it takes a lot of time, effort, and money to implement projects,” says Guivetchi. “This is not about weakening regulations, it’s about making sure that the regulations and incentives that the state provides are feeding into a consistent policy and we are moving on the same trajectory.”

Grace Chen of the Metropolitan Water District, who was part of the update’s Policy Advisory Committee, thinks the emphasis on agency and policy alignment is one of the most important parts of the plan. The call for regulatory alignment and agency cooperation echoes themes of the Delta Stewardship Council’s *Delta Plan*.

Adaptive management is an important aspect of sustainability, says Guivetchi, but managers face impediments such as inadequate methods and tools for assessing current and future water supply and demand, making data-based decisions, and tracking performance. In what it calls an “innovation,” Update 2018 proposes the development of Sustainability Outlooks — tools that would track local, regional, and state actions and investments, and help establish priorities. These tools

would identify outcomes associated with a particular societal value and develop indicators to assess how well that outcome is being served.

For example, “for the societal value of health and safety, one of the outcomes we have identified is an adequate water supply for domestic needs, sanitation, and fire suppression,” says Guivetchi. “One of the indicators that could help us assess that outcome is the number of public water systems that are not in compliance with drinking water standards.”

An Outlook includes four societal values, a dozen outcomes, and three dozen indicators. DWR has piloted Sustainability Outlooks in the Russian River and Santa Ana River watersheds, and Vogel notes that the supporting documents related to these projects have been useful in developing the water resilience portfolio. “I found it incredibly helpful to see which metrics [the Santa Ana] region chose to develop a sustainability dashboard, because there was a big stakeholder process to support that effort,” she says.

In another “innovation,” the update also calls for the development of regional Water Management Atlases. “We need more and better real-time information about our regions that they can use to improve their planning and management, and that the state can use to set policies to actually provide better assistance to their endeavors,” says Guivetchi. “We would work with regional entities to compile information about their water uses, water supplies, future water demands. What are

their main vulnerabilities to climate change, and what kinds of strategies and management actions are really best suited for them?”

The actions and initiatives outlined in Update 2018 are estimated to cost approximately \$90 billion over the next 50 years. “We wanted to be clear-eyed about what it will cost to do these actions over time,” says Guivetchi. About 80 percent of the money — \$78 billion — would go to local and regional water agencies to improve both built and natural infrastructure, while \$10 billion would go to state infrastructure improvements (none of which would be spent on any new Delta conveyance, which will be funded by water contractors if it ever comes to pass). Guivetchi notes that California currently spends about two percent — about \$2 billion per year — of its general fund on water, mostly for capital improvements. “To be more sustainable and resilient, the state should be spending about twice as much as it has historically,” he says.

The plan does not spell out where the money should come from, instead laying out several options, including traditional funding sources like bonds and “novel” sources such as new taxes. Metropolitan’s Chen says she wishes the plan had been more specific. “We need a stable stream of funding to achieve our vision, and that is a very difficult thing to come to consensus on,” she says. “Further updates will need to work on that.”

Guivetchi says work on the next water plan update, due in 2023, will begin after the governor’s water resilience portfolio is finalized later this year. “We want to see which of the water plan actions find their way into the portfolio. That will give us a sense of the logical trajectory of the next update. It’s a never-ending process,” he says. “Sustainability is a journey, not a destination.”

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DEEPER DIVE?

Water Plan Update: water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/Final/California-Water-Plan-Update-2018.pdf

F L O O D

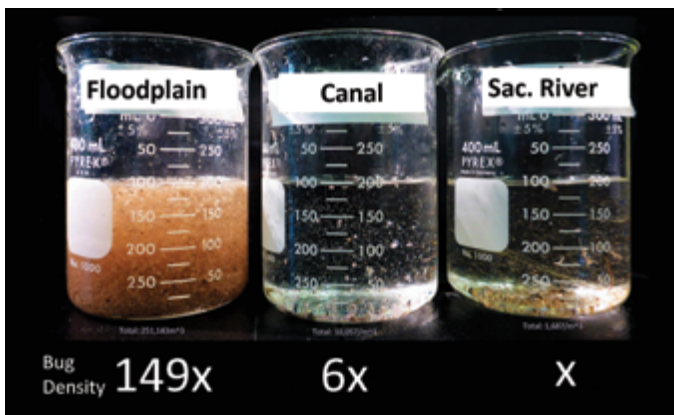
Clout and Cool Science Push Land-River Reconnection

ROBIN MEADOWS, REPORTER

When California natural resources secretary Wade Crowfoot presented a panel called Reactivating Our Floodplains in Sacramento this summer, he drew a standing-room-only crowd. He was just as jazzed. The panel kicked off his new speaker series, which highlights emerging ideas that are not yet institutionalized but have great promise. Statewide, 13,000 miles of levees disconnect our rivers from their floodplains, which once served as nurseries for young salmon migrating to the ocean. Crowfoot wants to help restore this connection.

