

SAN FRANCISCO

ESTUARY

Mice May Be More Scrappy Than Thought

Delta's Salmon Capacity Limited

**Region Still Slow to Power Share
on Sea Level Rise**

**Drones Help Scientists See Landscape
in New Ways**

**A Healthy Estuary Could Mean
Fewer Meds and More Green**

**Keeping an Eye on Regional
San Treatment Upgrades**

Duck Clubs Manage Dark Water

**Scare Tactics Undermine Climate
Communication and More**

**Special coverage of
the 2019 State
of the Estuary Conference**

**Reporters summarize
12 sessions and
115 speakers in
28 pages!**

**WATER
ENVIRONMENT
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**DECEMBER 2019
NEWS MAGAZINE
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**ONLINE FEATURES
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ESTUARY-NEWS](http://WWW.SFESTUARY.ORG/ESTUARY-NEWS)**



Questions of the Week

Q (11/7): If you could change one regulation or requirement to better reflect current Estuary conditions what would it be, and how would you change it?

A: Recognition that estuary restoration is about restoring processes, not just structure. Structural changes (e.g., "impacts" such as fill and scour) may be required in order to actively restore processes, and structural changes will occur as a result of the restoration of natural processes. These changes are necessary for estuary restoration and should not be regulated as impacts the way they are for development projects. In addition, performance criteria for estuary mitigation projects should be based on positive trends in process, recognizing realistic restoration timelines, rather than attempting to predict specific or arbitrary structural standards.

Bio: Kim Fettke is a wildlife and restoration ecologist with AECOM.



READ MORE ANSWERS ONLINE

www.sfestuary.org/estuary-news-question-of-the-month-regulation-czar/

NEXT QUESTION?

Describe a recent innovation or local adaptation in one of your water engineering or ecosystem restoration projects and why it will make a difference?

Answer any of the three questions here, you may get published!

www.sfestuary.org/estuary-news-question-of-the-month/

Q (11/14): Pretend you are creating a new position, Bay Area Czar, to overcome jurisdictional infighting and get the region to work as one to galvanize climate change adaptation and action on environmental equity issues around the Bay. What powers would you give them? What would be the first three things they should do?

A: Three-Step Plan

The Bay Area Czar would enact a regional policy to 1) restore Bay Area creeks and their connections to the Bay, 2) redesign hardened shorelines to improve green infrastructure, sea level rise adaptation, and carbon storage, and 3) revitalize public transportation, roads, bike routes, and pedestrian access in and around the Bay's shorelines. Collectively the Czar's policies would address looming threats to the Bay Area's real estate, economies, communities, fish and wildlife, improve quality of life through recreation, air and water quality, and reduce carbon emissions from transportation while increasing carbon storage. The Czar would help lead the nation (and the world) in climate change adaptation strategies.

Bio: Denise Colombano is a Bay Area native currently researching watershed sciences at UC Davis.



A: The Right Stuff

The right person for the job should know the end-to-end process of how work gets done in wet areas and would have the confidence to say no to the paralyzing circle of regulatory one-upmanship that generates mountains of impracticable mitigation measures.

Bio: Lance Dohman is a concerned citizen



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- ➔ **What makes Estuary different is it's about my place, my watershed!**
- ➔ **Your publication contributes to the glue that holds the Bay community together!**
- ➔ **As a teacher, Estuary is very helpful to target areas of interest and to illuminate my students on the types of research taking place in the Bay.**

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After 25 years and continued budget cuts, your contributions, large and small, are invaluable to maintaining our very own regional magazine.

Happy Holidays!



Photo: Noah Berger

C O N F E R E N C E

Regrouping Around the State of the Estuary

On a bright October Day, Kanyon Sayers-Roods (Hahashkani) opened the 2019 State of the Estuary Conference at Oakland's Scottish Rite Center with a land acknowledgement. She invited the audience of scientists, regulators, planners, engineers, teachers, students, and environmentalists to acknowledge that they were gathered on the ancestral lands of the Costanoan Ohlone.

Inside the center the audience shivered with the blast of air conditioning and the memory of the smoky air of 2017's conference during the Napa-Sonoma fires. Outside, locals hurried around the blue jewel of Lake Merritt to work, school, and cafes.

After adding her own welcome, Oakland Mayor Libby Schaaf promised the audience an interesting morning. "Waterfront in the Bay Area is never a dull subject," she said. Neither is Delta planning, California water politics, climate change adaptation, or the latest science on species, sediment, wetlands, or groundwater, all also in the conference line up. "We must all forget our cloaks of government and remember how we share and are united by the Bay and Estuary," said Schaaf.

Sitting in the velvet seats that day were half-a-dozen ESTUARY News reporters, and in this special issue they share with you what they found most interesting in sessions over the course of two days, summarizing the conference in 28 pages (apologies to any speakers or panelists we failed to cram in).

The conference also marked the release of the 2019 *State of the Estuary Report Update*. This 40-page report examines changes in five of 33 indicators of ecosystem health, updating status and trends in freshwater flows, wetlands, native fish, beneficial flooding, and urban water use throughout the Bay and Delta since the more extensive 2015 report. On page four, you'll find the report scorecard and a snapshot of three emerging indicators of resilience.

Top of the list in terms of future challenges for continuing to restore and protect the Estuary are factors like climate change and sea level rise, shrinking public funding, failing species, and increasing social and environmental inequities around California. As San Francisco Estuary

Partnership director Caitlin Sweeney wrote by way of introduction to the report and subsequent conference: "The projects we manage and the people and species they affect are all one, and we must recognize and work through the complexities. It will take much more than measures of acreage, elevation, and access to sustain California's ecosystems and residents in the future."

This year's conference and report also made a point of underscoring the need to make much stronger links between estuary health and human health, and between "elitist" science and science real people can understand and use to make decisions about their families, businesses, and communities. As lead scientist Letitia Grenier commented in the report and in a conference presentation on the scorecard: "We need more investment in creative ways to use and restore flows for environmental health, to expand and build resilient shorelines with rising land elevations, and to weave considerations of social equity more strongly into efforts to improve environmental health."

The full reports and associated videos, as well as information on the conference, can be found at www.sfestuary.org.

Links to many of the reports, articles, and resources mentioned in the following pages can also be found online at www.sfestuary.org/estuary-news

Zooming In

2019 Report Suggests Progress on Bay Wetlands and Urban Water Use

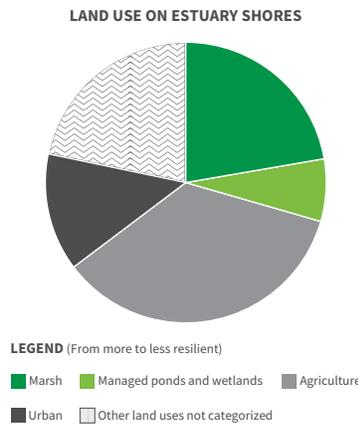
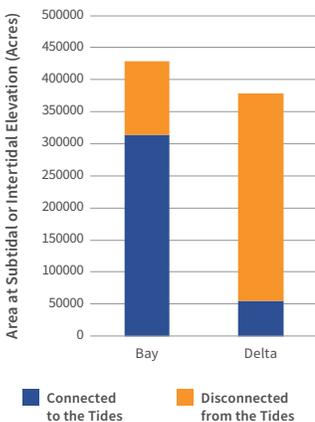
Estuary Health Update 2019

INDICATOR	STATUS AND TREND	AT A GLANCE
FRESHWATER FLOW		Freshwater flows in the Estuary have been highly altered, causing reductions in inter-annual and seasonal variability, and peak-flows. Freshwater flows into the Estuary in recent years reflect chronic artificial drought conditions, in sharp contrast to unimpaired flows.
TIDAL MARSH		Tidal marsh acreage throughout the Estuary has declined significantly from the historical amount, but restoration efforts are bringing back this critical ecosystem and associated benefits. Projects in the Bay are making extensive contributions to tidal marsh area, while efforts in the Delta are beginning to make progress towards regional goals.
FISH		The condition of fish communities varies across the Estuary. In the lower Estuary, fish communities are abundant, diverse, and dominated by native species. However, in the brackish and freshwater upper Estuary, native fish communities are in poor condition. Based on long-term monitoring data, native fish communities across the Bay are declining. In San Francisco and San Pablo Bays, this long-term data set is from sampling only the offshore areas of the Bay and may not reflect benefits to fish populations from recent wetland restoration.
BENEFICIAL FLOODS		The frequency, magnitude, and duration of floodplain inundation in both the Bay and the Delta are too low to support healthy estuarine habitats and sustain important ecological processes. While conditions have been variable over time, they have, in general, remained poor in the Delta and have declined in the Bay.
URBAN WATER USE		In both the Bay and Delta, total and per-capita urban water use have declined over the last several decades, despite growing populations. More efficient urban water use means that both regions met and exceeded benchmarks for per-capita use and drought-reduction targets. The regions have modestly increased water use since the end of the drought but still maintained improvements over their 2020 benchmarks for reductions in per-capita use.

LEGEND



Emerging Indicators of Resilience



SCALE 1 ft²

SUBSIDED LANDS

Subsidence and accompanying processes exacerbate flood risk, contribute to greenhouse gas emissions, and reduce the potential for restoring important intertidal habitat type

SHORE RESILIENCE

Levees and seawalls intended to keep people and property safe from flooding are not as adaptive as the Estuary's softer, more natural shores, nor are they designed to accommodate the kind of flooding projected for our future.

URBAN GREENSPACE

Open spaces within urban areas decrease urban runoff, improve downstream water quality, and provide habitat for native wildlife, while also benefiting human health and wellbeing.

Source: The State of the Estuary 2019, SFEP

Zooming Out: View from the Precipice

PERSPECTIVE FROM REPORTER JOHN HART

Scientific studies of the Bay and Delta tend to look intensely at small bits of the system. A countervailing theme at this State of the Estuary conference was the need to see wider, to “zoom out” — and most of all to help the public see the broad view, too.



Jim Cloern of the U.S. Geological Survey spoke of “looking through a macroscope,” with examples of four levels at which the Estuary changes. When the Delta pumps are quiet in October, certain waters grow saltier, a local effect. Almost 40 sewage treatment plants around the Bay are stuffing it with nutrients, a regional effect. In Suisun Bay, sediment input from inland rivers has declined by more than half since 1975, due largely to upstream dams, a watershed effect. And bottom-feeding fish and crabs are currently abundant in the Bay, a result of several interacting cycles in the northeastern Pacific — an ocean-wide effect.

