SAN FRANCISCO

ESTUARY

Outer Limits of Delta Science: Can we recover salmon, capture carbon, live with the Russian thistle?

Three Young Scientists with Eclectic Priorities

State Waters Down Flows Agreements & Fast-Tracks Restoration

WATER
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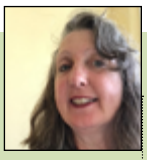


EDITOR'S DESK

Brain Fog, Drought Dread and Science Buzz

ARIEL RUBISSOW OKAMOTO

Drought is on everyone's mind these days — visible in the browning hills, the water conservation alerts from your local purveyor, the fast-drying creek beds, the falling trees. Everywhere I look, I see trees split open or keeled over: starved of water or riddled with disease these past few years. It feels like a metaphor for my pandemic fatigue. Many of us are still standing but we've become brittle, frail, uncertain. Add a heat wave, a fire, a bad day, and it could tip us over.

In the context of so much uncertainty and such rapid change in the patterns of rainfall and snowmelt we've built our water infrastructure around, estuary management is becoming an increasingly intricate endeavor. Underlying every story in this issue is complexity. Can natives and non-natives co-exist and still be healthy? Can humans and salmon share the water? Can we make as much food for fish as we have on our supermarkets, or are their supply chain issues? Can the ecosystem, as much as we have already altered it, adapt to climate change? The list of tough questions keeps getting longer but the core issues for the Estuary remain paramount: invaders, stressors, values about how we use land and water, and for what.

In this June issue of *Estuary News*, the Delta occupies the heart of our stories. We cover three major collaborative research endeavors: one attempts to reorient our thinking about salmon recovery, away from lawsuits and toward common interests; the second digs deep into the sinking Delta soils for answers to climate questions about carbon accretion and greenhouse gas production and capture; and the third considers whether we can control invasive plants, restore native habitats, and attract ducks all in one landscape, Suisun Marsh. Each study deploys scientists of different stripes and considers diverse sources of local knowledge.

Louise Conrad

"Science is evolving, reshaping itself to be responsive and reflective of how our communities and our climate are changing," says Louise Conrad, former head of the Delta Science Program, which funded much of this research, and a newly minted lead scientist at the California Department of Water Resources. "Researchers are tackling everything from mitigating greenhouse gases with nature-based solutions, to deepening our understanding of the human dimension of the Delta, which is a focal point for California's history and its future."

"The science is alive, buzzing with the exchange of ideas. Scientists are also broadening their approaches to form lasting partnerships for topics that are vital to the identity of California, such as the recovery of our beloved Central Valley salmon."

Mixed in with these wide-ranging stories, Estuary also visits with three young scientists. One is exploring the effects of climate change on fish. The second is monitoring the nutrients and contaminants that cause harmful algal blooms. The third is planning a survey to better understand how people's beliefs and behavior affect the health of the ecosystem. Through their eyes, we glimpse the future.

And no issue of Estuary would be complete without a water war story. This June, as we anticipate a summer release of the long-awaited environmental impact report for a proposed Delta conveyance (new infrastructure in the form of a tunnel carrying better-quality water to the export pumps), it is timely to review state efforts to come to a voluntary agreement on freshwater flows, as well as to fast-track restoration projects. And with infrastructure top of mind, Estuary also takes you on a tour of some of the Delta's oldest bridges — the kind that can open and close for both vessels and vehicles. Turns out, unlike in our cities and suburbs, here the boats have the right of way.

So as we sweat out the coming months, hoping for less heat, fire, and smoke, and by some miracle for more water, change is in the air. Science is flowing, collaborations are growing, and money from state and federal budgets for infrastructure, water quality, and climate resilience is coming to the Estuary region. Following this trickle of hope and progress promises to keep us occupied as we step gingerly onto the shaky ground of the future.

Photo: Florence Grow, DWR

Cover art: Sarita Camacho da Encarnaçã

CLIMATE

Sniffing the Delta for Greenhouse Gases

JANET BYRON, REPORTER

Dutch Slough in Oakley, on the southern edge of the Sacramento-San Joaquin Delta, is less than a mile from where biometeorologist Dennis D. Baldocchi grew up on his parents' orchard and fished with pals in nearby Marsh Creek. In October 2021, the California Department of Water Resources breached the levees here, restoring nutrient-rich tidal flows to degraded ranchland.

Early in the 20th century, Baldocchi's father grew dry beans and sugar beets on the peat soils of the Delta's Liberty Island, and his aunt's family raised asparagus, sugar beets, and corn on Sherman Island. In 1952, his dad started growing almonds and walnuts at the junction of Sellers Avenue and Cypress Road in Oakley.

"My family mined the Delta for agriculture, which led to subsidence and contributed to climate change," says Baldocchi, a University of California, Berkeley, professor whose current research focus is the ability of restored tidal wetlands to sequester carbon. "Now my generation is trying to use science to stop it."

Beginning in the mid-19th century, virtually all of the Delta's 360,000 acres of wetlands were drained and transformed into ranches and fertile farms via the construction of a vast network of levees. Without natural tidal flows, the land between those levees — with rich peat soil up to 50 feet deep — has been sinking rapidly, as much as 30 feet in some places. "Soil microbes eat carbon compounds and convert them into energy and carbon dioxide gas, which causes the land to collapse and subside," Baldocchi says.

Of the Delta's 740,000 acres, about two-thirds are in agriculture; top crops include corn for forage, alfalfa, wheat, wine grapes, and processing tomatoes. Global food production contributes an estimated 21% to 37% of the greenhouse gases that are warming the planet, including huge releases of carbon when vast aquatic ecosystems like the Delta are transformed for agriculture. Baldocchi and colleagues are now trying to figure out if bringing back tidal wetlands like the one at Dutch Slough can help reverse these processes.

Baldocchi at the end of one of the levees breached to restore tidal action at Dutch Slough. Photo: Janet Byron

"These are some of the most productive ecosystems in the world," Baldocchi says. "We want this to be a greenhouse gas sink to stop global warming."

continued on next page

Ariane Arias-Ortiz checks on a global experiment that is measuring carbon decomposition of dead plant matter by burying teabags in wetlands; Daphne Szutu collects data on the Dutch Slough weather station; Joe Verfaillie adjusts a walkway out into the new marsh. Photos: Janet Byron

Lab for Restoration Strategies

When Baldocchi was growing up in the 1970s, Oakley was a hamlet of about 1,300 people. Now it's a growing city of nearly 44,000, east of the Antioch Bridge. Before the city of Oakley incorporated in 2002, Contra Costa County had slated 4,500 homes for the Dutch Slough site, precariously below sea level; now a newish subdivision skirts the upland area above the flood and tide lines on its southern border.

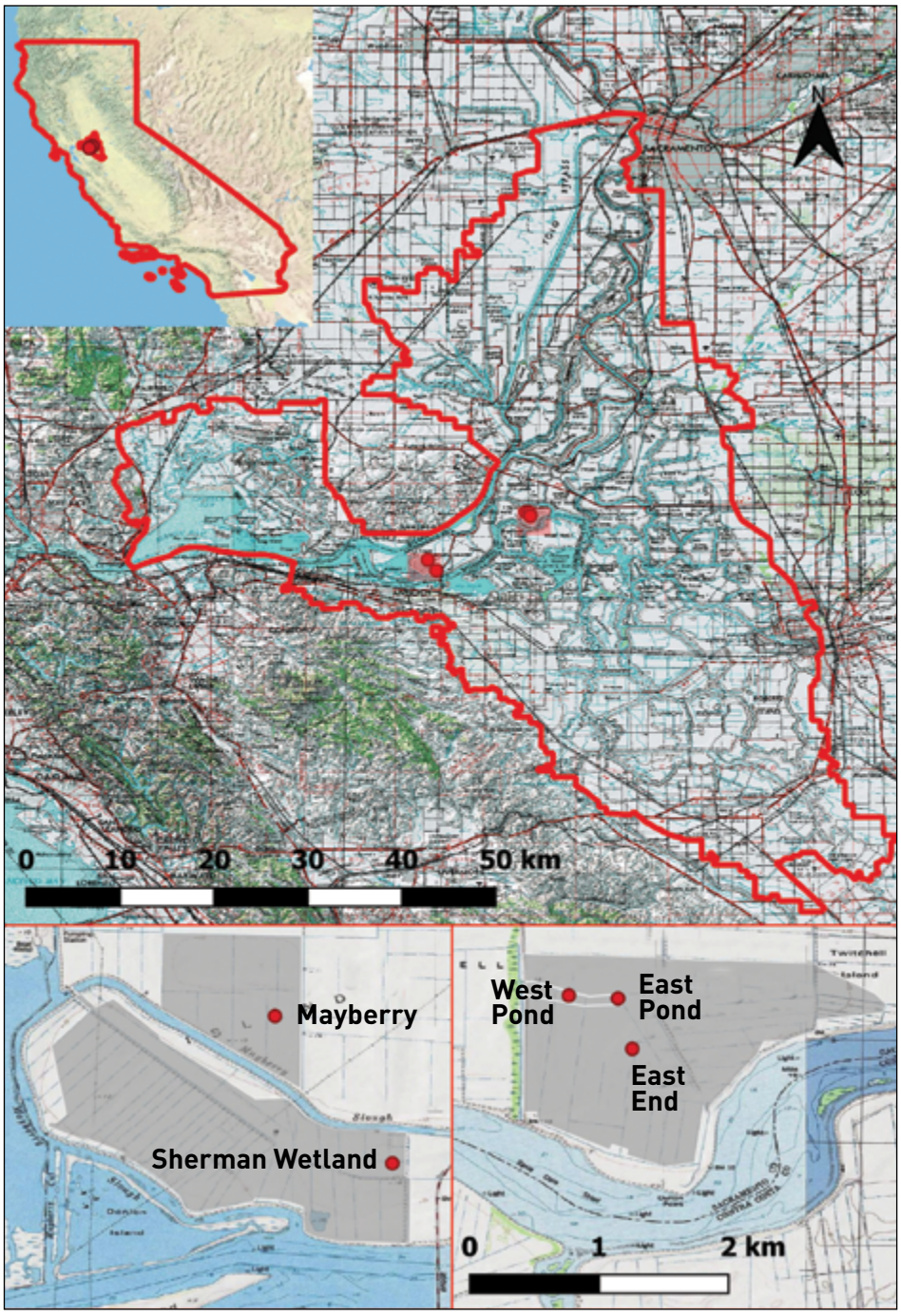
The $71 million Dutch Slough Tidal Restoration Project is a laboratory for ecosystem restoration strategies. When complete it will include tidal wetlands, marsh managed for the elusive black rail, nest-tree plantings for raptors, preservation of Indigenous lands and an historic vineyard, and a 55-acre community park with regional access trails.

Katherine Bandy, who manages the project for the Department of Water Resources, says that Baldocchi's research is important because Dutch Slough uniquely functions as both a freshwater and tidal marsh. "Most freshwater marshes are impounded, and most tidal wetlands are saline," she says. "This type of tidal marsh hasn't been widely studied before."

In the years before tidal action was restored, portions of the land were graded and the Department of Water Resources and River Partners planted 25,000 native tule plugs and 50,000 shrubs and trees. Just seven months after the levee was breached, the marsh is thickly vegetated with reeds and sedges swaying in the breeze; the trees and shrubs will need more time to become established. With restored tidal action, new soil is accreting at a rate of two to three centimeters per year, Baldocchi says.

The marsh is humming with wildlife. Red-winged blackbirds cackle and trill in the tule, egrets and a great blue heron fish in the channels, a pintail alights from the marsh, turkey vultures cruise overhead, and killdeer clown around in the upland area. This reporter was delighted to see an otter waddle across the levee.

On a clear spring morning, Baldocchi shows where the Department of Water Resources breached the levee, with a DEAD END sign marking the end of the road. Nearby, UC Berkeley Biometeorology Lab technician Daphne Szutu is up on the weather



Map showing five restored wetland sites on Sherman and Twitchell Islands in the Sacramento – San Joaquin Delta, which were analyzed by Baldocchi and colleagues in PLOS ONE, March 25, 2021. Site locations are marked (top) and enlarged (bottom) to show wetland areas (shaded grey) and instrument tower locations (red points).

station downloading data, while fellow technician Joe Verfaillie makes some adjustments to a narrow walkway out into the marsh.