"It's one of the most exciting parts of my job," he says during an interview just before introducing the panel, his face lighting up in a wide smile. "It's a win-win-win — it's a way we can reconnect water with land, create habitat, and provide flood protection." He also enjoys the break from California's perennial water wars. "So much water policy in the state can be characterized as conflict."

Three panelists represented a broader coalition, including scientists, farmers, and water managers, that came together during the recent record-breaking drought. Their goal is to find common ground instead of fighting about water. In particular, they want to restore the benefits of floodplains for imperiled Chinook salmon in the Central Valley.



Comparing invertebrates in a cubic meter of water in adjacent aquatic habitats of the Sacramento River, Tule Canal and a managed floodplain wetland in Yolo Bypass. Photo: CalTrout



Photo: River Garden Farms

Before all those thousands of miles of levees went in, the Central Valley had one of the West Coast's largest salmon runs, with a million or more of these mighty fish returning each year. A big reason for the salmon's success was that the valley was among the most extensive floodplains in the world. "In winter and spring, the rivers

would swell," says Jacob Katz, a coalition member and fish ecologist at the conservation nonprofit California Trout. "There used to be weeks and months of water flowing across the land." Today nearly all of these ephemeral lakes are lost. Most of the former floodplains in the Sacramento Valley — about half a million acres — are farmed for rice.

In 2012, early in the drought, Katz showed that these farms can double as salmon nurseries. The timing is perfect: young salmon make their way downstream during the winter, when rice fields are fallow. Moreover, these surrogate floodplains do just as much for fish as natural ones: in a three-week test, salmon grew seven times faster on a rice field than in the Sacramento River.

The reason for this phenomenal growth? Floodplains are crammed with tiny freshwater crustaceans like *Daphnia*, which Katz calls bugs, that little fish gorge on. Shortly after his success at rearing salmon in winter-flooded rice fields, he showed that the density of bugs there is a whopping 150 times higher than in the river. "That's 15,000 percent more food," Katz says. "If you're a CEO and you get that kind of return, you're going to get a big bonus."

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Repurposing rice fields as salmon nurseries works on farms in the enormous flood-control bypasses along the Sacramento River. When the river runs high, these leveed bypasses fill with water — and fish. The weirs that control this flow are fixed, however, which limits how often bypasses flood and thus how often fish can swim into them. Now, modifications are in the works to boost salmon access by inundating these former floodplains more often.

Once rice is harvested, farmers typically flood their land to decompose residual stubble, and soon the fields are bursting with bugs. This bounty no longer reaches fish in rivers, the way it did before they were bounded by levees. But it easily could. All it would take is pumping the bug-rich water back into the river.

“It’s really exciting,” says Roger Cornwell, a coalition member who manages River Garden Farms, a rice farm just outside the Yolo Bypass.

compatible with working landscapes. “We built levees so we created some of the problem,” he says. “We see new ways to protect farms so it still works for the environment.”

The coalition is beyond ready to put its science into practice on a scale large enough to benefit salmon at the population level. “Just do it,” Bair says. “This group gives a lot of talks — let’s not waste any more time.”

California Department of Fish and Wildlife Director Chuck Bonham wrapped up the panel presentation by adding his voice to Crowfoot’s in support of floodplain reactivation. “I’m for reconnecting nature and giving salmon a chance to roam,” says Bonham, who previously served as California director for the national conservation nonprofit Trout Unlimited. “We’ve got to go big. California is asking us to do this.”

Bair says making floodplain reactivation a reality will require more pots of money for multi-benefit projects, as well as acceptance that implementing their science will require some fine-tuning. “We’re still learning — we need the OK to do the best we can, learn from it, and do better next time.”

Katz welcomes the enthusiasm from Crowfoot and Bonham that bookended the panel, and says another need is meaningful reform of state and federal rules for fish restoration and floodplain management. “Counterintuitively, environmental regulations can often hinder environmental progress,” he explains, adding that the potential for losing a handful of salmon can block landscape-level projects that would benefit many more of these at-risk fish.