Like many a scientist before him, Cloern longed for data to be formatted and shared in ways that better allow comparisons to be made and lessons to be learned. “If we could bring these data sets together in a common set so that they can be synthesized We need a data hub!”

Jessica Law of the Delta Stewardship Council remarked that a disproportionate amount of Delta data has come from two sources: compliance monitoring and studies for water projects. That’s not sufficient. “We try for a wider lens.” The Delta Science Program speaks of “One Delta, One Science.” “It should be ‘One Estuary, One Science,’” countered Cloern.

Felicia Marcus also preached the gospel of wide views, of seeing the Bay and Delta together and as parts of larger wholes, including the bulk of the California water supply system. “Conversations tend to be balkanized, perhaps because of the enormity of scale and the complexity of the Estuary, perhaps because of convenience or design. Angelenos

may understand [the big picture] better than San Franciscans,” she observed. People like those in her audience have the job of spreading the word. “Broaden your messages! Make your work accessible! We have the ability to make the case, and it’s sitting in this room today.”

Rachel Johnson of the National Marine Fisheries Service and University of California at Davis spoke of “translational ecology,” the recently defined discipline that concentrates on communicating results and thus shaping action. “What piece of the Estuary puzzle are you holding, and who do you need to work with to plug it in?” Johnson asked. She warned that good data can suffer the fate described by William H. Schlesinger in 2010: “Unless the discoveries of ecological science are rapidly translated into meaningful actions, they will remain quietly archived while the biosphere degrades.” (See also p. 6.)

Andrew Schwarz, who recently transferred from the state’s Department of Water Resources (DWR) to the Delta Stewardship Council, described a relatively new way of approaching decisions in the era of climate change. Traditionally, he said, planners develop alternative climate “scenarios,” often three (good, middling, bad), and pick a future condition to plan for. This can lead to paralysis, because real and costly decisions in the present seem to depend on mere guesses about the future. The new idea, “decision-scaling,” begins with the matter at hand: a particular system and the levels of performance that stakeholders care about. For DWR, the system is the State Water Project, and one key benchmark is its past reliability as a server of water.

In decision-scaling, Schwarz said, analysts explore ways in which warming may alter results, gauging the odds of different outcomes. Then they test different strategies. As one paper puts it, “We change the question ... from ‘what will the future climate be’ to ‘is the climate

that favors Action A more or less likely than the climate that favors Action B?’” DWR has so far reached the unsurprising conclusion that the outlook is poor — “We are nearly certain to lose performance from the system” — and that new initiatives will be needed if deliveries are not to drop. Specific ideas — A vs. B — have yet to be weighed. The proof of this alternative pudding will surely occur when they are.

The Delta Stewardship Council is beginning a similar effort to assess the long-term prospects of the Delta levee system. “Science defines the risks,” Schwarz concluded. “Policy decides which risks to run.”

Another kind of widening of view was on the agenda: the overdue inclusion of communities that have long been neglected or, as a futurist once put it, “planned upon.” A Monday panel on equity endorsed “bi-directional power sharing,” in which questions and answers flow both up and down (see p.14). Looming in the background is the truth that sea-level rise and other disruptions will be hardest on the very people who have lost out in the past. At the governance panel, a voice from the audience challenged the hope for “win-win-win” outcomes, calling instead for compensation. “Some people will lose; we have to make them whole.” Jim McGrath of the regional water board said ruefully, “The crisis isn’t close enough. The system isn’t ready to confront the inequities yet.”

The parable of the blind men and the elephant — let’s try to understand the whole Estuary animal — came up several times in these sessions. So did the metaphor of lenses, wide-angle, “macroscopic.” Another image lingered: assessing the outlook for native fishes, their survival or demise, Felicia Marcus remarked, “We’re at a precipice where it’s going to be one or the other.”

On this and so many other issues, we indeed stand at the top of a cliff. It’s a vertiginous place, but also one that affords wide views.

IN BRIEF

Fish & Wildlife Check Up

Conference presentations featuring decades of data on fish, ducks, seabirds, and cetaceans revealed both hopeful and alarming trends.

The loss of federal funding for the midwinter waterfowl survey, usually conducted using small aircraft, has researchers looking at drone-based alternatives, said waterfowl biologist Susan De La Cruz of the US Geological Survey. Meanwhile, telemetry and site-specific studies show the value of managed wetlands for waterfowl, underscoring the need for duck-friendly features like ponds and channels in tidal restoration designs.

The overall community condition of the Estuary's fish (abundance, distribution, diversity, proportion of native to non-native species) has declined, reported the National Resources Defense Council's Christina Swanson, citing the Bay Study and other surveys. Conditions are worst in the Delta and Suisun Bay, while improving in Suisun Marsh. Record lows for natives and non-natives alike were recorded in the last three years; decreasing freshwater flows ("a chronic man-made drought cycle") and rising temperatures may be responsible. "There are only a few things we can manage," she observed, notably tidal marsh restoration and freshwater flows.

The breeding success of California least terns and Brandt's cormorants reflects the status of the forage fish they feed on, according to Dan Robinette of Point Blue. His data points to cyclic fluctuations in the Gulf of the Farallones, stability in San Francisco Bay, and declines along the coast to the south: "The Southern California Bight has lost its mojo."

Some gray whales now use the Bay as a feeding stopover, while long-absent harbor porpoises have returned and bottlenose dolphins have arrived, reported Tim Markowitz of the Marine Mammal Center, who said the cetaceans may be moving north because of poor conditions in the Southern California Bight. He also noted a dramatic spike in humpback whale activity (a "whaleapalooza"); and recent deaths by starvation and ship strike of nutrition-stressed grays. **JE**

H A B I T A T & W I L D L I F E

Boosting Chinook

ROBIN MEADOWS, REPORTER

A few years ago, Rachel Johnson set out to learn why tiny Chinook salmon, barely the size of a pinky finger, only make it all the way to the San Francisco Bay in really wet years. Johnson doesn't yet have an answer to that question. But the data analyzed along the way led to unexpected discoveries that could transform the way we manage salmon in the Central Valley.

"We thought, 'Wow, this has a lot of interesting implications,'" said Johnson, a researcher at the National Marine Fisheries Service and UC Davis, in a follow up interview to her presentation at the State of the Estuary conference.

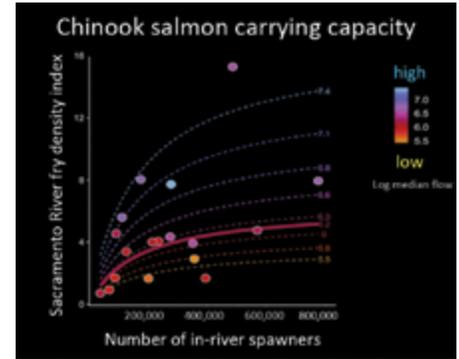
Notably, her team tracked both how many fall run Chinook spawned in the Sacramento River system and how many baby fish they produced. Fisheries managers use this tool, formally called a stock recruitment curve, to set catch quotas. The goal is to maximize sustainable fish harvests, which means making sure enough adults are left to replenish the population but not so many that they exceed the available spawning habitat. Fall run chinook are the only Central Valley stock that is still plentiful enough to target for harvest.

The team then combined the stock recruitment curve of spawners and babies with data on a third factor: flows at the base of the Sacramento River, right where it enters the Delta. This let them assess the interplay of these pieces of the salmon production puzzle.

"One cool finding is that flow had a pretty important role in the number of babies that could be produced for a given number of spawners," she said. "The habitat could produce a lot more in a high flow year."

That said, Johnson cautioned that we don't know exactly why high flows boost baby salmon. Possibilities include increases in the floodplains that serve as nurseries or in the turbidity that helps fry hide from predators. "The more we understand this, the more creative and refined our solutions can be," she noted.

Finally, the team added a fourth



factor to the mix of spawners, babies and flow: the total number of adult Chinook that return each year to the Sacramento River. This yielded another surprising finding. The state goal is to allow between 122,000 and 180,000 adults per year to escape the fishery and return to spawn, which is fittingly dubbed escapement. However, Johnson found that in years when salmon returns exceeded the target for escapement, production of babies can be far higher.

"If you double escapement, it makes a very big difference in high flow years," she said. "This shows there's a lot more capacity for juvenile salmon production than we thought was in the system."

This flow- and escapement-driven variability in baby salmon from year to year has implications for restoration efforts in the Delta. "There's a lot of emphasis on rearing habitat but we shouldn't expect them to use it unless enough adults are returning to spawn and there's enough flow for enough juveniles," Johnson explained. "If you build a restoration site, you need to look at those variables to see under what conditions they might be using it."

Such real-world applications are at the heart of Johnson's mission as a National Marine Fisheries Service researcher, which prioritizes an approach known as translational ecology that bridges the gap between scientists, the public, and decision makers. "We want to make sure relevant science is at the table when decisions are made," Johnson said.

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Not So Picky Mice

JOE EATON, REPORTER

The endangered salt marsh harvest mouse (informally “Salty”) is a poster child for tidal marsh restoration in San Francisco Bay. But recent research, presented by University of California at Davis postdoc Katie Smith in a State of the Estuary conference session on tidal wetlands, suggests we’ve misinterpreted what the mouse needs. “It’s been managed as a habitat specialist,” she said, based on assumptions that it requires tidal wetlands and a diet of pickleweed.

However, hours of mouse-tracking around the Bay show that it also thrives in managed wetlands and eats a variety of plants, including non-native species. Although restoration projects have created high-tide refuges for the mice, Smith’s preliminary data suggest other rodent species exclude them from those sites. That was in a wet year, though; a dry year could shift the dynamic, favoring salties. “We’ve thought about the species in isolation, ignoring the community context,” said Smith. “We need to look at it more holistically.”

This, as she observes, is no ordinary mouse. For starters, it’s the world’s only mammal restricted to coastal marshes. Genetic studies show that the species originated four million years ago, long before the Bay came into existence. Salt marsh harvest mice can drink salt water and swim for hours. Females build crude nests in tall marsh vegetation, sometimes appropriating marsh wren nests. The mice are highly vocal, especially on warm summer nights; if Smith can distinguish their

squeaks from those of co-occurring western harvest mice, monitoring calls may provide a non-invasive way of recording populations.