Crouching among the tules, Ariane Arias-Ortiz, a UC Berkeley postdoctoral researcher and recent NOAA Climate and Global Change fellow, checks the teabag index samplers. A few weeks ago, she and Baldocchi enlisted 5th and 6th graders at nearby Knightsen Elementary School in a citizen-science project that is burying household teabags in wetlands all over the world to measure how well they decompose carbon.

"By calculating the weight loss of the teabag after three months, students can estimate the rate of decomposition of plant material by microbes in wetland soils and compare it to that of other soils, such as their school garden," Arias-Ortiz says.

Marsh Plants Take Up Carbon

Baldocchi's research program uses the tools of biometeorology — the study of relationships between living things and atmospheric phenomena — to gauge how well plants in restored marshes take carbon out of the air and return it to the soil, and how the reintroduction of aquatic plants influences overall greenhouse gas levels.

Here at Dutch Slough and other restored tidal wetlands in the Delta, his team is continuously monitoring vertical fluxes of carbon dioxide and methane between water, soil, plants, and the atmosphere, as well as lateral fluxes of carbon dioxide as tides flow in and out. "We're sniffing the delta," Baldocchi says. "We can monitor pockets of air moving up and down and across the marsh. Our methods allow us to measure the breathing of the biosphere." A three-year, $700,000 grant from the Delta Science Program is helping to fund the work.

Baldocchi's current research at Dutch Slough and Hill Slough — a new wetland at Suisun Marsh in Solano County that was intentionally breached about the same time — builds on more than a decade of studies measuring the exchange of greenhouse gases on agricultural lands that have been restored as wetlands.

In a 2021 article in the journal *PLOS ONE*, Baldocchi and colleagues reported on 21 site-years of carbon flux measurements on five restored freshwater-to-brackish wetlands at the Delta's Twitchell Island and Sherman Island, which had been restored between three and 23 years ago (see figure).

Researchers found that a minimum of 55% of vegetation cover was needed for wetlands to become carbon sinks, and site-specific conditions including water levels, soil nutrients, and planting methods mattered in terms of how well they captured carbon from the atmosphere.

Greenhouse Gas Balances

Another Baldocchi study published in 2019 compared the amounts of carbon and methane that were absorbed and emitted by restored wetlands and drained agricultural lands, also at Sherman and Twitchell islands, for 36 site-years.

While sequestering carbon, natural and restored wetlands also release methane, which is created when soil microbes decompose plant matter under the anaerobic, or low-oxygen, conditions of land that is under water. A potent greenhouse gas, methane effectively traps 25 times more heat in the Earth's atmosphere than carbon dioxide.

After the initial year of restoration, Delta wetlands extracted an average of 339 grams per square meter (± 55 g/m^2) of carbon dioxide each year, while the agricultural sites released between 200 and 1,541 g/m^2 of carbon dioxide into the atmosphere annually.

But the Delta wetlands also released methane at an average rate of 44 g/m^2 per year, with significant variability among sites due to water management, soil nutrient levels, and other conditions. The agricultural sites, which included rice, pasture, corn, and alfalfa, released up to 12 g/m^2 of methane per year, and none in some locations.

In a subsequent analysis, Baldocchi and colleagues found that the restored wetlands quickly became carbon sinks once vegetation was established, and, if well-maintained, had the potential to be net greenhouse gas sinks within a century, and likely decades sooner. "The reality is these wetlands are very effective carbon sinks, and as time goes on the methane production and its release into the atmosphere will go down," Baldocchi says.

In addition to understanding the potential of restored wetlands to mitigate climate change, the biometeorology researchers are learning which restoration, water management, and planting strategies work best to provide long-term benefits for marsh ecosystems. "The Dutch Slough project," Bandy says, "is helping climate scientists to figure out what type of wetlands are the best bang for the buck for restoration when it comes to carbon sequestration."

Mitigating Climate Change

Baldocchi's studies are finding that Delta wetlands match upland forests in their ability to pull carbon from the atmosphere, providing important evidence to support their inclusion in the state's carbon-trading markets, a key component of California's strategy to lower greenhouse gas emissions.

"The research that is being conducted at Dutch Slough will help validate the efficacy of tidal wetlands in providing greenhouse gas benefits in the Delta," says Michelle Jesperson of the Department of Water Resource's California EcoRestore program, which seeks to bring back 30,000 acres of Delta wetlands.

Cal EcoRestore is on track to meet this goal, adds Department of Water Resources project manager Charlotte Biggs, with 10,000 acres of wetlands completed, 10,000 acres under construction, and the remaining acreage in planning and permitting.

Dutch Slough plantings flourish not far from a suburban subdivision and Mt. Diablo. Photo: Janet Byron

Back at the Dutch Slough research station, Arias-Ortiz says the UC Biometeorology Lab's work clearly demonstrates that carbon extracted by marsh plants has immediate benefits for climate mitigation. "As wetlands age, the carbon capture these ecosystems provide exceeds the negative effects of methane emissions, while additionally providing many other valuable services such as the reversal of subsidence and habitat for fish and wildlife," she explains. "The atmospheric carbon taken up by plants is being buried in the ground, and most of it stays locked up there."

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SURVEY

Listening to Vital Voices

ROBIN MEADOWS, REPORTER

Jessica Rudnick's first love was earth science. But after discovering that people's beliefs and behaviors were key to solving environmental problems, she fell for social science. Now, as the California Sea Grant extension specialist for the Delta, Rudnick is working to better integrate local people into plans for the region. Understanding the needs of people who live, work, and recreate in the Delta could make the difference between fixes that are rejected or embraced.

Jessica Rudnick

Delta planning has historically focused largely on ecological health. But, like many estuarine areas, the Delta is a lived-in landscape. "There are socially embedded challenges that play out in environmental issues," she says. "You can't just throw more data and research at a problem and think you will find a solution."

This epiphany struck while Rudnick was an undergraduate at Washington University in St. Louis, Missouri, studying land-use changes in Mississippi River floodplains. She counts herself lucky that her advisor urged her to go beyond biophysical data and into the real world to talk with communities impacted by the floodplains. "A lot of what happens on land is driven by individual landowners and managers and the choices they make," she explains. "It sparked my curiosity about the people side."

Rudnick's passion led to graduate work at UC Davis on the underpinnings of farmers' decisions on nitrogen fertilizer use, which can contaminate groundwater. She found that farmers' capacity for natural resource stewardship depends partly on their bandwidth for and access to new information. Larger farms and those growing high-value crops, such as fruit and nut trees, tend to have economies of scale and access to capital that let them experiment with and adopt the latest management practices.

Today, 18 months into her Delta position, Rudnick collaborates with a team that is poised to launch an ambitious and groundbreaking survey of Delta residents. The immediate goal is to incorporate local voices into Delta Stewardship Council efforts including a climate change initiative called Delta Adapts.

Climate-driven threats in the Delta include water temperatures too high for protected species like salmon and Delta smelt, as well as rising seas that overwhelm the levees encircling the many islands. Levee breaks could flood islands and draw salty ocean water far into the Delta, imperiling the water it supplies to 27 million Californians.

Designing an effective survey is no easy task, and Rudnick is grateful she didn't have to start from scratch. "We borrowed from the Puget Sound Partnership," she says, adding the Partnership already tracks how local people help or hinder ecosystem recovery. "They've learned a lot about which questions do and don't work, which we can learn from." More inspiration came from the Chesapeake Bay Stewardship Index, an assessment of residents' actions and attitudes that impact the environmental health of the estuary.

Rudnick is also getting input on the survey design from Delta community groups representing families that go back five or six generations as well as the much larger population of relative newcomers who have moved to the region in recent decades. "There's a lot of excitement over trying to capture what 'Delta as a place' means to people who call this region home," she says while on her way back from a focus group with Delta farmers. Designated as the state's first National Heritage Area in 2019, the Delta is a place rich in California's cultural history.

The Delta residents' survey taps into three major themes: social well-being, sense of place, and environmental change. "What does quality of life in the Delta look like for different groups, how are folks connecting with the Delta, and what are their environmental preferences — what would they like to see done?" Rudnick asks, adding that the survey is also designed to "go beyond the usual suspects to reflect the demographics of the general population." As San Francisco Estuary Institute ecologist Letitia Grenier points out, farmers and recreational fishers already add their voices to the conversation but other perspectives may be missing, including those of farmworkers, subsistence fishers, Native American tribes, and urban interests.

Rudnick and the team plan to send about 60,000 survey invitation letters out this fall, reaching every household in the rural heart of the Delta and a sampling of those in the region's urban edges. If this pilot survey takes off, local voices could become as fundamental to Delta planning as water quality, species trends, and other environmental indicators. "I hope the residents' survey will be viewed as another indicator of the health of the Delta," Rudnick says. She expects to have preliminary findings in mid-2023.

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ENDANGERED

Reorienting to Recovery

ALASTAIR BLAND, REPORTER

Twenty pound salmon carcass found after spawning. Photo: South Bay Clean Creeks Coalition

The days when salmon and steelhead teemed in California's coastal watersheds faded away last century. Today, many populations of the fish are gone or dwindling, the river systems where they spawn drained by diversions or too warm for native fish to survive. Warming trends and drought are squeezing water resources tighter. Nearly all efforts to revive the state's ailing salmonids have failed, often stalemated by political tensions, and it takes hatcheries and truck transport of juveniles to saltwater to maintain the feeble populations that remain.

California's disappointing history of salmonid recovery programs has motivated a group of scientists from public water agencies and environmental conservation groups to step back, dream big, and take a new path forward. This group wants to abandon familiar heated dialogues and litigious relationships between those with differing values and try a new approach toward fish recovery based on collaboration, common interests and science.

"It's an experiment in working together in a different way where the process is part of the product," says Trout Unlimited's California science director Rene Henery, who helped initiate the Reorienting to Recovery Project in 2020. Key to this process, he says, is having face-to-face conversations about the value and importance of salmon to different people — and having these conversations outside of the existing regulatory framework, where actions are typically made as a result of legal orders or requirements. "It's a voluntary process where we talk about a concept of recovery that is not linked up with any regulatory language and is based on what the science tells us is possible," he says.

Photo: Carson Jeffres

The Reorienting project's chief objectives include defining broad-sense salmon recovery. In this watershed-wide context, says Henery, "Recovery is not a word with a clear definition."

Another project goal is to include and utilize input from interested parties that might have been excluded from past dialogues, like indigenous tribes and disadvantaged communities where salmon are — or were — an important source of nutrition and recreation, along with fishery representatives, regulatory agencies and the agriculture industry.

"This project creates a pathway for direct communication between these groups and decision-makers," says Louise Conrad, former deputy executive officer for science at the Delta Stewardship Council, which awarded a $1.5 million grant to the project in 2021.

The project, which has been influenced by a similar effort in the Columbia River basin, began in earnest last summer with a series of remote workshops funded by $400,000 from the State Water Contractors, a nonprofit association of 27 water agencies that provides water for 27 million Californians and 750,000 acres of farmland. In this first phase, almost three dozen scientists focused on creating a new and detailed definition of broad-sense recovery for Central Valley salmon, with emphasis on both listed and unlisted runs. The participants, including Henery, Rachel

continued on next page

Johnson of the National Oceanic and Atmospheric Administration (NOAA), and Brett Harvey of the California Department of Water Resources, agreed that recovery must go above and beyond abundance levels sufficient to prevent extinction.

Recovery of salmon, as a fishery conservation objective, has not been formally defined in California. Often, it is equated to preserving species and, in successful cases, delisting them as legally endangered species — what The Bay Institute program director Gary Bobker thinks is an inadequate definition.