To restore the benefits of floodplains for salmon, Katz calls for institutional changes in the permitting process for multi-benefit projects, which are currently treated little differently from development projects. “We all need to work together to figure out how to move forward through that,” he says.

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These hatchery salmon were the same size before being placed in three adjacent habitats, and measured again three weeks later. Photo: CalTrout

The plan is to retrofit the weirs with operable gates called notches. This summer, state and federal permitting agencies green-lighted a \$190 million project to put a notch in the Fremont Weir on the Yolo Bypass, the Sacramento Valley’s largest former floodplain at nearly 60,000 acres. The weir is a gigantic concrete wall nearly two miles across, and the project will construct a 100-foot notch in it. Opening the notch during the winter wet season will let more salmon swim from the river to the floodplain.

Since discovering that fields make good salmon nurseries, proponents have pushed for the go-ahead to put fish on rice farms up and down the Valley. While waiting, Katz has moved on to other ways the fields can benefit salmon. Notably, most of the Valley’s rice fields are outside bypasses, making them less obviously fish-friendly because water must be pumped on and off them — but, as new research from last winter shows, these fields can still help nurture salmon.

“We’re sitting on such a wealth of productivity for our food web.”

Delivering food in rice fields to fish in rivers may sound improbable, but it actually works. This winter, Cornwell pumped bug-rich water from his fields to caged salmon that Katz put in the Sacramento River. Fish that got these extra servings of food grew faster than those that didn’t. This out-of-the-box collaboration is a direct fruit of the coalition. “It took a while to get out of our silos,” Cornwell says. “We worked hard to build trust.”

By helping endangered fish, water users help themselves too. “If you can support a healthy ecosystem, you can support a reliable water supply,” explains Lewis Bair, a coalition member who is an engineer at Reclamation District 108. The district provides water to nearly 50,000 acres of farmland, including River Garden Farms in southern Colusa County and northern Yolo County. Bair also emphasizes that ecosystem restoration can be

Scarce Shark Tough to Tag

ALASTAIR BLAND, REPORTER

Basking sharks were once so abundant along the California coast that a thrill-seeking trophy hunter reportedly harpooned a half-dozen in under three hours in Monterey Bay. That was in 1947.

Today, the big fish are so rare that it's taken a team of scientists between San Diego and Santa Cruz eight years to put tracking tags into just six animals. Their numbers are so low, in fact, that researchers, working with tiny sample sizes, can scarcely study them at all or draw firm conclusions about population trends, threats to their survival, typical behavior, or how global warming may affect them.

There is even concern that the sharks — filter feeders that may grow to 40 feet, bigger than an orca whale — are so widely scattered through the ocean that they may not be able to locate one another to mate and reproduce.

Sean Van Sommeran, founder of the Pelagic Shark Research Foundation in Santa Cruz and a collaborator in the ongoing tagging project, put a pop-off



satellite tag into a Monterey Bay basking shark in 2011 — a shark that produced migration data for a paper published last year in the journal *Frontiers in Marine Science*. He rejects the notion, sometimes floated in the media, that basking sharks are making a comeback.

“There’s more boat and air traffic today than ever before, and there are fewer sightings [of basking sharks] than ever before,” he says.