Smith credits her research interests to her family’s pet rats and the wildlife at a pond near her childhood home. After fish-tagging work, she joined ongoing salt marsh harvest mouse field studies and made the rodent her thesis and dissertation subject (only the third PhD on the species).

Previous work had detected the mice in managed wetlands, including waterfowl areas in Suisun Marsh where water levels are managed to favor the birds. For her post-graduate research, Smith trapped and radio-tagged mice, spending nights in the marsh tracking their movements. “I was surprised at how diverse their habitat use was,” she recalled. “We had mice running all over the place. There were variations in individual behavior: some crossed levees, some never approached them.” They used high ground for foraging, not for nesting. Reproductive and survival rates and home range sizes of mice in managed wetlands proved comparable to those in tidal marshes.

Smith offered captive mice a buffet of native and non-native plants and watched them chow down on non-natives like rabbitsfoot grass, in addition to native pickleweed. The salt marsh harvest mouse’s food preferences overlap those of waterfowl; the duck-hunting clubs in Suisun Marsh have been inadvertently farming mice.

Her current study looks at interactions with other rodent species and how this affects the mouse’s habitat use, especially during king tides. Even with high water, winds, and waves, the mice didn’t seek high ground this year; they stayed out in the marsh, chugging along like little Diana Nyads or clinging to tall vegetation. Voles in



Photo: Chris Rudolph

particular may exclude the mice from potential high-tide refugia, at least in wet years: “It’s like kids that play in the mud instead of using the nice new playground we built for them because that’s where the bullies hang out.” The mice might benefit from more vertical structure in the low marsh; even woody debris can be a life raft.

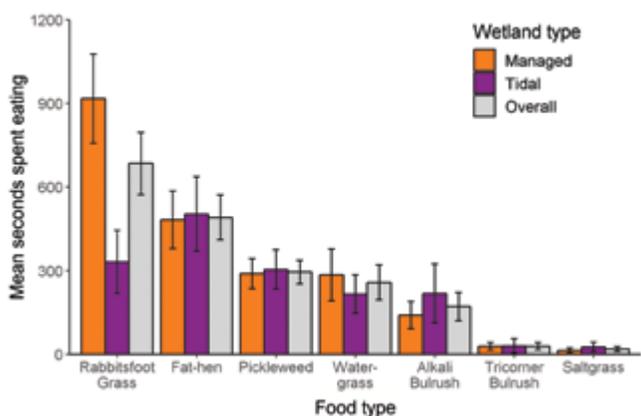
In the same session, Nadav Nur (Point Blue) and Levi Lewis (UC Davis) discussed other tidal marsh creatures. Lewis found unexpected fish abundance and diversity in tidal marshes previously unmonitored, including spawning aggregations of the threatened longfin smelt. Nur dealt with special-status tidal marsh birds like rails and song sparrows and their response to features of the transition zones they use as high-tide refuges, with implications for design parameters in future restoration projects.

Tidal wetlands are caught between the rising deep blue sea and the devil of shoreline development. “We’re losing habitat on both ends,” Smith said. “The marshes have no chance to migrate.” Industrial and residential construction is pushing right up to the edge of the marsh all around the Bay.

Why invest scarce resources in these obscure creatures? Smith’s take on the salt marsh harvest mouse would apply to smelt and rails as well: “It should be a point of pride for the Bay Area to have this cool and unique species — a very specially adapted and unique mouse. Beyond that, a natural ecosystem is like a Jenga tower. If you pull out some number of species, eventually it will collapse.” When marsh habitat changes, fish and birds can move elsewhere, but the mice, with their fragmented populations, lack that option: “If we’ve lost our mice, we know something bad is happening.”

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Food Choices Salt Marsh Harvest Mouse



Source: Smith & Kelt, 2019

H A B I T A T & W I L D L I F E

Coordinated Monitoring Will Hasten Wetlands Recovery

ROBIN MEADOWS, REPORTER

Monitoring may not be the sexiest part of restoration ecology but, as an expert panel attested during the 2019 State of the San Francisco Estuary Conference, it is a vital component. Notably, monitoring is key to re-establishing wetlands in the Bay — and that need is urgent.

Buffering the Bay's shoreline against inexorably-rising waters and powerful storm surges will require 100,000 acres of tidal marsh by 2030. We're only a little over halfway there. "Monitoring supports that effort," said Xavier Fernandez, head of the San Francisco Bay Regional Water Quality Control Board's planning division, at the conference. "Looking at the past guides the future."

Regional monitoring, he continued, would be best of all. Wetland restoration is typically assessed on a project-by-project basis, resulting in fragmented data. Pooling our knowledge would accelerate progress toward our ambitious goals for reestablishing tidal marsh. Just such a Bay-wide collaboration, called the Wetland Regional Monitoring Program, is in the works and is on track to be in place in about two years. Regional monitoring was first proposed as long as a decade or two ago.

Dave Halsing, who leads the South Bay Salt Pond Restoration Project (SBSRP), is eager to participate. As the largest tidal wetland restoration project on the West Coast at 15,000 acres, SBSRP has plenty to offer about what works and what doesn't. "We have benchmark sites, project sites, and monitoring data," Halsing said at the conference. "Our goal is to share all that with the restoration community — there are many opportunities for synergy."

He anticipates getting as much as he gives. "Our monitoring needs are greater than our capacity," Halsing said, rapidly ticking off constraints like time, money and physical access. Tracking outcomes of wetland restoration regionally, he added, would help all managers around the Bay choose better sites, boosting the chances of success, as well as helping to catch problems earlier, "before things start to go sideways."

Putting monitoring data in a larger context would also facilitate interpreting them. For example, phalaropes migrating along the Pacific Flyway favor hypersaline ponds,

which are now in shorter supply due to tidal marsh restoration. Phalarope numbers are down sharply in converted salt ponds, but the implications are uncertain.

This could mean a real decline, with fewer of these birds stopping over here, or it could just be that they now flock to other parts of the Bay. Halsing can't tell which, though, because his program can only handle keeping tabs on phalaropes in limited parts of the region. "We can't survey all possible areas in the short periods of time that they visit," he explained.

Another unknown that would benefit from regional monitoring, Halsing said, involves the sediment needed to rebuild tidal marsh in former salt ponds and elsewhere along the shores of the Bay. The big question is whether there will be enough. "We're working on it but we don't know how much is coming into the system, or how much we need to maintain habitats," said Brenda Goeden during the same session. Goeden manages the Bay Conservation and Development Commission sediment program.

Other questions on her long list included how sediment is transported from mudflats to shallows and then to tidal marsh, as well as how much sediment is removed from the Bay's many tributaries for flood protection and whether it could be managed to reconnect the Bay with marshes. "There are various sediment monitoring efforts but they're not necessarily connected," said Jeremy Lowe, a coastal geomorphologist at the San Francisco Estuary Institute who also spoke during the session. "We should connect the dots — we need to work together in the Bay."

Needs for launching the Wetland Regional Monitoring Program include funding, a common data management system, and standardized protocols. "If everyone collects data the same way, everyone can use it," said Rachel Tertes, a wildlife biologist at the Don Edwards San Francisco Bay National Wildlife Refuge. In other words, standardized protocols would let restorationists compare apples to apples, rather than apples to oranges.

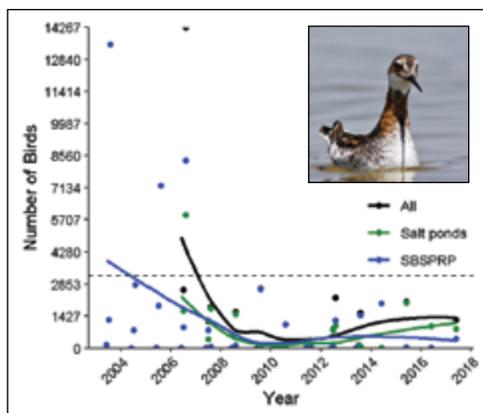
Moderator Heidi Nutters, an environmental planner at the San Francisco Estuary Partnership, wrapped up the session by asking the audience if they were involved in monitoring themselves. A strong show of hands prompted regulators in the panel to stress that regional monitoring will not replace project-by-project monitoring. "It won't go away completely," said Luisa Valiela, who leads regional Clean Water Act programs for the U.S. Environmental Protection Agency. "We have too many project-specific questions."

Fernandez agreed but also said regional monitoring could lighten the load. "At the Water Boards, we think vegetation and wildlife are better addressed at the regional level." Moreover, Bay-wide trends could reveal when an undesired outcome is caused by, say, a plant pathogen rather than the particulars of a given restoration project.

"The Wetlands Regional Monitoring Program will let us see what's happening and learn from each project," Fernandez said. "It'll help us get the most bang for the buck."

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Sky Sensors More Sensitive

NATE SELTENRICH, REPORTER

Tidal wetlands are complex, dynamic places — and famously hard for humans to reach. A rushing channel may be an empty ditch six hours later. Eelgrass gives way to boot-sucking mud; then to cord-grass, pickleweed, and salt grass; and finally to upland grasses and shrubs, only to be interrupted again by another channel. To better map and track this critical, varied habitat ringing the San Francisco Bay, scientists are increasingly turning to low-cost drones and distant satellites.

In a State of the Estuary conference session on new and emerging remote-sensing technologies, Tony Hale of the San Francisco Estuary Institute sang their praises. Mounting cameras and other sensors to satellites and drones allows researchers and managers to see the Bay and its familiar wetlands from a different perspective, he said, and to track minor changes over small periods of time in ways that field surveys never could.

“New technologies are allowing us to see the landscape in different ways,” Hale later said in an interview. “We are seeing changes induced by human impacts and we need to have a much finer-tuned vision of what’s happening, both in terms of the geospatial specificity and the temporal level of change, because the changes are accelerating.”

Pete Kauhanen serves as SFEI’s resident drone pilot and expert. “Monitoring wetlands as a whole system, we’re going to have to scale up some of our efforts to address what’s happening across the Bay Area,” he added. “Remote sensing is uniquely qualified to do that.”



Drone image of wetland. Photo courtesy Iryna Dronova

SFEI uses a fleet of three drones — each costing no more than \$2,500 each, sensors included — to do things like survey trash in creeks, rivers, and streams or to monitor wetland sedimentation and vegetation. “It really helps for monitoring restoration projects in hard-to-reach areas,” Kauhanen said. “You can go out and get images and see what’s happening each year, or after a storm event.”