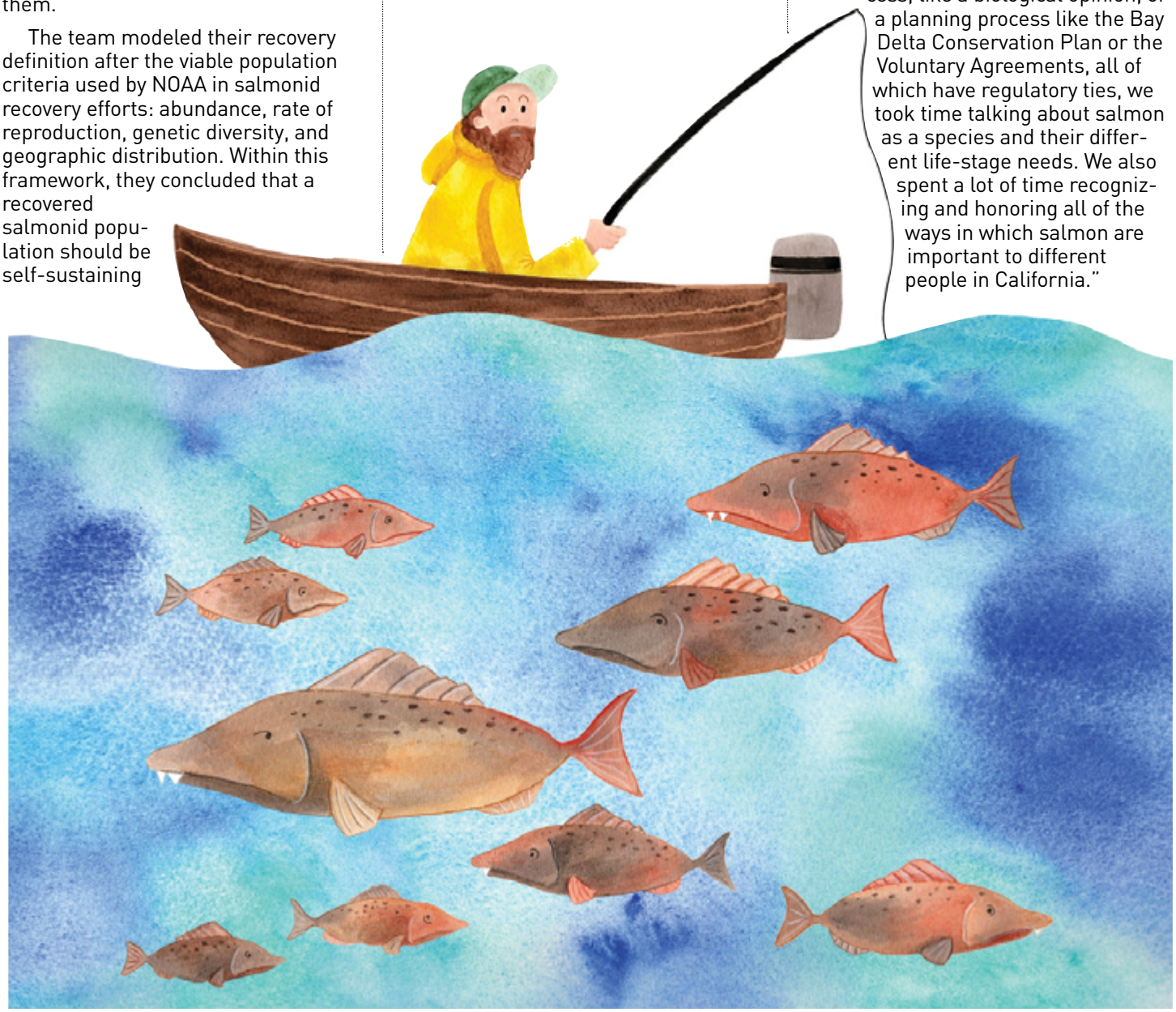
"I don't want just enough salmon so they don't go extinct," says Bobker, who has been closely involved in the Reorienting project. "I want salmon up the wazoo. I want salmon everywhere that it's possible to restore them."

The team modeled their recovery definition after the viable population criteria used by NOAA in salmonid recovery efforts: abundance, rate of reproduction, genetic diversity, and geographic distribution. Within this framework, they concluded that a recovered salmonid population should be self-sustaining with minimal human intervention and large enough to support substantial human harvest as well as ecosystem services in freshwater and marine environments. Such recovered populations must also, the group determined, be robust and diversified enough, genetically and spatially, to withstand significant environmental disruptions like droughts and disease.

Phase two of the project began in May and is being funded by the Delta Stewardship Council's science program. The phase two goals are to connect with potential interested parties, assess existing salmon restoration projects, and quantify how far toward recovery these efforts go. In the third and final phase, the participants will identify and evaluate actions that seek to achieve salmon recovery.

Jennifer Pierre, general manager of the State Water Contractors, has participated in the Reorienting project since its inception during the 2020 Covid shutdown days. After having several initial conversations with Henery, Pierre says she was convinced that a process built of conversations, community outreach, and scientific assessments of project potential could help participants advance past the adversarial roadblocks that have long precluded coordination between water agencies and fishery interests, stifling progress in restoration and recovery.

"I learned a lot about how the environmental community views the public water agencies and how that perception changes how we interact with each other," Pierre says. "Rather than being focused on a regulatory process, like a biological opinion, or a planning process like the Bay Delta Conservation Plan or the Voluntary Agreements, all of which have regulatory ties, we took time talking about salmon as a species and their different life-stage needs. We also spent a lot of time recognizing and honoring all of the ways in which salmon are important to different people in California."



These dialogues, Pierre says, will set the stage for a polished plan and list of projects ready for implementation. She points out that the Voluntary Agreements — an ecosystem enhancement plan that seeks to avoid contentious river flow increases — will require about $2 billion in restoration work. "Wouldn't it be nice if the restoration we'll be spending this money on will be projects that we've vetted?" she says.

Alison Collins, a Bay-Delta senior resource adviser with the Metropolitan Water District of Southern California and one of the Reorienting project's initiators, says this approach "gives ownership to participants so they can decide how they want to move forward."

In the conventional regulatory landscapes, restoration projects are frequently designed one at a time, often amid disagreement between sidelined participants, and they may be implemented in a sporadic, incohesive fashion — checkered across the watershed — that some people feel makes them relatively ineffective. By contrast, the Reorienting to Recovery Project aims to produce a to-do list of dozens of restoration actions that all parties have endorsed, designed to complement one another and support different life stages of each salmon run regardless of endangered status.

"This will make projects faster to implement, easier to implement, and with more political will to implement them," Henery says.

While the Reorienting project is novel in ways, it is up against some of the same political and environmental challenges that have stifled other programs intended to restore California's salmon. Farmers vie, now as before, to irrigate their land with the same water that environmentalists say salmon need to carry out their life cycles. Chronic drought and warming trends have magnified these conflicts, and they will likely intensify with each passing year. "The lack of water is something that's going to be really, really difficult to manage," Conrad says.

Restoring California's salmon is already required by law. The 1992 Central Valley Project Improvement Act, for example, calls on agencies to enhance flows and habitat in the Sacramento and San Joaquin rivers and double anadromous fish populations from levels seen from the 1960s through the 1980s. Enacting the law's mandates has been legally and logistically difficult, though, and except for in a few exceptional years, the act's doubling goal for anadromous fish restoration has eluded resource managers — even though, Bobker says, this vague numerical target is relatively unambitious. He sees room in the Central Valley's watersheds for a lot more salmon than lawmakers dreamed possible 30 years ago, and the Reorienting project aims to shift the direction of approach so that recovery becomes more feasible.

"We're trying to knit together a bunch of analytical tools to achieve goals above and beyond the CVPIA," Bobker says. "If we provided the optimal environmental conditions, salmon numbers would octuple."

Booth at 2020 International Sportsmen's Expo tests steelhead coloring skills. Photo: CDFW, Creative Commons

The Reorienting project is heavy on optimism, built on faith in the landscape's potential to support salmon and Californians' will to bring watersheds back to life. The project scopes out maximum potential carrying capacity, and maximum restorable habitat for all life stages of the fish. This could involve actions like restoring floodplain habitat, reintroducing salmon to waters upstream of Shasta Dam, enhancing spawning areas with gravel deposits, improving functional flows of cold water from reservoirs, and changing hatchery and harvest management. It could even, Henery says, include "things as yet unimagined." But there really is no knowing, he says, what the recovery effort will look like until all candidate projects are modeled in different combinations.

The outcome of these efforts, Henery hopes, could produce runs of salmon far greater "than the level of abundance required to delist an endangered species but probably less than the abundance we experienced historically."

Henery also hopes the effort will create "a positive feedback loop where we work together and see something really positive come of our efforts." He believes the project could help participants move beyond past disagreements over river and water management.

Bobker's organization, The Bay Institute, has been involved in litigation against water and fishery agencies and water users — lawsuits aimed at improving ecological conditions in the Delta primarily by increasing freshwater flows through the estuary. He considers the Reorienting project an important complement to existing recovery efforts. "A bunch of us who are fighting in court with regulators over water management are coming together to ask, 'Can we do this in a rational framework?'" he says.

California's salmon and steelhead need improved habitat, upstream and downstream, for both spawning and rearing — but, Bobker says, long-term salmonid recovery efforts cannot stop there: "Habitat restoration can't be a substitute for flows. These are aquatic habitats. They need water."

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SCIENCEINSHORT

Finding Her Way to Fish: Denise Colombano

BY JACOBA CHARLES & KATHLEEN M. WONG

The path into a career is not always a straightforward one.

"I hated school. I mean, hated school," says Denise Colombano, a postdoctoral fellow and Delta Science Fellow working on fisheries research at UC Berkeley. Today, Colombano feels that it is important to talk about her story as a way of encouraging inclusiveness and opportunity within her field — and in the sciences in general.

"I actually flunked ninth grade, and was attending a continuation school, when my science teacher asked if anyone was interested in skipping classes for the day."

Colombano jumped at the chance, and found herself at Martin Luther King Jr. Regional Shoreline in Oakland, helping the Audubon Society train schoolchildren in birdwatching. "We were supposed to be teaching these kids, but I was learning the entire time because I didn't know a thing about what we were doing," she recalls. "And I got completely into it. It was the first time I realized that I actually liked science."

After that, she returned to volunteer at every event that she could, eventually became an intern at the Audubon Society, and then went on to study environmental science and policy at UC Davis — where she also discovered her interest in fisheries through hands-on experience, this time in an elective class.

"I didn't really have an expectation for how much I was going to like it," she says. "But I got completely hooked on fish, all things fish." By the end of the semester, she once again had signed up for an internship.

Today, Colombano is part of the Berkeley Freshwater Group, which studies watersheds throughout California. She describes her work on the San Francisco Bay-Delta as having a holistic "one Estuary, one science" perspective. She uses time-series modeling to investigate how climate change effects on weather and freshwater flows will likely impact future habitat suitability and fish communities from the San Francisco Bay to the Sacramento-San Joaquin Delta.

Colombano is also helping to develop a web-based Shiny app that will allow users to click around and look at how different marine organisms such as fish and plankton respond under different climate change scenarios "This will be more of an interactive tool that lets people engage with the data and visualize different outcomes," she says.

Facilitating engagement with science is important to Colombano on many different levels. Her own experience of overcoming challenges in the classroom, and surprising even herself with her passion for science — once she got outside in nature — has made her keenly aware of how many other skilled fish and wildlife scientists might be falling through the cracks of society's expectations for them. While she says being a woman in a field traditionally dominated by white males has not always been easy (difficulties have included not having her ideas credited properly, or being expected to be pleasant or to act as a peacemaker in challenging situations), she is at the same time aware of the challenges that she has been spared because, though female, she is also white and privileged.