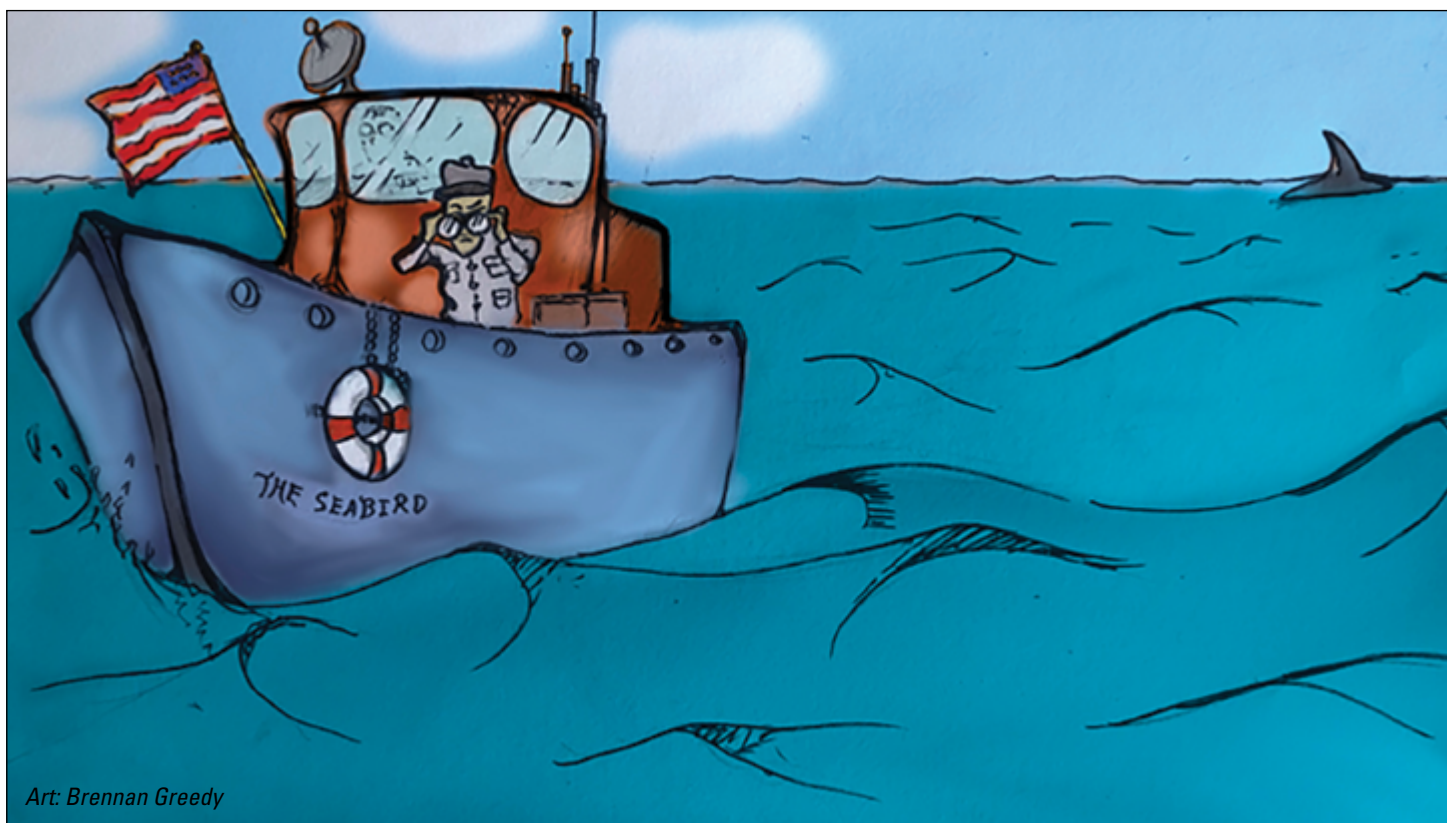
The fish were listed in 2010 as a “species of concern” by the National Marine Fisheries Service — a designation that vaguely calls for a better understanding of the animals but offers no clear research or conservation framework.

Van Sommeran thinks the animals should be granted a higher level of federal protection. “The criteria for endangered species status is pretty well accepted to be depletion to 10 percent of historic abundance,” he says. “Basking sharks are there, so why are they in this nebulous sidebar category of ‘species of concern’?”

Heidi Dewar, a researcher with the National Oceanic and Atmospheric Administration and the lead author on the recent paper, says listing a species as threatened or endangered is a complex process that depends on a species’ absolute population size, its potential for population rebound, and trends in population size. While there is no doubt that basking sharks are far less abundant than they once were, there is no evidence that the population, whatever it may be, is growing or shrinking.

“We just haven’t been able to study enough animals,” Dewar says. She says her team takes to the water in power boats when they receive eyewitness reports of the filter-feeding sharks cruising at the surface.

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Art: Brennan Greedy

Successful outings, though, have been few and far between. About four times out of five, she says, the sharks are gone by the time they arrive.

The low success rate makes each fruitful venture, with a tag jabbed with a long spear into a shark's back, a cause for celebration. "It's kind of like Wimbledon — we hug each other, throw our arms in the air, scream, celebrate," Dewar says.

It's also a high-stakes gamble. The tags, says coauthor Owyn Snodgrass, another NOAA scientist, cost several thousand dollars each. "It's like throwing a laptop into the ocean for a few months and hoping it will work later," he says.