Later in the session, UC Berkeley professor Iryna Dronova discussed new applications of remote sensing for mapping and monitoring vegetation. Of the more than 1,900 satellites orbiting the Earth, she noted, nearly 700 are used primarily for Earth observation and Earth science. About half of these are equipped with optical sensors that take photographs from space, though not necessarily in the visible light spectrum.

Together they generate massive volumes of data. The European Space Agency’s Sentinel 2 satellites, launched in 2015 and 2017, circle the Earth every five days. Combined with publicly available images from NASA’s Landsat satellites and the RapidEye Open California dataset from San Francisco company Planet Labs, that’s a lot of temporal and spatial change for a scientist to sort through, even when the pixels are as large as 30 meters squared.

Recently, more powerful data-processing capabilities including machine-learning algorithms have allowed researchers to make better

continued on back page

OVERHEARD

“Even in a highly instrumented system like the Bay and Delta, there are still a lot of gaps in our knowledge. So how do we leverage and apply remote-sensing to make water-quality management decisions?”

CHRISTINE LEE,
NASA JET PROPULSION
LABORATORY, SPEAKER



HUMAN DIMENSION

Cities Can Reboot to Boost Biodiversity

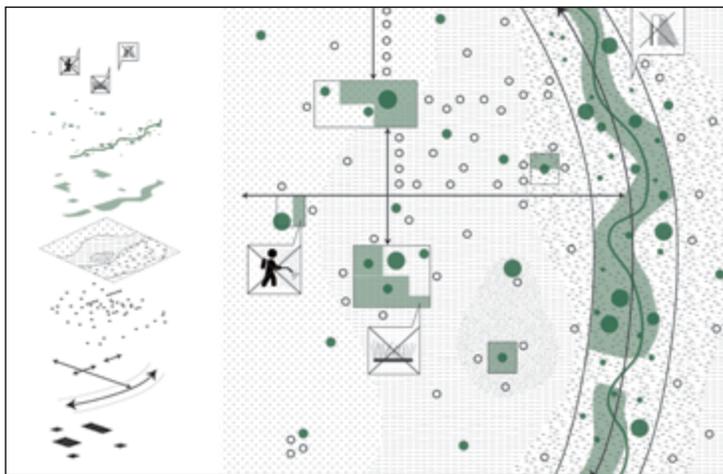
LISA OWENS VIANI, REPORTER

When Erica Spotswood picks up her daughter from elementary school every afternoon, she feels a sense of dismay. "There's nothing in this schoolyard, nothing growing, no trees, and just a few around the perimeter," she said at the State of the Estuary conference session on urban biodiversity and human health.

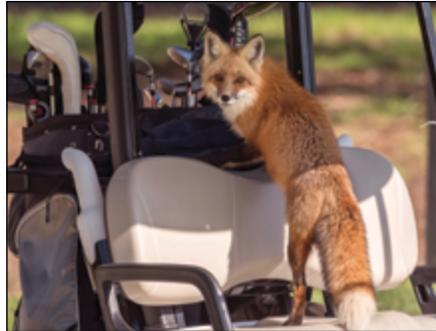
Spotswood, an applied ecologist at the San Francisco Estuary Institute, has spent years studying biodiversity and its importance to ecosystems. Her research — and that of many others — also ties biodiversity to human health.

"We have lost sight of something that is very simple but is not obvious to us now, which is that we need the same things biodiversity needs," she said. "The places biodiversity likes are the same places we like, and it's only because we've completely lost sight of that that we are creating places like this schoolyard for children."

She and other SFEI scientists are making the case for increasing biodiversity in cities, and have published a toolkit for how to do so in a recent publication, "Making Nature's City." Spotswood highlighted some of their findings and sounded a call to action.



The quality of the green matrix matters. Large patches of habitat and connections between patches help wildlife, and reduce stress and increase physical activity in humans. More green space helps reduce air pollution and urban heat islands while large trees and biodiverse areas give people a sense of awe and restoration. Source: Making Nature's City



Foxes are returning to both urban and suburban settings. Photo: Joe Galkowski

"We have a biodiversity crisis across taxonomic groups, including insects and birds," said Spotswood. "There's an alarming decline in common species as well. This is something we should care about more broadly but also something we should care about in cities." Research shows that physical and mental health are strongly influenced by a person's proximity to green space, Spotswood added.

But we haven't always built our cities with those benefits in mind. Another session speaker, C.N.E. Corbin, a Ph.D. candidate in environmental science at UC Berkeley, said that many cities were built to reflect the idea that cities and nature should not mix. "Historically and within

environmental thought, nature and cities are separate," Corbin said. "Humans were separate from nature, nature was sublime, and urban areas were places to escape from."

Spotswood described landscape features that support biodiversity and human health. Large patches of habitat sup-

port more species of wildlife but also benefit people. "In terms of human health, people who have regular access to large patches of green space tend to get more frequent physical activity and experience less stress, depression, and cardiometabolic diseases," said Spotswood. Similarly, corridors that connect habitat patches for wildlife create better access for humans as well and are linked to better mental health for residents living nearby.

The rest of the "green matrix" matters for both wildlife and people too, said Spotswood. "Whether it's a back yard, street trees, or habitat in medians, they all have habitat value, and the more habitat value the more species they support."

Other boosts to biodiversity include native vegetation, large trees, and water features such as creeks, lakes, and rivers, said Spotswood. Large trees also benefit people by providing a connection to nature in areas with little greenspace, she said. And how people interact with the landscape matters a lot. "How we use chemicals and fertilizers and pesticides — how and in what way and how frequently we prune trees, whether we manage light pollution, how we manage vegetation, it can all support or hinder biodiversity and human health," Spotswood said. Perhaps most importantly, she noted, greater ecological richness is associated with people experiencing a greater sense of restoration.

Another strategy for increasing biodiversity in cities is to add as much green infrastructure as possible, Spotswood said, as trees, shrubs, green walls, pocket parks, and rain gardens can all create habitat while reducing air pollution and mitigating urban heat islands, which take a toll on human health and contribute to environmental injustice. She and other researchers have found that in many disadvantaged communities, street trees are lacking — and pavement is plentiful. "We found that in places with really high impervious cover or high-percent pavement, trees are less able to cool the landscape."

One place where urban biodiversity is thriving is San Francisco's Presidio. Michael Boland, chief of park development and operations with the Presidio Trust, who spoke later in the session, said the Presidio

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Helping the Homeless Clean Up Watersheds

ROBIN MEADOWS, REPORTER

Chris Brokate used to blame homeless people for the endless garbage washing down the Russian River after heavy rains. “A lot of the trash on the beach came from encampments,” recalled Brokate, who founded the nonprofit Clean River Alliance in 2014 to remove rubbish from the river’s watershed. “I was not happy about that.”

Now, however, he sees the homeless as neighbors who have been displaced by catastrophic floods and fires. He also sees them as being integral to the success of his organization. Brokate shared his story during a State of the Estuary Conference panel called “Humanizing Homelessness for Healthier Creeks and Communities.” His turnaround came several years ago, when he began helping people living in encampments clean up after themselves.

“I started giving out bags and when I returned, they were filled with trash,” Brokate said. “People asked, ‘Can we get more bags?’ and ‘When can you come back?’” Now he hands out empty bags and picks up full ones at encampments throughout the Russian River watershed.

Homeless volunteers collect so much refuse there — 150,000 pounds as of October this year — that the state Water Resources Control Board sees Brokate’s approach as a model for the rest of California. “A state-level rule on trash in water is coming soon,” he explained.

His aha moment came when a “sweet, little old lady who shouldn’t have been living like that” asked if he was Chris Brokate. She then told him, “We call you the Trash Angel, we follow you on Facebook.” His first thought was, “They have Facebook accounts?” His next was, “They’re people too.”

As he told this anecdote, fellow panelists smiled and nodded their heads. Put yourself in their place, said Julia Lang, East Bay director of the nonprofit Downtown Streets Team, which helps homeless people beautify the environment in exchange for services that restore self-sufficiency. “Where would

you go if you lost your housing and had no social safety net?”

Lang recently worked with the homeless in Oakland, where rent increases squeeze many people out of their homes. The city’s unsheltered homeless population rose by nearly half in the last two years, to about 3,200 people living on the streets. Current rates are even more appalling: for every person who regains a home, two lose the comfort and safety of shelter.

Like Brokate, Lang has found that the homeless can be part of the solution when cleaning up waterways. In a nine-month Downtown Streets Team pilot program, homeless people collected more than 16,000 gallons of trash around Lake Merritt, where enormous encampments had sprung up. “Needles and cigarette butts were a huge problem,” she said. “Whatever goes into the lake goes into the Bay.”

Lang also stressed that the homeless are far from the only sources of trash in waters that flow to the Bay. “Don’t scapegoat an already marginalized community,” she said. “The problem goes beyond the unhoused — a lot of encampments become illegal dumping grounds.”

Talia Rubin, whose work with the City of Oakland includes managing encampments, pointed out that homeless people lack access to toilets, garbage service, and other basics that the rest of us take for granted. Since 2017, the city has provided porta-potties and garbage pickup to the largest encampments, along with toilet paper, hand sanitizer, and cleaning supplies.

Rubin also reminded the audience that while no one can see what’s inside our houses without our invitation, the homeless do not have the luxury of privacy. She asked those in attendance to imagine if all our worldly belongings — and the trash we generate — were out in the open. “Everything in encampments is visible,” she said. “Everybody sees the mess.”

OVERHEARD

“Just moving people around, even if it looks pretty, doesn’t solve anything. We need a plan for our unhoused neighbors.”

CORI RING-MARTINEZ,
ENVIRONMENTAL JUSTICE
COALITION FOR WATER



Photo: Amber Manfre

Encampments are now banned by Lake Merritt, following its restoration. “The entire perimeter of the lake is a no-camping zone,” Rubin said. To help compensate, the city provides what it calls community cabins — insulated Tuff Sheds with power, porta-potties, garbage service, and 24/7 staffing — around the lake.



Another part of the solution, the panelists agreed, is seeing the homeless as real people. More than 28,000 people in the Bay Area suffer homelessness, according to a 2019 report by the Bay Area Council Economic Institute, making our unhoused population the third-largest in the nation after New York City and Los Angeles. As Downtown Streets Team’s Lang said, “We need to find the balance between the environmental crisis and the humanitarian crisis.”