"One of the things I've learned about fisheries is that there is very little representation in leadership from different backgrounds," Colombano says. "As much as I would like to pat myself on the back for being a woman in science, I really have to be aware of the fact that I'm not part of a minority group, I'm part of the majority group. So I want to focus on creating an inclusive space for others, to welcome people and use my privilege to make sure that anyone who wants to study science feels like they belong and are given equal opportunity."

https://soundcloud.com/user-346725849/science-in-short-finding-her-way-to-fish

INVASIONS

Living with a Novel Landscape: Suisun Evolves

MICHAEL ADAMSON, REPORTER

Morning at Suisun Marsh is a living watercolor with a soundtrack. Miles of tule and pickleweed populate the foreground, split by canals glinting silver from the sun. In May, the hills undulate across the northern boundary in classic California gold. A red-tailed hawk's iconic hoarse screech punctuates the insectine buzz as it takes off from a powerline. At 7:40 AM, it's already 72 degrees and there's no trace of a breeze.

I've come to visit the Marsh from downtown Oakland seeking to learn from biologists, hunters, and land managers what's at stake in the myriad battles with rising seas, worsening drought, and, especially, encroaching invasive species and what makes it such a singular, attractive landscape.

Indeed, the pastoral foreground is cast in stark relief by the imposing steelworks surrounding the periphery. To the south, the towering Pittsburgh stacks loom on the horizon. To the west, refineries in Martinez and Benicia puff miniature cumulus into an otherwise crystal-clear blue sky. In a kind of call-and-response, the hawk's cry is echoed by a whistle from Amtrak's Capitol Corridor train, hurtling across the western marsh towards Fairfield and on to Sacramento.

A cursory glance suggests a sort of unaltered refuge, but Suisun Marsh is as much a human construction as the steelworks that surround it, as improbable as the railroad that traverses it. Comprising dikes and levees, floodgates and canals, the ecological paradise that serves as an indispensable stop on the Pacific Flyway is thoroughly human-made.

At 180 square miles, the Marsh is often called the largest brackish marsh in North America (this is debatable but it is certainly the largest in California). Unlike at many ecological preserves across the continent, more than 80% of Suisun's vast swath of land is managed by private interests. Of that private land, the majority is managed for waterfowl habitat and hunting interests. Each of these landowners and hunting clubs has its own priorities and concerns. A levee raised along a contrived property line divides two utterly different ecosystems, fostered by the interests of the respective landowners.

The Marsh as we know it is buttressed against reduced freshwater input from the Sacramento-San Joaquin Delta and a rising sea, but vulnerable to encroaching invasive species that thrive in an ecosystem lacking the natural checks against their rampant spread.

One such species, *Phragmites* australis, or the common reed, has entrenched itself in Suisun Marsh, and threatens to dominate the habitat the hunting clubs have worked hard to preserve for Pacific Flyway ducks and waterfowl. While *Phragmites* is a well understood problem and control methods have been implemented, its rate of spread has increased in the last 20 years. Effective control requires an approach as novel as Suisun's own land-management mosaic.

Among the Reeds

Adrienne Ernst parks her tan SUV next to an old hunting shelter and hauls out a rectangular sled loaded with native plants. Her research associates Gabe Rodkey and Jason Hagani follow in a UTV (Utility Terrain Vehicle) and, after assessing the plant inventory, strap the sled to it. Following Ernst's recommendation, I've come dressed in waders. The research team is wearing the duck-hunting kind, and my borrowed

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LEFT: UTV loaded with supplies. RIGHT: Research associates Gabe Rodkey and Jason Hagani. Photos: Michael Adamson

'90s-era neoprene trout-fishing waders would offer some comfort in the frigid waters of alpine meltwater, but are a sticky, sweaty, miserable mess in the Suisun heat.

"And we're off like a herd of turtles," quips Rodkey as he and I follow Ernst's UTV on foot. After passing between head-high plants, the road opens up and follows the riprap levee marking the southern terminus of Suisun Marsh.

Rodkey points out a stand of *Phragmites* where they are conducting their research. Like with many invasive plants, *Phragmites* looks right at home in its assumed habitat. It's a tall, woody reed with long leaves curling downward and a feathery, duster-like tip. Up close, though, the reed's utter ecological dominance is more apparent. It grows in such density that other native plants, including those that wintering birds rely on for food, can't compete. When an individual reed goes to seed, it leaves behind a brittle stalk that can puncture skin and impede wildlife travel.

At this particular stand, the research team had cleared a section of reed and planted a representative sample of native plants in a grid framework several months ago. They've returned today to check the plants' progress.

"Things seem to be growing pretty well," says Hagani. "I mean, the phrag is too, but so is the other stuff." New *Phragmites* shoots have already outpaced the new plantings, but rather than composing a homogenous stand, they're interspersed with the others. "I'll take it," says Ernst.

For each block like this one, the researchers have applied three different "treatments," or arrangements of native plants. One features aggressive species that show resistance to invasion, one is drought- and salt-tolerant species, and the final is a selection of species preferred by the Marsh's waterfowl.

Ernst's past work has looked at tallgrass prairie ecosystems and how different types of plant diversity affect resistance to invasion. Her postdoctoral research, under the supervision of *Phragmites* expert Karin Kettenring at Utah University, is one component of a larger socio-ecological study on *Phragmites* in Suisun overseen by John Takekawa, operations manager of the Suisun Resource Conservation District.

"Despite efforts to control, it has expanded," says Takekawa. "The part of why, where, and how is where we're trying to provide a historical review." More than a simple collection of native plant and invasive *Phragmites* data, the project will also look into the cultural background of land management that affects invasive species control.

Ernst's research takes place at sites both public and private across a representative sample of the Marsh, and her findings will be used to inform plant management practices – but it may not lead to a simple, easily implemented solution. "There's a lot of heterogeneity in vegetation and land usage," she explains of the Marsh's complex ecology. "All of our sites look very different."

So not only may there not be one simple plant-management plan that will work across the entirety of the landscape, but it might also be difficult to find agreement between, say, a landowner concerned about salinity intrusion and a landowner concerned about other, newer invasives.

At a second site in the south of Grizzly Island, Ernst and Hagani notice the cleared-out plot has a new problem. "This looks like the mother," says Hagani, who hefts a large, tangled tumbleweed and removes it from the plot. As the bramble tumbled across the marsh, a spread of waxy-green Russian thistle has taken root in its wake.

Russian thistle is a newer invasive species on the marsh and may pose an even greater risk of degrading habitats than *Phragmites*, but it's challenging and costly to manage. And for a private landowner, like Kent Hansen of the Goodyear Land Management Company, whose hunting club foots the bill of managing their wetlands parcel every year, it can often come down to an either-or decision.

Kent Hansen describes the lay of the land. Photo: Michael Adamson

A Rich Man's Game

Dressed in denim, a ballcap, and a blue pinstripe button-down shirt, Hansen invites me into the Goodyear clubhouse with a firm handshake and an easy, welcoming demeanor. Decorating the walls are taxidermied ducks and historical maps and newspaper articles. He offers me a sports drink from the clubhouse fridge and talks a bit about the club's history and amenities and his plan for the day.

Climbing into Hansen's own UTV, which seems to be the preferred vehicle for transiting the rugged Suisun Marsh landscape, we tour the Goodyear property.

Private duck-hunting clubs are central to Suisun's present role as an ecological refuge. Hunting on the marsh survived through attempted land reclamation (farming failed because of salt intrusion; mining interests didn't pan out) and territorial battles between late-19th-century clubs that local press covered with the same fervor normally reserved for European land wars.

Thanks in large part to the popularity of hunting and Suisun Marsh's proximity to urban centers, San Francisco's high society took on the lion's share of the costs associated with maintaining good hunting habitat, including both land management and legal battles with conflicting interests.

For example, when railroad moguls in the late 19th century planned to shorten the western end of the transcontinental railroad by cutting out Vallejo, they chose a route from Fairfield to Benicia, cutting through Suisun Marsh, rather than build the connection on the bedrock between Cordelia and Benicia, where Interstate 680 currently runs. Some of the oldest of the Marsh's private clubs are situated directly adjacent to this railroad, which took nearly 50 years to build and rebuild as it sunk into the marsh.

Born to Montana ranchers, Hansen doesn't appear to have much in common with those urban uppercrusters of hunting yore, but he recognizes the same financial challenges of managing attractive waterfowl habitat. "It's a rich man's game," he says.

Goodyear Land Development Company owes its name to an old mining claim, but, when surveying the property with Hansen, it struck me as curiously apt for a duck hunting club. While the hunting season is confined to only a few months a year (which the clubs further restrict to two or three days per week by voluntary historical precedent), the land management is year-round.

Goodyear's property, which is managed for puddle ducks like northern pintail and green-winged teal, is mostly dry in May. Hansen's group spends $25,000 to $30,000 on

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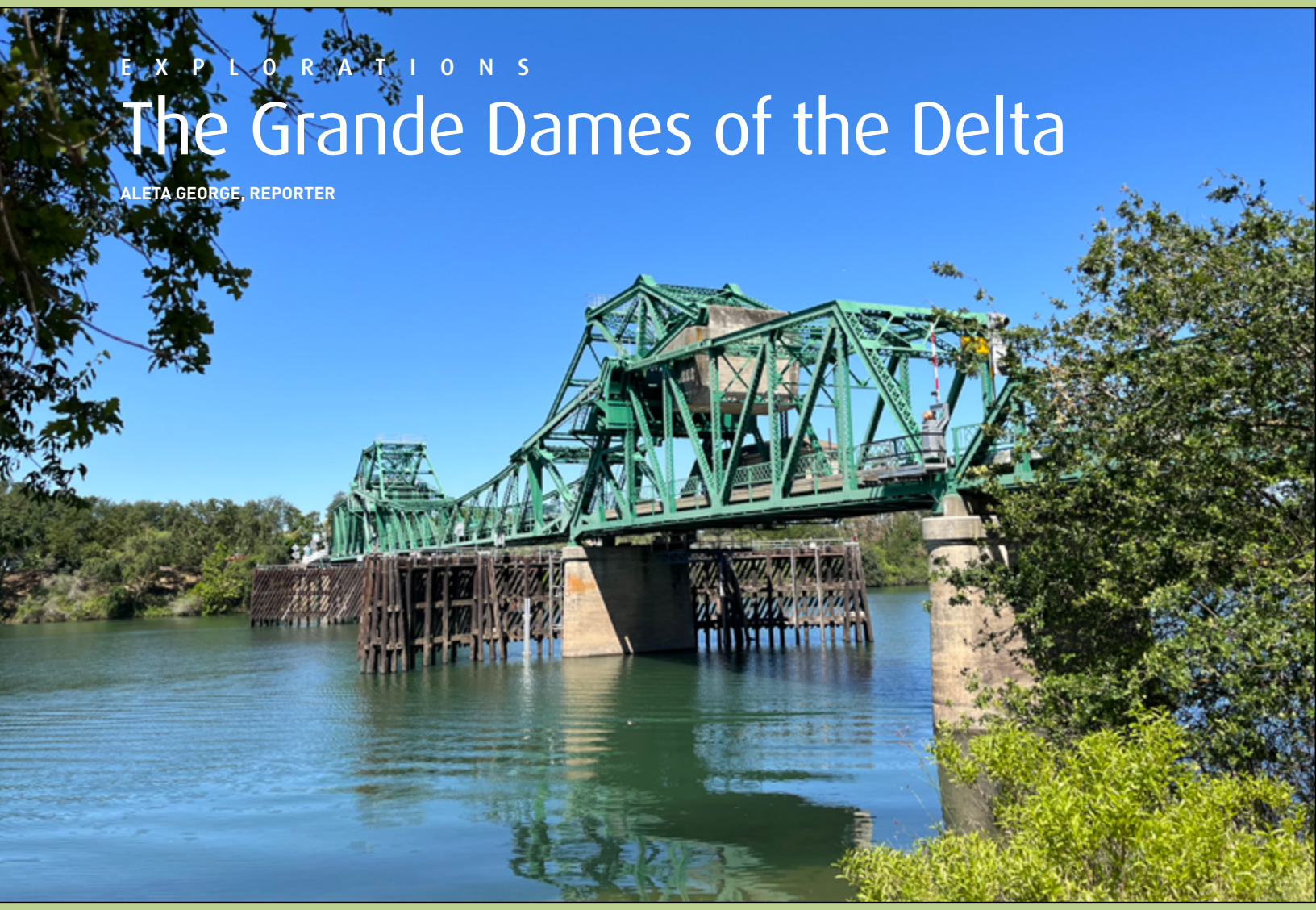
EXPLORATIONS

The Grande Dames of the Delta

ALETA GEORGE, REPORTER



The moveable bridges that cross the rivers and sloughs in the Sacramento-San Joaquin Delta were built in the first half of the 20th century, and most are operated by control panels as old as the bridges themselves. A day spent touring these strong-boned grande dames on backwater levee roads or zigzagging across the Sacramento River on scenic State Route 160 is time well spent. But that's leisure time, and for the tens of thousands of commuters who use the heavily trafficked corridors of the Delta, the four-to-twenty-minute wait for a bridge to open for marine vessels can be frustrating.