The tags the scientists use are designed to break free from the fish and float to the surface after a preprogrammed period of time — usually a few months. At the surface, the tags transmit data skyward, and passing satellites bounce the signals to the researchers' computers.

"It's always a thrill when you open your computer and see that email telling you your tag has surfaced," Snodgrass remarks.

For the researchers, the data generated by the tagged basking sharks has provided a glimpse into the ocean-wide migrations and day-to-day behavior of what is certainly one of the least-understood large marine animals. One of the six sharks tagged so far left the California coast, swam to Hawaii, and spent most of its time at depths of 800 to 1,500 feet beneath the surface. Another shark traveled south along the Baja California peninsula and came to the surface on a daily basis. Two more tags essentially malfunctioned, releasing after just nine days and 51 days, respectively, not far from the point of deployment. (Two more sharks were tagged after the paper was written.)

The tags from the longer migrations showed intriguing patterns of vertical movement through the water

column. The fish tended to remain near the surface while in nearshore waters — probably taking advantage of coastal upwelling and the abundant plankton it helps generate. When they moved farther offshore, the sharks descended into deeper water.

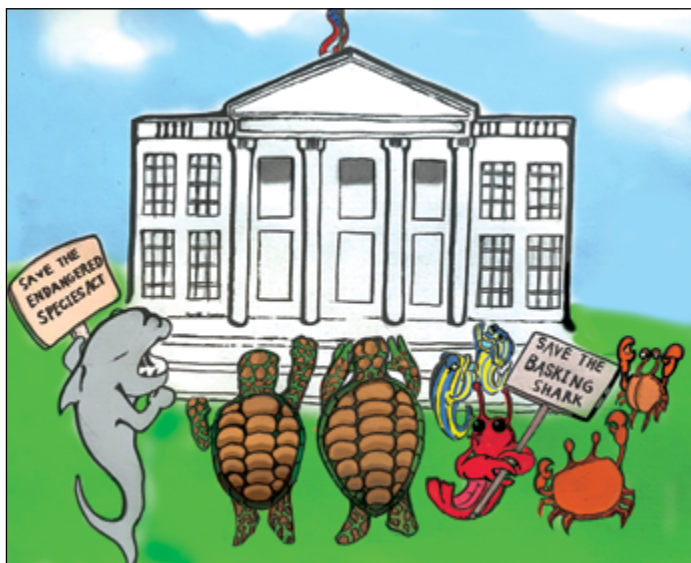
The study solved few mysteries while laying a foundation for further investigations into where the fish go and whether these migrations place them in harm's way.

"We want to know where they're going and what fisheries they interact with," Dewar says. She says the sharks, when caught in nets in international fisheries, are often killed for their large and valuable fins. She says this rarely, if ever, occurs in United States waters, where finning is prohibited.

Gregory Skomal, a biologist with the Massachusetts Division of Marine Fisheries who was not affiliated with Dewar's research, says the California scientists' paper provides "insight



Art: Brennan Greedy



into the biology of the world's second-largest fish." (The whale shark is the world's largest fish.) Skomal has studied basking sharks in the Atlantic Ocean. There, he says, "you can consistently locate them."

Skomal notes that the scarcity of basking sharks in the Pacific Ocean doesn't just make it difficult for scientists to study them; it can also have consequences for the very survival of the species.

"We just hope they haven't become so rare that they can't reproduce," he says.

Historical accounts tell of fishermen and mariners seeing hundreds of basking sharks in a single day, and the fish — navigational hazards for boats — were considered pests. Off the coast of British Columbia, they were actively culled by the Canadian government by fitting boats with large blades on their bows designed to fatally injure the sharks in collisions. This eradication effort, which began in the 1940s and ended in 1970, removed somewhere between 1,000 and 2,600 basking sharks from the ocean.

They were treated similarly in California, where harpooning them for sport was a niche tourist attraction in Monterey Bay for several decades. This vulgar pastime, described by writer and historian Tim Thomas, persisted from the 1920s until the early 1950s — about the time when the sharks slipped into scarcity. According to the *Frontiers in Marine Science* paper, fishermen in California may have taken 700 to 800 basking sharks in the first half of the 20th century. So depleted is the West Coast's basking shark population that only three have been incidentally

caught by the Canadian groundfish trawl fleet since 1996.