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HUMAN DIMENSION

The Next Wave in Conservation: Community-Based Design

AUDREY MEI YI BROWN, REPORTER

Designer Brent Bucknum of Hyphae Design Lab likes to refer to humans as the “dominant megafauna of cities.” We are, on the one hand, part and parcel of our ecosystem, yet as a species we impose outside influence on the ecology and land we live on — this is, after all, the Anthropocene. For Bucknum and his fellow panelists at a State of the Estuary conference session on community-based design, people are integral players in their ecosystems,

and that makes them central to any conception of environmental conservation. “Ecosystem health is human health,” says Bucknum.

The session’s mixed group of designers, researchers, and architects expressed a common preoccupation with fostering beneficial human-nature interactions, particularly through multi-use green space. Coming up with designs with different benefits for different stakeholders, all in one project, can draw diverse interests to rally

together to get it built. Highlighting multiple benefits also offers multiple pathways to access diversified funding.

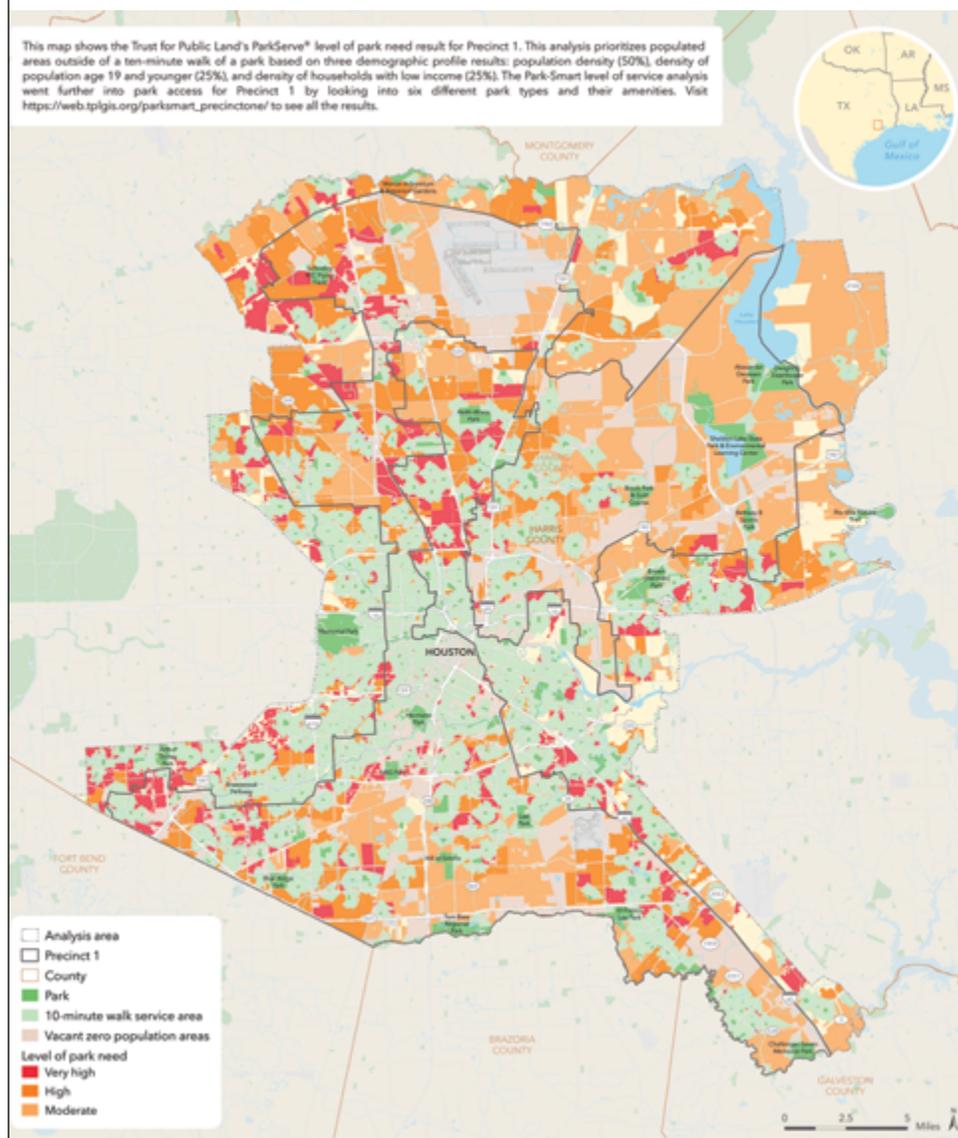
One area where human and environmental benefits naturally collide is parks and greenspace, according to several speakers. Benefits of green space include everything from purifying air quality to regulating urban heat islands to improving the mental health of park-goers. Amanda Brown Stevens of the Greenbelt Alliance described how she was trying to conserve Coyote Valley from urban development. She encourages regulators to think of nature as infrastructure— ready-made, multi-benefit infrastructure at that. Among other benefits, keeping Coyote Valley undeveloped would bolster climate resilience, maintain wildlife connectivity, and help with aquifer recharge, she said.

Consultant Amy Morris described how she uses park space as a doorway to understand community needs more precisely and intimately in her research in Harris County, Texas. It is precisely because parks lie at the nexus of health, environment, and equity that they offer such a wealth of data to draw from, she said. Using the park as her bounded territory, Morris maps aspects like racial diversity, socioeconomic class, and the prevalence of community member concerns around park space. The result: rich, stackable images of the community.

Another appealing type of project that helps designers connect with communities and stakeholders is green infrastructure. In order to do their job, designers must push their designs through the bog of infrastructure development, where movement is anything but guaranteed. Sharing the potential multiple benefits builds momentum.

Session speakers offered contrasting examples. One of Bucknum’s projects, a sculptural roundabout by the Los Angeles River, took ten years to bring to life. The timeline was so drawn out that parts of the design had to be reworked as technology changed

Level of Park Need in Harris County, Texas.



Source: Park Smart

and made the initial design obsolete. Not only did it take ten years to realize the design as a physical sculpture, but towards the end, “a lot of it was volunteer work, just to get it done,” said Bucknum.

Regardless, Bucknum stands by his hefty time investment in the project, and more generally, long-term relationships with communities. A rare water-permeable oasis in Los Angeles’ concrete sprawl, the completed design is undoubtedly striking. Egg-shaped sculptures reveal ghostly faces of local residents as drivers circle the roundabout. It’s so eye-catching that it has caused car accidents.

By contrast, a recent Resilient by Design Bay Area Challenge project that Richard Mullane spearheaded with the Hassel+ team lasted a mere year — a timeline that drew controversy amongst Bay Area community organizations for its pace and brevity. Describing the experience, Mullane said he had no regrets, however, and still prefers shorter projects with a hard deadline. He felt the deadline was a necessary tool for not only motivating the design team, but every other regulatory body and stakeholder involved.

Mullane points out that a short-term project doesn’t necessarily mean a short-term community relationship. Following the Bay Area Challenge, the Hassel+ team opted to continue working with the community, and are now 18 months into the second phase of the project, which is focused on Colma Creek in South San Francisco.

The different durations of the Bucknum and Mullane projects reflect their respective approaches to community design. Mullane believes that to be an effective designer for a community, it is best to go in, listen, take inspiration, and then let the designers design.

“Not everyone should be the designer,” Mullane said. While some design teams in the Bay Area Challenge labeled their community participants co-equal designers, he felt that the distinction between community member and designer should remain intact. Mullane prefers to engage with communities to understand local needs, but then narrow the field of design input in order to focus the design and expedite progress. “We think designers are a tool for community members,” he says.

From his presentation, it was clear that Bucknum plays the long game. He seeks to build long term relationships and projects in the communities he works with. One such community, West Oakland, is his own neighborhood. He described bringing his own local knowledge to the table when identifying and troubleshooting problems.

The photos of West Oakland on his presentation were not computer-generated visualizations, but shots that looked snapped with his phone, on the street and within people’s homes. In pictures, his neighbors washed particulate filth from their window screens, an outcome of severe air pollution. “This is a regular activity in my neighborhood,” Bucknum said, clicking through his slides.

In this talk, Bucknum recalled the long process of building a relationship with Margaret Gordon, a stalwart Bay Area environmental justice activist and co-director of West Oakland Environmental Indicators Project. Copious after-work drinks and conversation finally helped him convince Gordon of his commitment to the community for the long haul. Community engagement is time-consuming, but trust that isn’t built upfront can’t be salvaged later.

In the conference session, the designers all agreed on one point: that in order to go forwards you have to look backwards. In Brown-Stevens’ fight to conserve Coyote Valley, digging into the area’s history yielded one key to understanding the area’s vulnerability. She realized that a lack of long-term protection meant the area continually became available to development. The field was tilted against conservation of the valley.

“You have to win every battle, and if you lose even one, you’ve just lost the whole war,” she explained.

For Mullane, looking backwards meant getting closer to the people who know what Colma Creek used to be like. He and his team collected oral histories from residents and elders in the community whose memories of the area had never been recorded on paper consistently. It was only through this live archival research the team realized that people in the past had indeed felt connected to the Bay and the creek. It motivated the designers to make it happen again.

Mullane recounted one past resident’s memory of the creek. “In those days, one would head for the beach with bathing trunks and a towel. No lunch, no snacks, no bottled water, just salt water and sunshine,” Karl Rolih had told the team. This former resident’s recollections revealed that the creek had been a part of local imagination and culture in the past, but that the connection between people and water broke down as the creek became less accessible.

“We continually returned to Karl’s words, and we put them up on our wall so we’d see them every day,” said Mullane.

Ultimately, this panel of designers, architects, and researchers wanted people to feel connected to their natural environment, and for that environment to be healthy, safe, and vibrant. To get there, the distinctions between person versus environment or nature versus infrastructure blurred into one.

“Human = Ecosystem = Health,” read Bucknum’s closing slide.

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Colma Creek vision by Hassel+ team for the Bay Area Resilient by Design Challenge.

P L E N A R Y P A N E L

Striving For Equitable Outcomes

AUDREY MEI YI BROWN, REPORTER

As 11am drew near, five people of color, four of whom were women, took center stage in a full amphitheater. The panel looked markedly different from past State of the Estuary conference plenaries. Indeed, the sight could be called unusual for any primetime session at an environmental conference.

Mishal Durrani, an undergraduate researcher at UC Berkeley, observed from the audience. "As a woman of color from an underrepresented community, it was powerful to see a panel with so many women of color represented - it's uncommon to see that," said Durrani, who later presented her research on how sediment composition affects the functionality of levees.