Although vehicles far outnumber vessels these days, watercraft has the right of way. "When we open the bridge, we follow United States Coast Guard rules and regulations," says Rio Vista Bridge operator Phil Pezzaglia, citing federal regulations for navigation and navigable waters that a drawbridge must open "promptly and fully" upon request from a vessel.

When road vehicles proliferated a century ago, bridges were needed to cross the waterways of the 55 constructed islands in the Delta. Today, on Georgiana Slough and the Sacramento, Mokelumne, and San Joaquin rivers alone, there are 22 narrow moveable bridges that represent three types: bascule bridges that leaf open with the help of concrete counterweights; swing bridges that pivot from a fixed, central point; and vertical lift bridges that raise a segment of the roadway between two towers. On average, the two-lane bridges are 23-feet wide, a tight squeeze for a full-size SUV that is nearly seven-feet wide.

All the bridges in the Delta are controlled by operators or tenders, who are either stationed at the bridge house or on call. Hope Kirch, 77 years old, has been an operator at the Walnut Grove Bridge for 21 years. Built in 1951, this bascule bridge connects east and west Walnut Grove.

"The Walnut Grove Bridge is our gem," says Bill Rowton, bridge operations supervisor for Sacramento County, which manages the bridge along with four others.

I visited the bridge one spring morning with Kirch on duty in the bridge house. Before opening upon request from a vessel by phone, radio, or a long and short blast of their horn, Kirch sounds a warning bell and goes outside to ensure the bridge is clear. Once the cars have stopped and the bridge is free of pedestrians, she lowers the traffic safety gates and moves inside to open the bridge from the original control panel.

Photos above: Freeport Bridge (left) and Walnut Grove Bridge (right). Photos: Aleta George

The two leaves open and rise in the middle with a grinding metallic sound, causing nesting swallows to panic and fly in circles. When Kirch isn't opening or closing the bridge, she enjoys watching river otters, sea lions, and swallows from the bridge house.

Roughly 6,600 vehicles cross Walnut Grove Bridge daily, but on an early Saturday morning only about 20 vehicles had to wait for the four-minute opening. In 2021, the bridge opened 591 times, less than two times a day.

Different agencies own, manage, and operate the bridges. Caltrans District 4 is in charge of six, including the Mokelumne River Bridge. Built in 1942, this swing bridge crosses the Mokelumne River on California SR-12 and has the greatest number of openings among all Delta bridges. In 2019, the bridge made way for boats approximately 1,600 times, says Pezzaglia. Nestled into tules on the banks of the river below the bridge, I clocked a seven-minute swing. While seven minutes doesn't sound like long, traffic can back up fast with up to 21,000 vehicles driving SR-12 daily, with nearly all of those crossing the Mokelumne and Rio Vista bridges.

The Rio Vista Bridge (also called the Helen Madere Memorial Bridge) is one of five vertical lift bridges in California, and you can see its two lift towers from miles away. The original Rio Vista Bridge was a bascule bridge (like the Walnut Grove Bridge) built in 1918. Construction of a new bridge started in 1943 on the east side, but due to World War II steel shortages didn't conclude until 1960, when it was named the most beautiful steel bridge in its class by the American Institute of Steel Construction.

The 306-foot-long lift span provides 135 feet of vertical clearance for vessels, a height that is necessary to accommodate cargo ships traveling to the Port of Sacramento in the Sacramento River Deep Water Ship Channel. Last year the bridge opened 974 times, an average of less than three times a day.

The process of lifting and lowering the span for marine traffic requires vehicles to stop for about 20 minutes, a significant wait made longer when cars ignore the amber, then red, lights signaling that the bridge is about to close to traffic. "At an intersection, people stop their cars at a red light. When you have a bridge with a red light, it seems people say, 'Put your foot on the gas!'" Pezzaglia says. "I have counted as many as 50 cars that blow through the red light."

Once the cars do stop, Pezzaglia engages the safety gates on the roadway and walkway, and raises

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Bridge tenders Hope Kirch and Phil Pezzaglia. Photos: Aleta George

the safety barriers. These precautions are warranted. According to a 1944 article in the Sacramento Bee, a tomato farmer travelling across the old bridge didn't notice that the span was opening. By the time he did, he had to jump out of his truck. His truck smashed into the side of the bridge, the farmer got 36 stitches, and the bridge was left with a ketchup clean-up.

On the modern-day bridge, the operator pushes buttons and levers on the control panel (the original from the 1960s) to lift the span at 50 to 60 feet per minute. A safety feature ensures that both sides are rising equally. If a five-inch skew is surpassed, the process will stop.

But it wasn't a screwy skew that infamously gummed up the Rio Vista Bridge in 2018; it was a failed gear box. At about 2:30 pm on Thursday, August 9, the operator opened the bridge, but couldn't get it down and traffic backed up for miles. Specialty crews from Caltrans District 3 (which owns the bridge) and District 4 (which maintains and operates it) were able to lower the lift span by Saturday. Then it was stuck in the down position. To accommodate vessels, a team of electricians and engineers devised a workaround with fuel-powered winches, and crews with radios on both towers coordinated a lift that would not exceed that five-inch skew. They used the technique to raise and lower the bridge for more than three weeks until the repaired gear box came back from the manufacturer.

To ensure that nothing like this recurred, Caltrans put in place an emergency repair plan to upgrade the bridge's mechanical and electrical systems. New backup drives for each tower have been installed, and next year Caltrans will put in new drives for the main system. Upgrades to the bridge house include an automated identification system for tracking vessels and a camera system to monitor the bridge. The estimated cost of the emergency upgrade is $32 million, which will include a new lightweight pavement for the lift span.

The steel bridges in the Delta are old, but safe and sound, says Caltrans project manager Soka Soka. "On the Rio Vista Bridge we're putting in a new electro-mechanical operating system to catch up with the available, modern technologies. It's like we're giving life to an old thing with new blood circulation."

Yet even with a new circulatory system, the Rio Vista Bridge will take 20 minutes to lift and lower, a wait made more bearable if only commuters would embrace the views of pontists (old-bridge enthusiasts) who travel to the Delta to enjoy the unique history of these grande old dames.

Bridge counterweight. Photo: Aleta George

ENVIRONMENT

Flow Deal: Peace Treaty or Trojan Horse?

CARIAD HAYES THRONSON, REPORTER

Promising up to 825,000 acre-feet a year of new water to protect endangered fish and thousands of acres of habitat improvements, the Newsom administration and others hailed the March announcement of a proposed voluntary agreement on Bay-Delta flows as the beginning of the end of California's water wars, and a boon to the Bay-Delta ecosystem.

"We think this has the promise to give us more benefit for ecosystems because we would be combining both flow and habitat assets," says California Natural Resources Agency spokesperson Lisa Lien-Mager. And by providing an alternative to government mandates already in the works, proponents say the deal will head off litigation that could delay guaranteed environmental flows for years.

Following a decade of stop-and-start negotiations, in March the Resources Agency signed a memorandum of understanding outlining the agreement together with three other state agencies, the U.S. Bureau of Reclamation and 11 water agencies — almost all of them state or federal water contractors, including Metropolitan Water District (Met) of Southern California and Westlands Water District.

The Newsom administration will propose the voluntary agreement (VA) to the State Water Resources Control Board as means of implementing the Board's update to the Water Quality Plan for the Bay and Delta. The new agreement would, in effect, be an alternative to the Board's 2018 framework for Sacramento River Basin flows. That framework, which would require 45% to 65% of unimpaired flows into and through the Delta to San Francisco Bay, was never formally adopted, and has been on hold during the VA negotiations.

The eight-year, $2.6 billion program established by the agreement would implement the Board's water-quality plan "in a way that doesn't result in a long, protracted water rights process," says Met's Bay-Delta policy manager Steve Arakawa. "The idea is the environment will see [benefits] much quicker."

Bay-Delta environmental advocates are skeptical at best. The proposal is light on details, and includes a lot of red flags, they say, starting with that 825,000 acre-feet of new flows. When you dig into the numbers, says San Francisco Baykeeper senior scientist Jon Rosenfield, it turns out that in both wet years and critically dry years — which account for 47% of years — the agreement only claims to provide around 150,000 acre-feet for fish. "I get going with your top line," he says, "but in almost half of years, it's not going to be anywhere close to that top line."

Describing the water as "new" or "additional flows" for the environment is also problematic, argue Rosenfield and others. Previously,

Low freshwater flows necessitate construction of a rock barrier on False River this April, to prevent salt water intrusion into the Delta. Photo: Florence Low, DWR

specific flows have been committed to beleaguered species by various standards, decisions, and opinions. The March voluntary agreement uses water required under the Water Board's late 1990s Decision 1641 (which set the "X2" estuarine habitat health standard) and the biological opinions issued in 2019 under the Trump administration as a baseline.

Those Biological Opinions, or BiOps, which dramatically increased the amount of water that could be exported relative to the previous BiOps, are widely viewed as deeply flawed. Arguing that they are inadequate to protect endangered salmon and other species from extinction, California sued the federal government to invalidate the 2019 BiOps, and the Biden Administration has declined to defend them in court. Last year the Bureau of Reclamation reinitiated consultation on water project operations, launching a process that will lead to new BiOps by 2024. In the meantime, as drought and exports continue to squeeze flows, populations of endangered salmon and smelt will likely decline precipitously.

"Why [is the state] using the Trump baseline when they disagree with it?" asks Rosenfield. "This is a case where you lower the floor to

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make your table look higher. The water promised in the VA is basically filling a hole that was created when the Trump administration lowered the floor compared to the 2008-2009 Biological Opinions."

According to Doug Obegi , a senior attorney with the Natural Resources Defense Council,

"Once you account for the changed baseline and the different water-year types, the VA proposes around 300,000 acre-feet of water per year for the environment compared to the 2008/2009 BiOps, whereas the State Board's 2018 Framework and Amendments to the Bay-Delta Plan would have provided 1.6 million acre-feet of new flows for the environment."

"In critically dry years," says Rosenfield, "the new VA proposal would provide less flow for the environment than it received under previous regulations that everyone agrees were inadequate."

Lien-Mager notes that the voluntary agreement includes the 2019 BiOps because they "refer to the current regulatory framework for the Central Valley and state water projects and solely for the purposes of measuring whether the flows and habitat are additive to the system." The agreement acknowledges that the BiOps may be modified, she says, adding that any discrepancies between water commitments in the VA and future requirements under a new BiOp would be reconciled prior to completion of the State Board's regulatory process.

Although the March agreement is billed as an eight-year program that will be monitored and adaptively managed to ensure that environmental goals are met, "the state plans to use this agreement as their proposal for flows the planned Delta tunnel must meet," says Obegi.

Emails obtained through a Public Records Act request indicate that "when the Department of Water Resources submits their water rights petition for the Delta tunnel to the State Board, they're not going to analyze a wide range of outflows, they'll just propose what's in the VA," says Obegi. If the petition is approved, the flow requirements in the agreement would effectively become permanent, unless the rules were changed in the future.

Lake Oroville in July 2021. As the drought continues to deepen, flows for the environment may become more contentious than ever. Photo: Kelly M. Grow, DWR

Whatever the exact amount of environmental water that's provided by the VA really is, it's clearly inadequate, say Bay-Delta environmental advocates. They cite the State Board's 2018 framework and its 2010 flow criteria report to the California legislature, as well as numerous studies by state and federal fish and wildlife agencies, NGOs and academics, that found that a much greater amount of flow, released on a more natural pattern, is needed to restore the estuarine ecosystem.