But the history of the basking shark's interactions with humans is not quite the typical linear storyline of a species driven from abundance to near extinction. In their paper, Dewar and her colleagues, referring to historical records, describe periods in the 19th century in which basking sharks would go unseen for 20 years

at a time — a pattern indicating global migrations and other behaviors still not understood.

For now, scientists at the leading edge of studying the basking shark know virtually nothing about them: where they mate, where they give birth, why they leave productive coastal zones, to what degree regional populations intermingle, and so on.

"So much about basking sharks remains mysterious," Skomal says. "Their age at maturity, their size at maturity, how long they live, how fast they grow — there is a tremendous amount we don't know."

Dewar and Snodgrass say they have plans to address some of these persisting mysteries in future research. But due to the difficulty of tagging and studying basking sharks, progress will come slowly. "It could be 10 years before the next paper is published," Dewar says.

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DEEPER DIVE

www.sfestuary.org/estuary-news-scarce-basking-shark-tag/

Link to study:

www.frontiersin.org/articles/10.3389/fmars.2018.00163/full

Video! youtu.be/8C7tdQh12Bg

NEWSSTREAM

- **The California least terns that colonized Montezuma Slough around 2005 just had a banner nesting season with record-high survival,** says Montezuma Wetlands LLC managing partner Jim Levine. The endangered seabirds are being accommodated in an ongoing tidal marsh and seasonal wetland restoration project, one of eight recipients of the initial round of Measure AA grants last year. JE
- **Adding a type of red microalgae to cow feed could dramatically reduce methane emissions associated with livestock farming.** Scientists in Australia found that feeding *Asparagopsis taxiformis* to dairy cows cut methane — a powerful greenhouse gas — in their burps by 99%. CHT
- **A combination of biochar and woodchips goes a long way towards detoxifying urban stormwater runoff,** according to a study in the May 2019 *Water Research*. The pilot system removed nitrates, trace organics, and, with the exception of zinc, heavy metals. RM
- **Shellfish farming can help remove excess nitrogen from coastal waters.** Scientists working on Cape Cod found that oysters removed an average of 0.28 grams of nitrogen per animal, while quahogs removed 0.22 grams of nitrogen per animal. CHT
- **Communities can use a new national wetland data set to help focus wetland protection and restoration efforts to reduce the impact of flooding.** Researchers Justin Bousquin of the EPA and Kristen Hychka of Chesapeake Biological Laboratory overlaid population, flood-risk, and land type data and compared it to the number of people who live in the area to determine how many people would benefit if wetlands were protected or restored nearby. CHT

S P E C I E S

Paddlers Monitor Plovers

ASHLEIGH PAPP, REPORTER

The inconspicuous coloring of snowy plovers makes it extremely difficult to find nesting birds, not to mention the fact that they are often surrounded by water. “It sounds fun and glamorous to kayak to work, but it’s not always the case,” says Ben Pearl, plover program director for the San Francisco Bay Bird Observatory (SFBBO).

Pearl spends six months of the year in the field researching predator threats, habitat status, and breeding behavior of the local snowy plover population. “One time, I was shoring my kayak after spotting a female return to her nest,” Pearl continues. “The water was shallow and the kayak was wobbly. I ended up going straight into the mud and still had to get out and complete the rest of the day’s survey.”

Snowy plovers ready to breed seek out land that is dry, flat, and sparsely vegetated. As a ground-nesting shorebird that eats invertebrates in and around the water, plover breeding habitat is often surrounded by water, which may also reduce the likelihood of a land predator’s ambush. Former South Bay salt production ponds in the Eden Landing Ecological Reserve and Don Edwards National Wildlife Refuge are now managed to offer valuable breeding, roosting, and foraging habitat for plovers year-round. In 2018, the Bay Area hosted about 10 percent of the West Coast’s approximately 2,400 snowy plovers.

“All of this habitat used to be tidal marsh and was converted to salt ponds, so the ground is sometimes soft and nearly impossible to walk through,” says Pearl. His small team does use a car to get as close to the nesting areas as possible, but the plovers, nearly perfectly camouflaged against the surrounding landscape, can be difficult to observe even from a short distance. “At some breeding sites, a kayak is almost always required to reach the nests,” says Pearl. “Especially earlier on in the season when water levels are higher.”

While navigating the shallow waterways of common plover nesting sites, Pearl and team not only track nesting activity but also keep an eye on predators. The biggest threat right now is common ravens, followed by northern harriers and peregrine falcons, he says.