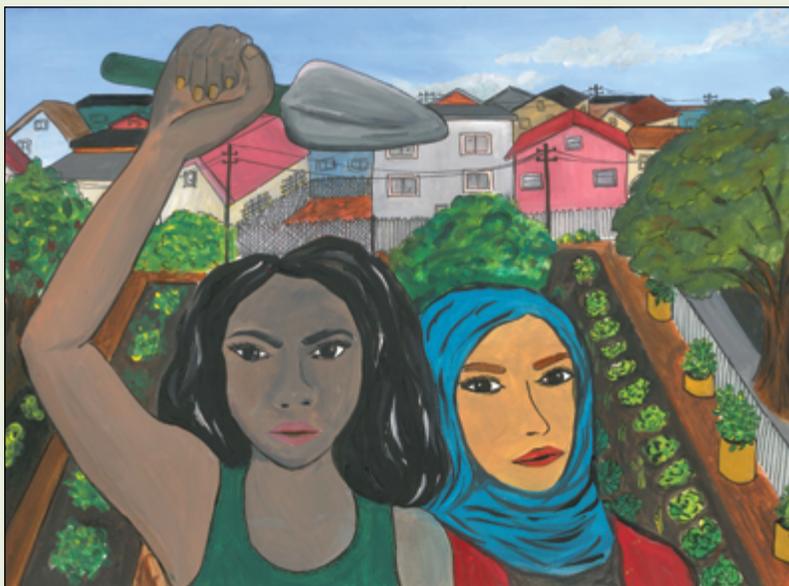
When she was organizing the panel, Liz Juvera knew it would be a departure from the past. "There was strong consensus from past conference attendees that there needed to be more of an equity focus, and that it needed to be brought to the forefront at a prominent conference event," says Juvera, an environmental planner at the SF Estuary Partnership. The final lineup brought together a mosaic of people with direct experience of equity challenges from throughout the Estuary. "The goal was putting people center stage who wouldn't normally be there, but should be," she says.

As multi-racial as it was multidisciplinary, the diversity on the stage was striking. From community frontlines to the university to the EPA, each panelist brought expertise in equity work from a different field. However, despite the diversity in their fields, it quickly became apparent that they all experience many of the same barriers in their work.

Many had observed regulators and researchers discount and overlook their expertise. To the speakers, it felt like a symptom of implicit biases and an assumption of deficit (be it resources or knowledge) in black and brown communities.

"They went straight to the white person who hadn't even been in the community for ten years," said Vallejo

organizer LaDonna Williams, recalling the way a research group entered her community. "There are people who've been around seventy years. I've been around for over thirty," Williams said. This kind of exclusion, she says, is the power and threat of white legitimacy. "People who look like me don't get treated the same as people who look like you," Williams told the majority white audience.



Art: Amy Tam

Violet Saena, a community organizer with Acterra in Palo Alto, echoed the need to scrap for recognition, especially when it came to tracking down funding. Financial under-resourcing is a crucial way that communities get overlooked. "With this work, a lot of the resources don't trickle down to communities," said Saena. For one, clunky bureaucratic processes act as a barrier to community involvement. Moreover, it is up to communities to learn how to navigate legal bureaucracy, which is often complicated and time consuming, and sometimes not language accessible. "We can't spend all our time applying for and managing 50 - 75 page grants applications, we need to spend that time doing the work in our communities," says Williams. Another panelist, Josue Medellin-Azuara, a professor at UC Merced, works with agricultural communities in the San Joaquin Val-

ley. He said their rural location and challenges to organize can also act as barriers to attracting resources and research interest.

Beth Rose Middleton, also on the panel, knows firsthand the deep knowledge that frontline community members can bring to research partnerships. As an associate professor of Native American Studies at UC Davis, she has developed partner-

ships with community groups, and she sees benefits for both sides. Research consultation and internships for students provide a way to share the resources of the university with communities. In turn, the university and its students ac-

cess deep local knowledge that may not be recorded in a library database.

Communities are experts on their own experience, and their expertise — which has historically been overlooked — ought to be respected, said Middleton. At the end of the day, expertise must be compensated as such, she suggested, regardless of whether it comes from a community member or outside consultant. Community organizers are boots on the ground, and they gain a depth of access that is contingent on close proximity. Williams added that community organizers reach people who might never show up to a government office to file a complaint. "We are the frontline. We're living it, and that's where we get our information from," she said.

The panel agreed that building equity will require bi-directional learning and collaboration. "We're in this together," said Williams.

When it came Deldi Reyes' turn to speak, this Environmental Justice Program Manager at Cal EPA approached the same idea from a different tack. She asked the audience to engage in self-reflection: recall an experience of being the subject of implicit bias. "As scientists, you should be very familiar with what bias is," she quipped.

For regulators, meaningful work towards equity may require pounding some pavement. It certainly requires stepping outside of routine. "We need agency regulators to go out of their comfort zone and go listen to

communities. Come ask, and we'll share," said Williams. For regulators wondering what that might look like, moderator and EcoEquity consultant Nahal Ghoghaie cited a recommendation from East Oakland organizer Marquita Price: cafe office hours. According to Williams and Ghoghaie, time and effort spent on the ground matters. Talking directly with locals is a crucial step in building trust. Whether it's office hours at a neighborhood cafe or another method, regulators and officials need to provide an access point for community members.

"Go to barbecues and church events, visit beauty and barber shops, stop by homeless encampments. That's where you find out what people really care about," added LaDonna Williams.

To panelists Williams and Saena, pounding a little pavement doesn't seem like too strenuous of an ask. Compared with life on the frontlines, a few cafe office hours is a low-commitment gig. "Communities don't get to clock out of environmental risk — it doesn't end like a nine to five job," says Saena.

OVERHEARD

"When it comes to funding, you can't keep giving money to white led groups with black faces."

LADONNA WILLIAMS

"In this state we've learned to manage for extremes, like the drought of 2012-2014, and we've been resilient thanks to groundwater. But poorer communities with rural water systems don't do so well, because water markets and trading often don't consider their needs."

JOSUE MEDELLIN-AZUARA

"One to five minutes engagement with a community or two weeks of town hall meetings is not engagement. For us to answer your questions you have to include us, teach us, support us."

VIOLET SAENA

"The time to start building relationships is not when you're facing a grant deadline. If you want to build trust, you can't just talk about your data and models."

DELDI REYES

"Early public works projects, such as water supply projects, only benefitted large land-owners. There has been an institutional lack of attention to native lands and water rights, and persistent patterns of exclusion from water distribution. The recent formation of native land trusts, working on land restoration and restitution, is hopeful."

BETH MIDDLETON



(Left to right) Ghoghaie, Williams, Saena, Middleton, Reyes, Medellin-Azuara. Photo: Noah Berger

WATER QUALITY

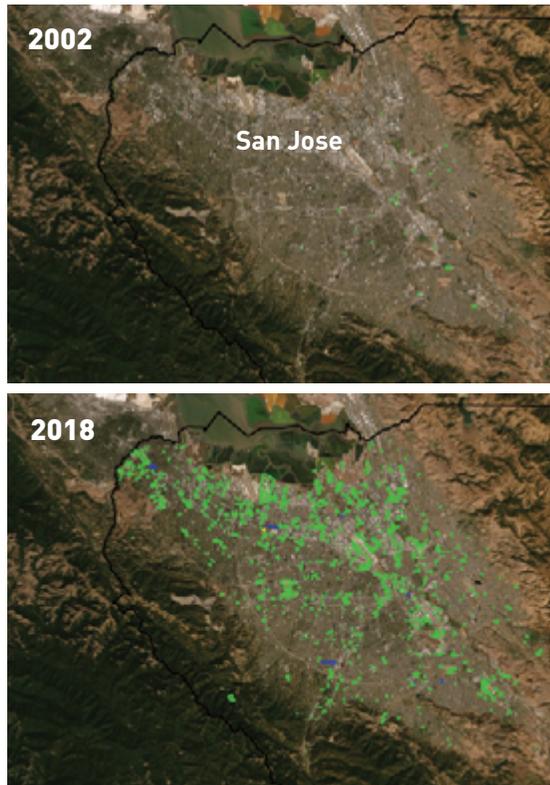
Putting Roads on a Green Diet

ARIEL RUBISSOW OKAMOTO, REPORTER

While trying to add bike lanes and bioretention facilities to San Pablo's Rumrill Boulevard in the East Bay, Amanda Booth learned a central lesson. Look underground first. Most streets cover a spider web of gas, power, water and other utility lines, each with their own special requirements for buffers and setbacks. "One utility told us they don't want concrete to be placed over their facilities," said the City of San Pablo project manager. "Now that's a challenging work around."

As one presenter in a conference session on how cities around the Bay are progressing in building green stormwater infrastructure, so as to prevent polluted runoff from draining into the Bay, Booth went deep into the nitty gritty. "Talk to the utility agencies before you even start," she said. "Read PG&E's Greenbook guidelines. Know your city's franchise agreements with gas, electrical, sewer, and water companies, figure out who pays to relocate facilities, for example."

Booth also had some above ground lessons to share, including troubleshooting how to protect bioswales from being damaged by vehicles, and saving money by consulting the city's street maintenance crew about possible problems arising from the new street design. She also warned that minor tweaks and accommodations



Green infrastructure growth in Santa Clara County 2002-2018. Source: EOA/SCC

in layout can disrupt drainage through new biofilters, trees, and grassy medians. "Check the flow lines, then do it again and again," she urged.

Changing the flow lines of runoff at the street, parcel and regional scale is what stormwater management via green infrastructure is all about. The idea is to percolate the spilled oil, worn tire dust, dog poop, and pesticides, among other contaminants that build up on our urban surfaces, through pervious soils and pavement in "bio" filters and detention basins. In the past, most of these elements have been added to streetscapes, or to parcels as a requirement for new and redevelopment. "Regional projects that treat runoff from hundreds of acres are the most challenging to site," said EOA Inc's Chris Sommers during the session. "To build large stormwater detention projects at a watershed scale you need to find relatively large undeveloped areas in our urban environment, such as school yards, parks, and other larger properties."

Municipalities around the region have been scrambling to finalize green infrastructure plans this fall, as required by regional regulators. Sommers reviewed efforts in Santa Clara County and the City of San Jose, where careful mapping has revealed that more than 5,000 acres in the county are now being treated with green infrastructure, with the capacity to treat more than 400 acre-feet of runoff each year. Sommers pointed out, however, that there is a very long way to go — all this new green infrastructure is still only reducing the amounts of PCBs and mercury entering the Bay by less than 5%, he said. He also warned that you can't just install green infrastructure and walk away: "People tend to forget about the need for funding to support operations and maintenance of these projects so they can continue to properly function over time."