It's also unclear where the water for the voluntary agreement will come from. According to the agreement's term sheet, about one quarter of the water will come from the San Joaquin River Basin (most of the rest will come from the Sacramento River and its tributaries, and water purchases). However, none of the San Joaquin River water districts have signed onto the voluntary agreements.

"Why are they counting new contributions to tributary flow from water districts that have not signed on to the VAs?" wonders Rosenfield.

Lien-Mager hopes "the water agencies on the San Joaquin tributaries can and will become part of the VA at some point." She adds that if the State Water Board approves the agreement, "the intent is to have a dual path — the VA implementation path for those who sign on, and the regulatory path for non-VA parties."

The San Joaquin Basin is covered under Phase One of the water quality plan update, which the State Board formally adopted in 2018, and which requires that 40% of unimpaired flow stays in the rivers from February to June. The proposed VA provides less than 30% of unimpaired flow from the San Joaquin's tributaries, says Obegi, noting that the State Water Board, the California Department of Fish and Wildlife, and the U.S. EPA all rejected 35% as inadequate in 2013 when that figure was proposed as part of a prior VA.

Several San Joaquin Basin water agencies, the Modesto and Turlock irrigation districts, and the San Francisco Public Utilities Commission have proposed their own Tuolumne River Voluntary Agreement.

"Although we were not asked to participate in the development nor the signing of the state's memorandum of understanding, Modesto and Turlock irrigation districts are committed to a collaborative solution," says Modesto Irrigation District spokesperson Melissa Williams. "We still believe that a voluntary agreement is the best resolution that will provide water and habitat improvement for fish, while ensuring water supply certainty for our region."

A key selling point for the VA is that it would provide for about 45,000 acres of habitat restoration to benefit Delta species. This would be on top of the 25,000 to 30,000 acres of restoration already required as mitigation for the state and federal water projects, says California Department of Fish and Wildlife director Chuck Bonham, who calls the water commitments in the VA "not insignificant." He believes that focusing too closely on flows is a mistake.

"The debate often devolves into 'Is it more freshwater flows [that are most important to species protection] or is it habitat?' I actually think it's both," says Bonham. "There's an equation between cold, clean water in sufficient volumes and the abundance of aquatic species. But abundance alone isn't a long-term fix. When you restore habitat, you're creating resiliency. They have more space and places to live and thrive. If we don't do more good restoration projects, faster, we're missing an equally important part of the problem, and the solution for it."

Most of the funding for the VA would come from a combination of state and federal funds, with less than 25% coming from a self-assessment paid by the water agencies. Exporters from the state and federal projects would impose a $10 per acre foot charge for deliveries, says the Metropolitan Water District's Arakawa. Besides habitat restoration, the bulk of the money would go to water purchases, which provide a significant portion of flows under the proposal.

"It raises the question of why is the public paying for water that it owns?" says Rosenfield. "The citizens of California already own the water."

"The idea here is a comprehensive way of managing the system, because the system has been affected by more than just the water projects," says Arakawa, pointing to the effects of climate change. "So it's a combination of things that we need to manage for both supply reliability and environmental protection. It's bringing those resources together to implement a comprehensive approach that goes beyond just setting flow requirements."

Hovering over all the questions about what is in the VA are concerns about who negotiated it. When talks began back in 2012, participants included a range of stakeholders, including environmental groups, fishermen, tribes, and Delta communities. But for the last several years, those stakeholders have been excluded from talks, and none participated in the development of the new VA.

"This was a deliberate attempt by the administration to exclude all of the other relevant interests in their discussions,' says Gary Bobker, director of the Bay Institute.

The California Natural Resource Agency's Lien-Mager says the public's opportunity to weigh in is still to come. "Once this is translated into a legally binding document the State Water Board will need to analyze and do their whole public process. There are still many steps and a lot of process that will happen."

On April 29, the Department of Water Resources invited several past participants in voluntary agreement negotiations to two governance and implementation workshops for the VA, the first of which was scheduled for early May. The invitation was not received warmly.

"Asking our organization to participate with three-day notice for the first meeting in a process that is near completion is not an offer rooted in equity," wrote Restore the Delta director Barbara Barrigan-Parrilla, who declined the invitation. "Such a late request, after the bulk of the planning has been completed, diminishes the broader environmental justice and tribal community to a checkbox in order to say such outreach has been completed."

Some say the entire premise of the voluntary agreement — that it will avoid litigation and deliver environmental benefits more quickly than if the State Water Board just adopted and implemented the existing water quality plan update — is flawed.

"Of course it will be litigated," says Bobker. "We're talking about water and endangered species in California."

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Surveying for salmon carcasses on the Feather River in 2020. Photo: Kelly M. Grow, DWR

KEYWORDS

Demystifying "Unimpaired" Flows

For the second time in four years, a proposal for a voluntary agreement between agencies and water contractors on flows into and through the Delta from the San Joaquin and Sacramento rivers and their tributaries is wending its way through the State Water Resources Control Board. The proposal, which would replace the regime outlined in the Board's most recent update to the Bay-Delta Plan, calls for substantially less water remaining in the system than the update, but comparing the two requires understanding some terminology, specifically the concept of "unimpaired flows."

In 2018 the State Board adopted Phase 1 of the Bay-Delta Plan update, calling for San Joaquin River inflows to the Delta of 40% of unimpaired flow; a framework for the Sacramento River and its tributaries (yet to be formally adopted) would require 45%-65% of unimpaired flow into the Delta. The framework describes unimpaired flow as "the flow that would accumulate in surface waters in response to rainfall and snowmelt and flow downstream if there were no reservoirs or diversions to change the quantity, timing, and magnitude of flows."

"In general, the unimpaired flow of a stream at a given location represents the magnitude of the flow that would occur at that location if there were no upstream impairments caused by agricultural or urban developments," says the Department of Water Resources Tariq Kadir. Such impairments might include surface water diversions, or reservoir storage operations (if a reservoir exists). For a most upstream watershed, the unimpaired flow can be calculated by starting with the "impaired" (measured or estimated) stream flow at a gauged location and then modify the value by adding in, or subtracting out, all upstream impacts. For example, an upstream surface water diversion would be added in, since that water would show up at the gauged location if the diversion did not exist, or in the case of a surface reservoir, the water into the reservoir storage would be added to the gauged flow (since if the reservoir did not exist the water would show up at the gauged location), and water released from storage would be subtracted.

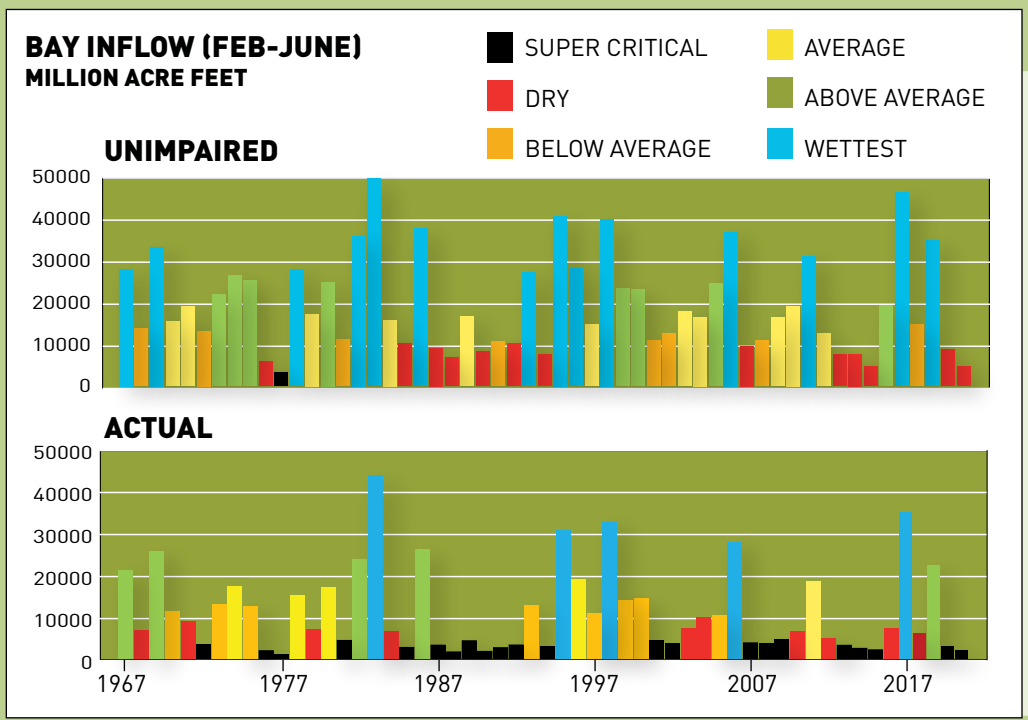
Unimpaired flow should be distinguished from natural flows in streams, which are the stream flows that would exist if all agricultural and urban land use developments were reverted to their native vegetative classes, all impacts of storage and diversions removed as well, and streams are channelized by natural levees (much lower than existing conditions, and thus subject to overtopping during high flow events).

The State Board's Diane Riddle says unimpaired flow represents "the water that flows into the river in the existing configuration of the watershed" but without dams and other diversions, emphasizing that "it's the existing landscape and the existing hydrology, not what would happen in a natural, unperturbed system."

Unimpaired flow is useful as a measure of the total amount of water entering the watershed, says Riddle. "It gives us a sense of just how much water is available for different purposes, including human uses and environmental purposes." She adds that it may be especially useful as the climate changes because "it automatically adjusts to variable hydrology."

Generally, unimpaired flow is calculated as seven-day running average, says Riddle. However, the Bay-Delta Plan framework includes implementation provisions that could allow for a different timeframe — possibly weeks or months — so that flows could be "shaped" to "maximize the benefits from the quantity of water available for environmental purposes," she says.

In this case, some amount of water representing a specific percentage of unimpaired flow over a certain time period is managed for specific objectives, rather than being released, according to the natural hydrograph. San Francisco Baykeeper's John Rosenfield, says this "block of water" approach may reduce the benefits of using unimpaired flow as a metric. "It loses a lot of the natural variation in timing that's very beneficial," he says.



Over time, the median actual flow to San Francisco Bay in the ecologically critical winter and spring months has declined to less than half of the unimpaired runoff. This bar chart divides actual inflow (the amount that actually made it to the Bay) and unimpaired runoff (the inflow to the Bay that would occur if there were no dams or diversions) into quintiles from wettest to dry, and marks years drier than 2015 (roughly, the driest 2% of years) as "super-critically dry" years. Over the last 54 years, "super-critically dry" runoff conditions in the Bay's watershed occurred naturally only once, in 1977, but the Estuary received runoff volumes in the super-critical range in 22 years, or 40% of the time. Overall, flow volumes characteristic of the driest 20% of years now occur more than half the time as a result of storage and diversion of runoff for consumptive uses. Source: The Bay Institute, based on data from California Department of Water Resources.

REGULATION

Cutting Green Tape

SIERRA GARCIA, REPORTER

A novel exemption lawmakers passed to California's landmark Environmental Quality Act (CEQA) in late 2021 has helped fast-track at least four habitat restoration projects so far, with more to follow in the next couple years. The Statutory Exemption for Restoration Projects, or SERP, offers a rare reprieve from California's stringent environmental review and permitting process — and a clear indication of the urgency the state's leaders feel in advancing ecological restoration work.

"When [SERP] passed, it was a little bit controversial," says Sara Johnson, executive director of the fledgling California Ecological Business Association. Sluggish regulatory approval timelines are the top grievance member organizations of the association share, she said at the Society for Ecological Restoration's conference in Carmel Valley in May.

"Under current regulation, it's supposed to take one to two years to approve a conservation bank, but members complain it often takes five years or longer," she added. "It's chilling investment in the space." Conservation and mitigation banks sell preemptive habitat restoration work credits to offset environmental impacts in a different place. As of 2021, 87 banks throughout the state contained 67,879 acres of habitat.