“Trying to control flying predators is nearly impossible,” noted Yiwei Wang, executive director of SFBBO. In some areas, plover nests and hatchlings are also vulnerable to mammalian predators unafraid of swimming, like foxes and skunks.



Photos: Sebastian Kennerknecht & Josh Scullen

When Pearl spots a plover nest, the small, black and white speckled eggs become the focus of attention. Anticipating an exact hatching date can be difficult, so an “egg float” is performed on each new egg. This involves carefully removing each egg from the nest and dipping it in the surrounding water — the heavier the egg, the earlier it is in its development.

To keep track of the chicks after they emerge from their eggs, the researchers band as many birds in as many nests as possible. But because the nesting birds are so hard to find, the data gathered by Pearl and his team represents a subset of the total population.

By banding those in the nests they do see, Pearl and his team are able to track each identified hatchling’s progression towards success. If the young plover is able to survive for approximately 28 to 33 days, they will begin to fly and are then known as a fledgling. Although not all fledglings will survive their first winter, most will become breeders the following year. The predatory dangers in the initial weeks of a hatchling’s life often prevent much of the newborn population from reaching fledgling status. Of the 31 hatchlings banded by the team in 2018, only six were confirmed to have fledged.

While the overall local plover population documented by the team declined slightly from 235 in 2018 to 195 in 2019, Pearl notes that this change isn’t yet considered significant or alarm-worthy due to historical oscillations over time.

“The snowy plover is one of a few federally threatened bird species in the Bay Area,” says Wang (referring to the coastal Western snowy plover subspecies). “Habitat management is one way we aim to help conserve it.”

Protecting these areas for plovers and other species requires ongoing work. “It’s a lot of ups and downs,” says Pearl, “I band chicks knowing that most of them aren’t going to make it.” But the habitat improvements are worth the effort, even if the work does involve the occasional unplanned dip, he says: “We’re encouraging future generations of plovers in the Bay.”

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P E O P L E

New Regional Rainmaker

JOE EATON, REPORTER

Environmental issues were important to Michael Montgomery as a young man. When he wasn't backpacking in the Southern California wilderness, he helped pick up trash on Newport Beach. From there, Montgomery's career path led to 33 years with the United States Environmental Protection Agency, where he gained a wealth of experience in navigating complex regulatory landscapes to protect water resources, and ultimately to the San Francisco Bay Regional Water Quality Control Board, where he now serves as executive officer.

Montgomery, who succeeded Bruce Wolfe in the role earlier this year, is a third-generation Californian with Bay Area family roots who grew up in Orange County. After majoring in political science at the University of Redlands, an internship with the EPA in Washington evolved into a job implementing changes in the Superfund program and eventually to Region 9, covering the Southwestern states and Hawaii. With the region's Water Division, he partnered with state and tribal governments in curbing improper disposal of hazardous waste while pursuing continuing education in the environmental sciences.

In 2015, after contaminated water from the Gold King Mine spilled into Colorado's Animas-San Juan River watershed, Montgomery spearheaded the EPA's surface-water recovery efforts, helping stakeholders develop a restoration plan. "The San Juan is a multijurisdictional watershed with four states and multiple tribal lands, disadvantaged communities, agricultural uses," he says. "The stakes are high with water in the desert."

That was good preparation for working with the Bay Area's mosaic of local and regional authorities, along with a six-month assignment to the Bay Area Air Quality Management District in a federal executive development program.

"I'm looking forward to bringing my skills in collaborative problem-solving to a more focused geographic scale," he says. "The Bay Area has

a strong tradition of coming up with collaborative solutions." That's how he intends to address the range of issues the Regional Board handles: groundwater pollution, nutrient loads, emerging contaminants, resilience to sea-level rise. This approach will also be key to strengthening California's role in a changing regulatory climate.



Montgomery swimming selfie.

"The Regional Board isn't a land-use planning agency," Montgomery explains. "Because our authority can influence and be influenced by land-use decisions, we want to work with local governments and landowners so we can promote projects that improve water quality." The Board is pursuing local partnerships in expanding climate-change-related actions, like adapting to sea-level rise and recycling municipal water.

Montgomery sees the agency's new nutrients permit, which was in process before he arrived, as an example of the precautionary approach he wants to continue to promote: "Right now there's no immediate expectation of a significant nutrients problem in San Francisco Bay, but with climate change and changing sediment loads we could see large-scale impacts if we don't stay on top of it."