Speaker Terri Fashing reviewed Oakland's progress on green infrastructure planning. "We're a city that cares very deeply about our creeks and waterways, and we're working hard to shift from gray to green across the city," she said. Fashing showed maps of all GI done to date in Oakland, which amount to 19 acres of public and 168 acres of private land. On screen the little purple patches in a sea-of-grey map didn't look like much to the audience, but Fashing explained that the City lacks adequate funding dedicated to maintaining, let alone, enhancing the storm drain system. More interesting than acres achieved, perhaps, was what Fashing called an attempt to "bake equity" into the prioritization process for approving and funding projects. She explained that proposed projects get more points if they invest in East or West Oakland, which are historically underserved areas. Fashing also described the efforts Oakland has been going to to ensure quality work. "We've developed a worksheet checklist for project managers with guidance on how best to incorporate GI in their projects," she said.

OVERHEARD

"The focus of our preventative and monitoring work [in surface waters] is aquatic organisms, which tend to be much (generally multiple orders of magnitude) more sensitive to pesticide inputs than human-health end points."

JENNIFER TEERLINK,
CAL. DEPT. PESTICIDE
REGULATION, SPEAKER

continued on page 22

WATER QUALITY

Haunted by the Ingredients in our Effluent?

NATE SELTENRICH, REPORTER

The best way to begin a conference session on contaminants of emerging concern might be to name these new pollutants we're so worried about. Easier said than done. That's because CECs, as they're generically known, are principally defined not by what they are, but rather by what they are not: regulated.

The category is indeed vast, including pharmaceuticals, microplastics, antimicrobials, flame retardants, pesticides, phthalates, water- and stain-resistant surfactants called PFASs, and more. These pollutants have little in common beyond the fact that they are not regulated or widely monitored in surface waters, but have the potential to harm wildlife or humans, explained first speaker Melissa Foley, head of the pollutant-tracking San Francisco Bay Regional Monitoring Program.

In all the CEC category includes tens of thousands of individual compounds, many of which are product ingredients that are proprietary or protected as "trade secrets" and thus hidden from regulators and researchers who don't know their identities, let alone how toxic they may be to aquatic life or to humans.

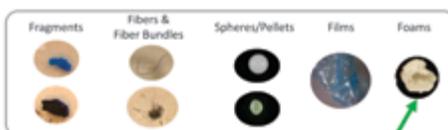
Many chemicals that regulators work to keep out of the Bay — those released into the air or surface waters by vehicles, industry, agriculture, and other outdoor uses — can arrive via stormwater runoff and perennial creeks and streams. But many of the newer CECs are also likely to originate within our homes and to reach the Bay through wastewater treatment plants, which are not designed to remove the likes of pharmaceuticals, phthalates, and BPA.

That's a problem not only for fish, invertebrates, and other aquatic life, noted Kelly Moran, president of San Mateo firm TDC Environmental, in her introductory remarks, but for humans, too. Someday — and perhaps someday soon, given our state's boom-bust water cycle — treated wastewater effluent, whatever it contains, may no

longer be emptied to the Bay via long pipes on the muddy bottoms. Along with reclaimed urban runoff, it may, instead, be put to better use supplying the region with irrigation and even valuable drinking water.

"It's still a really new concept for people, but we have to rethink our whole water system," Moran said in an interview. "The governor issued an executive order early in his term that basically was challenging us to find new water supplies and take care of all the different waters — and part of that was looking at wastewater effluent and stormwater runoff. I think that the move up the chain is much more rapid than most people know."

What do microplastics look like?



Polyester
Polystyrene
Polypropylene
Polyvinyl chloride (PVC)
350 million tons



In this context, the discharge of unknown CECs straight to the Bay via sewage treatment plants unequipped to remove them becomes an even more troubling thought. Fish and their food supplies may be first to feel the effects, but if nothing is done we could be next, since even federal drinking-water standards don't address many CECs including microplastics, pharmaceuticals, and thousands of PFAS compounds.

That's why Foley and others who spoke at the session emphasized the importance of source control — eliminating the pollutants upstream, rather than struggling to remove them downstream — to reduce exposures to CECs across the board. "For emerging contaminants in particular, source control is an important strategy for reducing the number of contaminants that make it to wastewater facilities in the first place, which reduces the

"The bar for [the California Safer Consumer Products program] to take action is a lot lower than for many other regulatory setups in the world. It gives us the ability to be more precautionary in our approach."

ANNE-COOPER DOHERTY
CAL DEPT. TOXIC SUBSTANCES
CONTROL, SPEAKER

number of contaminants that will be found in effluent that could be used for a variety of purposes," Foley said in a follow-up interview.

Source control is a particularly effective strategy for managing microplastics, noted SFEI scientist Diana Lin, who presented her comprehensive and groundbreaking new study of tiny plastic fragments in the Bay. "Microplastics are the detritus of modern-day society, where more than 350 million tons of plastics are produced annually," she said. "Over time, microplastic is likely to continue to accumulate, especially in places like the San Francisco Bay."

Indeed, Lin's study found higher concentrations of microplastics in the Bay than similar studies have found in other water bodies nationwide. While local sources of these tiny particles are myriad, including the breakdown of vehicle tires and larger pieces of plastic litter in the environment, a significant portion can again be traced back to our homes in the form of plastic clothing fibers, which wash out in the laundry and eventually make their way to — and through — wastewater treatment plants.

To intervene, Lin suggested using plastic-fiber filters in laundry machines that can capture microplastics for safer disposal, hopefully keeping them out of the Bay — and, maybe one day, our tap water.

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WATER QUALITY

Duck Clubs Roll with Dark Water

ALETA GEORGE, REPORTER

While “Black Water” was a hit song in the 1970s for the San Jose-based Doobie Brothers, a visible slick of black water in a wetland slough — whether it’s rollin’ or not — is not good for fish or other living things.

The Doobies lyric echoes Huck Finn descriptions of life along the dark Mississippi, but here in the western Suisun Marsh, you aren’t supposed to see black water, or wastewater. And yet, black water is what you can sometimes see emanating from the managed wetlands of duck clubs in the Marsh, said Stuart Siegel, a wetland ecologist and San Francisco State University professor. Siegel shared results of a pilot project as part of a State of the Estuary conference panel exploring how to improve water quality and habitat on working lands.

As part of a team of scientists, Siegel worked with duck clubs that exchange pond water with Boynton and Peytonia sloughs, west of the Suisun Slough and south of Old Town Suisun. The goals of the project were to improve the water quality in the tidal sloughs, and to help the duck clubs remain high-quality wetland habitats and working lands, ideally on a volunteer basis not burdened by regulations.

Siegel worked closely with Steve Chappell, director of the Suisun Resource Conservation District, to tailor best management practices for nine private duck clubs. They coordinated efforts with the Fairfield-Suisun Sewer District and the Solano County Mosquito Abatement District.

The best management practices explored began by addressing water discharge from the ponds. Duck clubs manage their ponds to produce waterfowl food plants and attract waterfowl in advance of the fall migration. Once flooded during hunting season, the ponds exchange small amounts of water daily with the tidal sloughs.

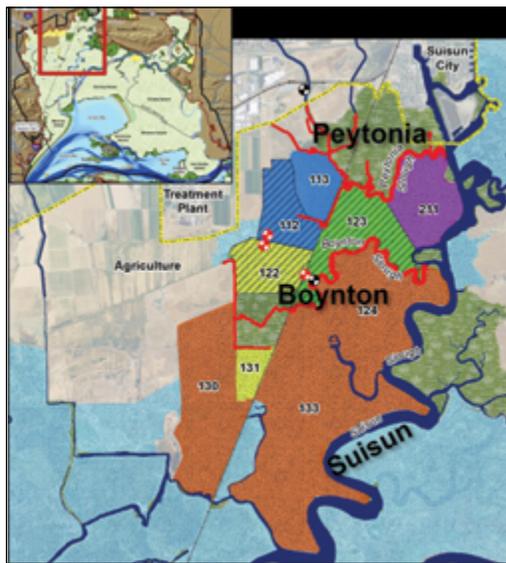
The management actions voluntarily adopted included staggering discharge schedules among clubs. In some locations Siegel changed the discharge locations from small, dead-end sloughs to larger, energetic channels. Other actions included

upgraded water control structures and ditches to allow clubs to drain quickly and allow higher circulation rates. The species of plants used for duck habitat is also an issue, and scientists helped the clubs manage for less leafy vegetation, such as exchanging fat hen and cockleburs for pickleweed and swamp timothy. The project managers also encouraged the clubs to mow earlier, and discouraged them from disking the soil, which increases carbon available for decomposition.

“Now that best management practices have been developed and tested, we can use the practices marsh-wide, working with private landowners on a voluntary basis,” said Chappell, who assists the 150 duck clubs in the Suisun Marsh with their managed wetlands, and who answered a few follow-up questions by phone. “The Suisun Marsh is perceived as a bunch of duck clubs, but in reality, it’s a wetland complex that provides habitat for resident and migratory species year-round.” The Suisun Resource Conservation District is under a mix of public and private ownership, comprising 116,000 acres of bays and sloughs, uplands, and tidal marshes and managed wetlands, including 50,000 acres of duck clubs.

“The clubs were very cooperative,” said Siegel. “Private duck clubs are a passion requiring ongoing investments, not agricultural lands producing income, and none of them want to impact water quality.”

The levees in the wetlands are not tall, he adds, which is a challenge with climate change and sea-level rise. The question is how to maintain low-cost water management with the lowlands behind the levees. The results of the pilot project showed that the devel-



Suisun Marsh has a public private patchwork of ownership.

oped best management practices could improve migratory species habitat and water quality, and be effective on a regional scale.

One finding that Siegel reported during his panel presentation was based on the comparison of monitoring data from 2008 and 2016. The

dissolved oxygen and methylmercury measured in the study area represent the pilot program’s before-and-after numbers in sloughs that receive outflow of water when duck clubs drain their ponds.

“The significant finding is that methylmercury concentrations in water exhibit an increase when dissolved oxygen levels drop below 0.5 milligrams per liter. Above 0.5 mg/L, methylmercury concentrations are significantly lower and show more variability,” said Siegel.