It's not just industry perception. A 2019 internal summary of California's Department of Fish and Wildlife budget found that the agency is understaffed across the board, with the Species and Habitat Conservation branch needing an estimated fourfold increase in staffing to meet its target timelines for duties like processing permits.

SERP beneficiaries have to get a final sign-off from Fish and Wildlife, but first have the exemption approved by a separate "lead agency" like the California Coastal Commission.

Exempting beneficial habitat-conservation projects from the lengthy CEQA approval is part of a larger effort within California conservation regulations called "Cutting the Green Tape." Although only a handful of restoration projects have been approved through SERP so far, there are dozens of others in the pipeline, according to Fish & Wildlife Deputy director Chad Dibble. He estimates that one or two projects per month could receive SERP approval as staff and applicants grow more comfortable with the process.

"[We're trying to] maximize restoration opportunities that are true restoration and fit the letter of the statute," says Dibble, adding that some beneficial restoration projects, like those mandated for mitigation, may also qualify for SERP. "It's really important for us to have multiple environmental review and permitting tools available to fit different projects rather than trying to cram every project into one tool."

The exemption is set to expire on the first day of 2025, leaving less than three years for agencies to prove to lawmakers that accelerating beneficial projects for habitat is possible without letting questionable actors circumvent full environmental impact assessment obligations.

In the meantime, SERP may be just an early gust of a tailwind nudging the restoration of California's creeks, wetlands, and dunes forward. At press time, a new bill labeled AB 2362 (dubbed the "Publicly and environmentally beneficial projects" bill) is moving through the legislative revision process, which could further smooth permitting for ecosystem restoration. The growing appetite for these projects is likely tied to the recognition that the state's twin goals of combating carbon emissions and protecting Californians from their impacts can both be met with robust green and blue infrastructure, and signals a possible heyday for ecological restoration on the horizon.

"We need resiliency, and we need restoration of a lot of areas to support our fish and wildlife and plant communities," Dibble adds. "We're all benefiting as Californians [from restoration]."

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LEFT: Lakeville Creek in Sonoma County, where one of the first restoration projects approved through the SERP process will soon break ground. Photo Courtesy Julian Meisler, Sonoma Land Trust. RIGHT: Upstream of the Garcia River estuary restoration project in Mendocino County, the first in the state to be granted SERP approval. Photo Courtesy The Nature Conservancy/© Bridget Besaw.

PERCEPTIONS

Building Buy-in for Restoration

ROBIN MEADOWS, REPORTER

The success of a restoration project is in the eye of the beholder. Take the recently revitalized salt marsh edging Drift Creek in Alsea Bay, Oregon. To ecologists, the sight of new channels winding through bare, brown mud is a thing of beauty, heralding the abundance of life to come, from sedges and rushes to fish and shorebirds.

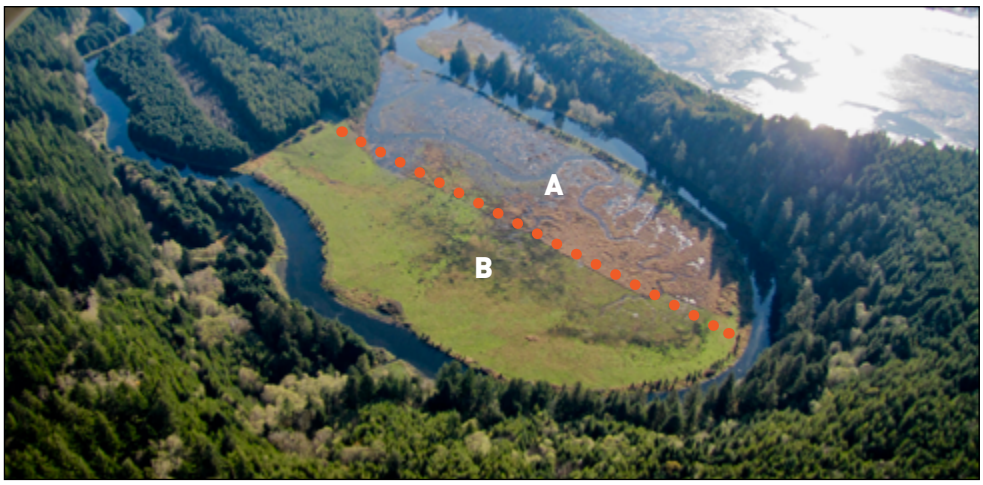
But, as researchers learned while speaking with people living nearby, not everyone shares this view. Some locals favored the unrestored side for its lush green vegetation and vistas of grazing elk. Resolving such differences in perception is key to local support, which can be required for project funding and permitting.

"Restoration can look unsightly at first," said UC Davis salt marsh ecologist Julie Gonzalez. "There's often a disconnect between scientists and other user groups, like community members and landowners, about what successful restoration actually looks like."

In a new study, Gonzalez and colleagues gauged how various users perceived Oregon salt marshes in Alsea Bay, Yaquina Bay, and South Slough National Estuarine Research Reserve in Coos Bay. This one-year pilot wrapped up in December 2021, and the team presented their work at a May 25, 2022 webinar called Restoration Success: Linking Social and Ecological Metrics.

Besides offering habitat to a wealth of native species, salt marshes provide ecosystem services such as storing carbon, enhancing water quality, and buffering coastlines against rising seas and storm surges. But only 15% of West Coast salt marshes remain; the rest have been diked and drained for conversion to farms and housing.

The team devised social metrics for perceptions of salt marsh restoration, compared them to ecological metrics, and suggested ways to reconcile differences between the two. "We wanted to know what to highlight in communications with the public," study lead and Portland State University environmental scientist Catherine de Rivera explained during the webinar.



Drift Creek project, restored on one side (A) and left as is on the other (B). Photo: Paul Engelmeyer.

The pilot results heartened the researchers. For example, focus groups that brought together ecologists and community members revealed a surprising commonality of environmental values. "They were all concerned with habitat, pollution, and sea-level rise." said Portland State University's Melissa Haeffner, who was social science lead on the study.

Social metrics were based partly on how the people in focus groups ranked images of high versus low ecological function. For example, participants chose between an image of the curving tidal channels found in healthy salt marshes and one of the straightened channels typical of developed coastal areas. Ecological metrics included channel sinuosity (hydrology), nonnative plant cover, and wildlife use.

A favorite moment for de Rivera came when a dairy farmer gave the lowest ranking to a photo of a cow standing in a tidal channel. An environmentalist in the same focus group was agog to discover this common ground with the farmer. "The environmentalist said, 'What, you think that?'" she recalled. "After that, the group came together — it was a powerful experience."

However, comparison of social and ecological metrics also revealed a divide between community members and restoration practitioners. "There were mismatches between social and management perspectives," Gonzalez says.

Based on their findings, the team created a public-facing brochure describing restored salt marshes in a different way. While technical reports highlight metrics like hydrology and vegetation, these local people rank these on the low side. The brochure explains why these elements influence issues the public cares about, for example clarifying that sinuous channels provide habitat for fish and other wildlife, while marsh plants provide both habitat and ecosystem services.

The mix of people in the study, from those involved in the restorations to those affected by them, gives credence to the findings. Sabra Marie TallChief Comet, South Slough's coastal training program coordinator, also credited the team with engaging a broader slice of the community, including those with "less trust of government." That said, the researchers cautioned that the study may also have an intrinsic bias: because it was conducted during the pandemic, participants had to be willing to wear masks.

To see if their results hold up more broadly, the team wants to extend their work to other sites on the West Coast, including in Oregon, Washington state, and California National Estuarine Research Reserves in the San Francisco Bay, Elkhorn Slough, and Tijuana River. "We can do better on designing restoration projects and collecting metrics with people's use in mind," said de Rivera.

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PROFILE

Bagman for Bay Mussels

AMY MAYER, REPORTER

Martin Trinh practically bounces along the dock at the Coyote Point Yacht Club on a breezy, sunny spring morning. He's carrying a case full of instruments and scopes out an open slip at the end of the pier. Soon he's lowering a probe into the water, alongside kelp clinging to the underside of the dock. Another trip back to his Prius, still sporting South Carolina license plates, and he's got a white plastic dish pan and a scrub brush. He fills and rinses a brown plastic bottle several times before finally capping it while full and placing it into a zip-top plastic bag. Then he lies on his belly, reaches into the water, and with blue nitrile gloves feels amidst the kelp for the last thing he needs here today: five medium-size mussels.

"While I'm looking for the mussels, I'm also looking to see how many mussels are there, what is the average size of a mussel?" he says. "It looks like this site is a little sparse." He gets his catch and then scrubs them clean before bagging them to take to the lab.

Trinh began his work as an environmental analyst with the San Francisco Estuary Institute (SFEI) less than a year ago, shortly after graduating from Duke University in Durham, North Carolina. "I've been primarily continuing the projects and the passions I've had from my undergraduate studies," he says, "analyzing what we call 'contaminants of emerging concern.'"

In college, Trinh combined his love of science and the outdoors. "I realized this confluence between the environment and human health was something that I was really interested in," he said. "It was a lot more fun getting out in the field" versus being in an indoor lab.

His persistent smile shows he's enjoying the work. He'll deliver these and other samples to the SFEI lab in Richmond, where the water will be tested for chlorophyll and phytoplankton and the mussel tissue will be analyzed for domoic acid, microcystin, and saxitoxin. SFEI is the lead institution implementing the San Francisco Bay Nutrient Management Strategy. Sampling throughout the Bay happens every other week. Together these data will give an indicator of the presence of harmful algal blooms, Trinh says.

San Francisco Bay gets a lot of nitrogen and phosphorus washed into its waters. This human-caused nutrient loading, which occurs at higher levels in San Francisco Bay than in some other estuaries in the country, can cause harmful algal blooms that threaten both recreational uses and drinking water. As SFEI outlines on its website, "[u]ntil recently, the Bay was considered to have innate strong resistance to high nutrients. However, recent observations suggest that the Bay is experiencing a 'regime shift' toward higher sensitivity to nutrients." Monitoring nutrients through regular sampling will help scientists establish and maintain a consistent picture of what's happening.

Trinh's work as an undergraduate introduced him to the long-lasting impacts that water pollution can have on surrounding communities. His focus was on PFAS (per- and polyfluoroalkyl substances), which are often called "forever chemicals" because they don't break down in the environment. They're found in certain coated paper packaging, non-stick cookware, and water- and stain-resistant fabrics, have been implicated in a variety of human diseases, and often get washed into waterways. Studying these at Duke led Trinh to the fields of environmental toxicology and environmental justice. Born and raised in Spartanburg, South Carolina, he says he came to realize that "these adverse health effects impact different people differently."

Trinh's supervisor, Melissa Foley, who runs SFEI's Regional Monitoring Program, says that combination helped Trinh land his current job. The Regional Monitoring Program, or RMP, collects data that informs management decisions about contaminants in the Bay. Foley says SFEI's goals include environmental justice. "He also has done a lot of work in his spare time volunteering for different immigrant groups in the Carolinas," Foley says. "That's an area where SFEI is really looking to expand our work."

Trinh has attended community meetings to hear from people with varying interests in the Bay's health and to take notes and provides summaries to colleagues. He says he also talks to locals when he's on a dock or shore gathering samples to bring back to the lab. Hearing from these people about their different connections to the Bay is something he enjoys.

continued on next page

Photos: Amy Mayer

"It's pretty awesome," he says. "People are always curious to hear what we're doing. [So I have] a wealth of conversations with different community members, which are very informative for us and for them. It's a symbiotic relationship."

Foley says these conversations are fundamental to SFEI's efforts to engage everyday people. "The community provides, oftentimes, a different perspective than the management agencies do."

Trinh sees, and is able to share with others, how what happens in the Bay will impact various groups of people differently. "Investigating how different areas of the Bay ... affect different populations, and their specific cultures, has been a real focus of SFEI in the past couple years," he says, which added to his interest in the organization. North Carolina, he notes, "has a rich history of environmental activism and then environmental tragedy, as well," like drinking-water wells contaminated with PFAS. He's pleased to see that California has been more proactive, for example by banning long-chain PFAS before the federal government.