Also on the horizon: the connection between groundwater pollution and air quality in buildings, especially with new construction in the South Bay. He's seeing "a big uptick in our work from developers coming to us for approval of projects in areas nearer to former landfills and

areas with existing groundwater contamination," including residential or mixed-use developments on properties previously used by industry. "We get involved to make sure contaminant vapors from shallow groundwater aren't getting into buildings."

Montgomery also inherits an ongoing dispute over Point Buckler Island in Suisun Bay, where a landowner destroyed tidal wetlands without authorization. With the Bay Conservation and Development Commission, the Regional Board has appealed a 2017 Solano County Superior Court decision voiding fines and cleanup and restoration requirements imposed by the two agencies.

As for the evolving roles of federal and state regulators, Montgomery sees a mixed picture. "There's always going to be a relationship between the state and U.S. EPA," he says. "Federal laws are still significantly aligned with what we're trying to accomplish in water quality and groundwater protection. But the state is taking more of a leadership role with emerging contaminants like flame retardants, where we probably won't see a lot of movement on the federal level."

California, he says, is stepping up on issues like defining what is a regulated waterbody: "The Newsom administration adopted new rules in April providing a common statewide definition of what constitutes a wetland. Given the uncertainty of federal policy, it's important to establish how we're going to treat state waters jurisdictionally so they can be protected." Overall, Montgomery feels the Regional Board "is aligned with Sacramento about the need to fill these gaps."

Montgomery also notes his strong ties to the water. "I swim in the Bay, fish in the Bay and the ocean, and paddle where I can," he says. "I am avid in my belief that it is our obligation to protect and restore the rich resources we are blessed with for the generations to come."



San Francisco Estuary Partnership
375 Beale Street, Suite 700
San Francisco, California 94105

San Francisco Bay and the Sacramento-San Joaquin River Delta comprise one of 28 "estuaries of national significance" recognized in the federal Clean Water Act. The San Francisco Estuary Partnership, a National Estuary Program, is partially funded by annual appropriations from Congress. The Partnership's mandate is to protect, restore, and enhance water quality and habitat in the Estuary. To accomplish this, the Partnership brings together resource agencies, non-profits, citizens, and scientists committed to the long-term health and preservation of this invaluable public resource. Our staff manages or oversees more than 50 projects ranging from supporting research into key water quality concerns to managing initiatives that prevent pollution, restore wetlands, or protect against the changes anticipated from climate change in our region. We have published *Estuary News* since 1993.

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COVER PHOTO: Above the Bay on the Bay Trail.
Barbara Christianson

BISPHENOLS, *cont'd from page 9*

time, requires cashiers to actually ask customers if they need a receipt before printing one out (cashiers can absorb bisphenols from their fingertips with repeated handling). SB54 and AB1080 (Allen/NRDC), meanwhile, are aimed at reducing plastics at the source, and increasing plastics recycling statewide. And another bill, SB392 (Allen) would update California's 10-year old Safer Consumer Products Program to reduce toxics in products, promote green chemistry, and make sure "regrettable substitutions" don't occur. The update would give the program more data collection authority, enabling it to demand ingredient lists from the industry, for example.

"If you regulate BPA and end up with BPS, that's not acceptable," says Ventura. "We need to start making products from scratch with the most benign materials possible."

With tests of Bay waters now complete, RMP researchers will now sample wastewater and stormwater flowing into the Estuary to try to pinpoint inputs. "Since the South Bay had higher levels of bisphenols during the dry season, that suggests wastewater discharges may be a pathway of contamination, but we won't know until we test it," says Sutton.

If discharges from our treatment plants are one culprit, it may only point to the need for more source reduction. "We can't keep treating our way out of contamination issues, nor should consumers have to be chemists. They have the right to know that the materials they are buying are safe," says Ventura.

Being a curious consumer myself, I asked my personal water purveyor, the San Francisco Public Utilities Commission, if there might be bisphenols in my tap water. "It was a 'non-detect' when we monitored it in 2006 and 2012, but we have highly protected source water," says SFPUC's water quality director Andrew DeGraca. "We own most of the land around our reservoirs and keep it clean."

Maybe there's a message in this for all of us about not fouling our own nest.

"This study is incredibly relevant to every person living in the Bay; we're all contributing to the problem, we're all being exposed to these chemicals, and we all, individually, have the opportunity to be part of the solution," says Shimabuku.

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RMP crew sampling Bay for contaminants. Photo: Shira Bezalel (SFEI)