At stop number two on this day, South San Francisco's Oyster Point Marina, the wind is strong and Trinh pulls out his smartphone to check the speed. It's about 12 mph and he mentions that when he's playing beach volleyball, a 10 mph wind is "definitely a factor." He declines to play if it exceeds 15 mph. But he's enjoying his sport here and the shared place he's renting in San Francisco. Moving during the pandemic opened options he says he might not otherwise have had; plus, being young, nimble, and gregarious, he didn't balk at housemates.

A sudden gust grabs a plastic baggie Trinh had tried to secure. It lands in the water nearby and he gets back down on the dock, pulls up his windbreaker sleeve and waits as the soggy bag floats to within reach. He snatches it, then looks around carefully for something heavy enough to hold it in place until he fills it.

For the Regional Monitoring Program, Trinh says his field work is often reactive in the sense that just after a heavy rain, he and colleagues will grab pre-staged equipment they keep at the ready and rush out. That's because his main assignment is as part of the stormwater monitoring team. During and right after a storm, runoff washes contaminants directly into the Bay. That's when his team wants to capture and analyze samples. But in California's persistent drought conditions, opportunities to leap into action are few and far between. "There was this time period in October, November, where we were going out a decent amount," he says, "and we thought, 'Oh, this is forecasting a really good year, a really wet year.' And since then, nothing."

That makes him available to fill in with the harmful algal bloom project on this day, or with water-sampling cruises on others. From the pier at Coyote Point, he watches as a California Fish and Wildlife research vessel goes by. It's the type of boat he'll board for field work that can't be done from terra firma. He has one more stop this Thursday, at the Golden Gate Yacht Club in San Francisco, before heading across the Bay in his trusty Prius to deliver all of his carefully labeled samples to the lab.

Foley says Trinh is just as eager to help "pull together all the necessary details to keep a program running" on the back end. He handles contracts with labs and other partners and keeps track of what the internal staff needs. "There's a lot of moving parts to the program," she says, and Trinh has been a "super go-getter," jumping in wherever he's needed. "Usually, it takes a little bit longer for us to give [new staff] technical projects," such as literature reviews, data analysis, and visualizations or writing reports, she says. About two months shy of his one-year anniversary, "he's really one of the co-leads for coordinating and doing our stormwater monitoring."

The environmental analyst role at SFEI, Foley says, is often a young scientist's introduction to professional research in a nonprofit setting. "They're a really important component in our staff," she says, but the institute also wants to make sure the "EAs" have a fruitful experience. "We're hoping that we're kind of helping to create a pipeline of folks," she says, who "can take that experience and incorporate it into their future."

Trinh appears poised to do just that.

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BUDGETS

Greenbacks for Blueprint

ARIEL RUBISSOW OKAMOTO

For the first time in decades, California's federal estuary management and water quality programs are getting a big boost in bankroll. Priority actions in the newly updated Estuary Blueprint, a 25-action consensus plan for improving the health of San Francisco Bay and the Delta, are poised to take advantage of a new influx of federal money.

"We're fortunate with timing," says San Francisco Estuary Partnership (SFEP) environmental planner Darcie Luce. Completed this spring, the 2022 Blueprint includes some well-thought-out actions oriented toward greening grey infrastructure, making the region more resilient to climate change, and improving equity in adaptation planning and projects — all of which are federal priorities.

The new money will flow toward Estuary Blueprint actions and related projects in multiple ways: the March 2022 Consolidated Appropriations Act bill will provide a one-time injection of $24 million to the San Francisco Bay Water Quality Improvement Fund, up from the previous average of about $5 million for the fund's annual budget. Another $24 million from the November 2021 Bipartisan Infrastructure Law (BIL) will go to US EPA Region 9. The latter will also provide $4.5 million over the next five years directly to the Estuary Partnership for implementation of the Blueprint.

Despite many lean years in estuary management budgets, forward-thinking groundwork in the 2016 Blueprint that remains relevant today puts the partnership in a promising position to implement the Biden administration's Justice40 Initiative. According to a White House blog, the initiative "is a whole-of-government effort to deliver at least 40% of the overall benefits from Federal investments in climate and clean energy to disadvantaged communities."

The 2022 Blueprint includes one new action explicitly aimed at equity through engaging frontline, underserved, and indigenous communities in estuary restoration and management, and incorporating social and cultural science in planning. Equity is also a focus of specific tasks in most of the other actions. "We created a space that will open the door to advancing equity-oriented tasks and actions," says Luce.

Across many actions, highlights of the updated regional Blueprint include accelerating wetland restoration, adapting to sea-level rise, and performing other multi-benefit nature-based projects along the shoreline; cutting through "green tape" and removing hurdles to implementing nature-based solutions; decreasing carbon emissions and increasing carbon sequestration; reconnecting and restoring creeks to provide habitat and reduce flooding; and increasing the use of dredged sediment and soils for flood management and restoration.

"Sediment looms large in the updated Blueprint," says Luce. Its approach benefits from extensive research and planning work done in the San Francisco Estuary Institute's recent Sediment for Survival report concerning how much sediment will be needed to adapt to rising sea levels and restore buffering wetlands, and where it might come from. Seven Blueprint tasks add weight to the region's sediment strategy.

Years of working to create a stronger throughline between the upper Estuary (Delta and watershed) and the lower Estuary (Bay and ocean coast) are also apparent in the updated Blueprint. Almost every current action includes a Delta component, according to Luce. Steadily increasing collaboration between the Delta Stewardship Council and the SFEP was key, she says.

While the task and action list has shrunk dramatically since 1993, when the first 300-page Comprehensive Conservation and Management Plan (early Blueprint) was published, the list of partners only seems to be getting longer. "Since the Blueprint isn't regulatory, we have the freedom to be collaborative while still holding each other accountable for implementation," says SFEP director Caitlin Sweeney.

With a bigger budget and years of experience under its belt, the Partnership is indeed well positioned to push the frontiers of environmental equity, adaptation planning, and nature-based solutions across the region. "It's deep work that will take years." says Luce.

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"ground maintenance" each year, which includes tasks like spraying invasive plants, abating mosquitos, and "discing," a practice that turns over plots of dirt to allow more diverse assortments of waterfowl-friendly plants to grow (Hansen is particularly fond of grass buttons, whose black seeds he calls "caviar for ducks").

After each hunting season, the soil has to be "leached" of salt through a series of flood and drain cycles. A new floodgate costs $35,000, and one needs to be replaced every year. The swales that drain each field fill up with sediment and need to be dug out periodically to the tune of $25,000.

All of this is to say that land management comes at a steep cost, one that Takekawa, whose Resource Conservation District works closely with the Marsh landowners, is keenly aware of: "You have to decide where to put those funds," he says of the many either-or decisions landowners have to make with their budget each year. "That can be a difficult choice to make."

Communicating A Plan

At one point on my Goodyear tour, Hansen's ATV rolls up along a levee at his southern property line, and we're presented with a pretty demonstrative juxtaposition. While Goodyear is drained and dry this time of year, the property across its southern border, which is managed for mallards, is flooded, both with water and *Phragmites*.

Hansen explains that they have a different "water idea," or that they manage their water to attract their preferred species, and different water ideas apparently carry different problems. Goodyear has *Phragmites* pretty well under control and is much more concerned about Russian thistle. This land to the south has a keen *Phragmites* problem, however, and according to Hansen, the only real solution, due to problems of access and spraying herbicides in water, is to manage it with controlled burns.

The either-or decisions landowners make with their money are further compounded by the fact that management decisions are not made in a vacuum. "If one side of a levee is doing a good job [controlling *Phragmites*] and the other isn't, it can return to the areas where people are trying to control it," says Takekawa. "Everyone needs to work together."

Coordinating a consensus in a management group the size it is in Suisun presents a problem of collective action, and one that Takekawa's colleagues in the larger *Phragmites* project, backed by the Delta Stewardship Council, are working on. Richelle Tanner, an ecophysiologist and science communicator, has looked into the data of how science is communicated to the public and is building a strategy for communicating the threat of *Phragmites* from the Suisun Resource Conservation District to local landowners.

"We've noticed that there is very little top-down communication about coordinated control of the species," says Tanner, and "there aren't many communication methods for landowners right next to each other."

Tanner's work uses environmental psychology and linguistics to build an evidence-based strategy for communication around *Phragmites* that can serve as the framework for disseminating a coordinated control plan. "There is a set of cultural values that many people share in a specific stakeholder group," she explains of her strategy. "You can tap into that sense of community and trust if you use a cultural value. You can get people to take in info in a less biased way."

Tanner offers an example: In a survey, she asked participants to read a few versions of a statement that defined "control measures" and asked them to rate how well they understood it and how it made them feel. The first one used language like "crowd control" and "crowd out their neighbors;" the second used "vaccination" and "difficult for the heart of the ecosystem to keep pumping." The third described control measures as "used by everyday people when they weed" and "can help wetlands and vegetable gardens in the same way."

Contrast between two water ideas. Photo: Michael Adamson

If you felt the most positive emotional response to the third statement, then you're in the same camp as the surveyed participants. Tanner believes data collected in this fashion can help guide the efforts to present a *Phragmites* plan that doesn't alienate landowners or build mistrust and allow a plan to move forward with Marsh-wide consensus.

Tanner's research is less about finding the one "golden ticket" solution that solves the *Phragmites* problem in Suisun Marsh, and more about finding one that works for the diverse interests and perspectives of the many landowners. "There isn't one solution to anything," she says. "We just need to make sure that all the different solutions can work together to create a strong, resilient ecosystem."

The Novel Ecosystem

The book *Suisun Marsh: Ecological History and Possible Futures*, introduces the idea of the "novel ecosystem," or an ecosystem owing its current state to anthropogenic change and without an historical precedent to look to for guidance on how to imagine its future. Takekawa agrees with this assessment of the Marsh.

"Bringing back the time before people is not gonna happen," says Takekawa. "We aren't going to let Sacramento flood, we aren't going to tear down the dams in the Sierras, many things are changed that cannot be changed back." Similarly, he feels that a future without *Phragmites* isn't a realistic expectation.

A "*Phragmites* sea" (a possible end state where the Marsh becomes a single-plant monoculture) might not even be the worst outcome imaginable. Takekawa notes that the plant is valuable for its ability to sequester carbon, and Tanner notes that research shows that the reed is a good home for aquatic invertebrates which may in turn attract a new group of birds to the Marsh.

Suisun Marsh identifies how competing perspectives complicate Marsh management going forward: "The problem, of course, is that beauty is in the eye of the beholder, so one person's positive outcomes is another person's bad dreams. Therefore, debate and dialogue among those who care about the Marsh are vital to looking forward with intention." In other words, if my vision of a marsh was as a haven for aquatic invertebrates, who's to say *Phragmites* is such an enduring problem?

Still, "In most people's view, a marsh managed for species diversity is much preferred over a *Phragmites* sea," Takekawa notes. It's not a preferred outcome because too many people are too invested in keeping the Marsh headed in the direction started by the decades of work done by those who frequent it most.

"I think that's the perspective we have for this area." says Takekawa. "It's novel, and that's okay. What values do we get out of it society-wide, and what things make it so it's still an enriching part of the natural ecosystem?"

Before leaving Goodyear, I shared the novel ecosystem idea with Hansen. Hunters like him have some concerns about a future with easier-to-find sources of entertainment and fewer and fewer young people taking up hunting, but he finds optimism in the work done by the Suisun Resource Conservation District, and by the duck hunters and private landowners who have helped make the Marsh such a valuable stop along the Pacific Flyway.

"People think of the marsh as this big old mushy place, but that isn't true at all," he says, gazing out towards Rio Vista and the windmills hanging on the eastern horizon. "You should come back sometime for a sunrise. They're really spectacular."

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Control measures for managing Phragmites and other vegetation include spraying a herbicide and burns. Photos: Suisun Resource Conservation District

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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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Who needs kittens when we have western toads?

Photo: Robin Meadows