In addition to Siegel, participants on the upland working landscapes panel included staff from other resource conservation districts. Lucas Patzek gave an overview of LandSmart, a program developed by the Resource Conservation Districts of Napa, Sonoma, Mendocino, and Gold Ridge, in collaboration with the USDA Natural Resources Conservation Service and other agencies. The program helps vineyards and other land managers reduce sediment and meet other resource conservation goals.

Alyson Aquino discussed cattle pond improvements in Alameda County, where the majority of ponds were built between the 1940s and 1970s, and like any reservoir

Continued on back page

WATER QUALITY

Bloom or Bust Future in the Nutrient Rush?

ARIEL RUBISSOW OKAMOTO, REPORTER

Ladies feeling faint in old movies were often revived with a whiff of ammonia under the nose. Estuary managers hope smelt may be equally revived by the removal of ammonium and other nutrients in Delta waterways downstream of Regional San, once this Sacramento-area wastewater treatment plant is upgraded. The project could decrease total nitrogen loads (ammonium plus nitrate) in the plant's effluent by about 75%. Exactly whether, where, and how these improvements may help declining native pelagic fish in the Delta was the focus of Tamara Kraus' State of the Estuary conference presentation in a session on nutrients. "Instead of discharging ammonium, they'll be discharging nitrate — a significant change on top of the overall reductions," said the U.S. Geological Survey scientist.

Kraus discussed how the Delta ecosystem might respond to Regional San's considerable effort to reduce the impacts of 1.4 million people's wastewater on estuarine fish. "It's not very common to undertake such large step changes in nutrient inputs to an estuary; community investments of nearly \$2 billion in infrastructure changes don't happen all the time," said Kraus in a follow-up interview.

Also uncommon is how nutrients behave in this West Coast estuary versus those on other coasts more heavily impacted by agricultural runoff and wastewater discharges. "The Delta doesn't fit the classic nutrient enrichment model. Although it has high nutrient concentrations, we don't have issues with nuisance blooms that lead to eutrophication. If anything, we have too little phytoplankton," said Kraus.

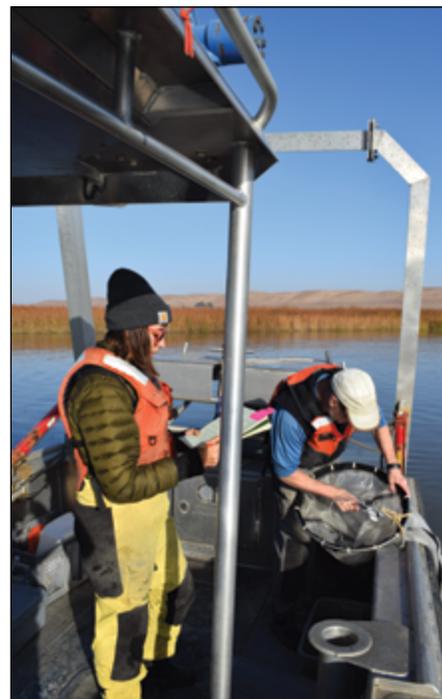
Many different factors contribute to nutrient effects on the ecosystem, from water temperature and clarity to residence time and clam grazing, but the primary effect is to fuel plant growth — both the little plants that fish eat, and big aquatic plants (often non-native weeds) that choke Delta waterways.

"There's some controversy over whether the decline in nutrients [or the change in chemical form discharged from the treatment upgrade] will have a good or bad effect on phytoplankton, producing BABs or HABs, beneficial or harmful algal blooms," said Kraus.

There's also controversy about whether its ammonium or nitrate or other factors that are affecting the failure of Delta plankton to thrive, and how that in turn may influence the kind of plankton fish chose to eat, or not. "If someone offered you

wheat or white bread, you wouldn't care if one was healthier than the other if you were really hungry," said Kraus in a follow-up interview. The Delta's rivers, streams, and bays are dominated by nitrate, and plankton have likely

evolved to thrive on it, but there's a lot of other confounding factors. "It's a bit of a mystery for us scientists, as to why we have high nitrogen but low productivity in terms of plankton growth. It's not intuitive. It's really complex."

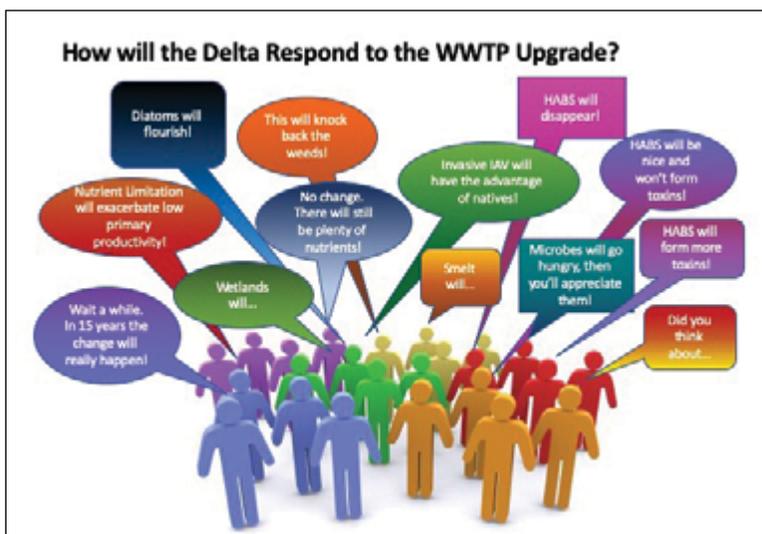


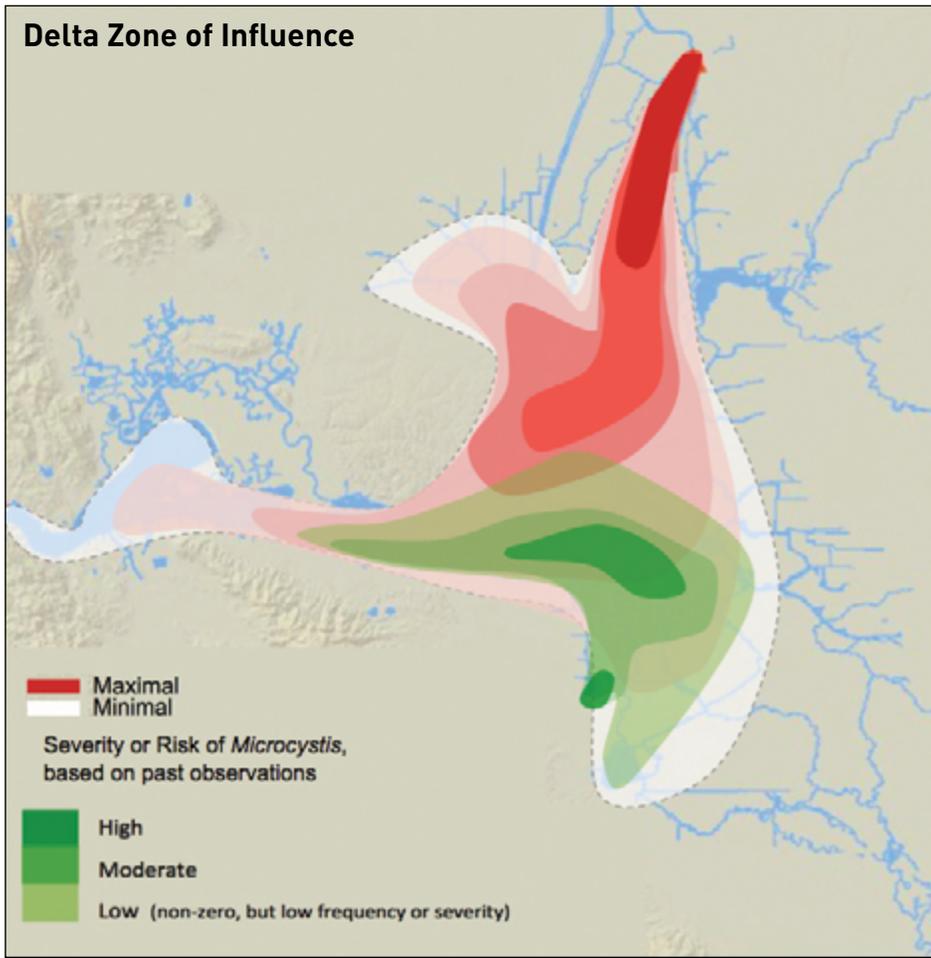
Sampling plankton in Montezuma Slough. Photo: Micah Bisson

Kraus and her colleagues are tasked with coming up with a framework for carefully monitoring the results of the Regional San upgrades: "science that hits the ground running and answers pressing management questions," she said, reflecting recent science priorities associated with Delta Stewardship Council funding.

During her presentation, Kraus showed maps of the effluent zone of influence, charts of different factors driving nutrient cycling, and elements of the framework. "A lot of the monitoring programs we have in place weren't set up to answer this new set of questions. We don't want one person measuring this and another measuring that, in different places. We need a coordinated approach," she said, warning that this may not be the only challenge to getting good information. "As you go downstream and get farther from the treatment plant, it gets harder to predict effects, and we're not sure all the effects we expect will be measurable."

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Extent of (green) regions in the Delta where blooms of the harmful blooms of *Microcystis* have occurred most frequently or been most severe; and (red) Zone of Influence (ZOI) for changes in dissolved inorganic nitrogen related to Regional San's upgrade. Source: Senn, et al, (In Prep). *Changing Nitrogen Inputs to the northern San Francisco Estuary, SFEWS*

Nutrient issues farther downstream were the focus of two other major presentations in this conference session. First, the San Francisco Estuary Institute's David Senn outlined San Francisco Bay's Nutrient Management Strategy, a multi-interest effort to understand the effects of high nutrient loads to the Bay. The Strategy also examines whether reducing these loads will protect water quality as Estuary conditions change in the future. The Estuary's natural resistance to harmful effects and blooms may be diminishing, scientists think.

Senn presented data indicating a 30% increase in dissolved inorganic nitrogen (DIN) loads from the Bay Area's five largest plants between 2000 and 2017. Like Kraus, his team is also trying to project via numerical models how Bay habitats will respond to nutrient influences now and in the future. "It's a beast of a model, it takes ten days to run one year," he said. One place in particu-

lar they think needs more monitoring is over the South Bay's shoals, where conditions may be more favorable to phytoplankton growth.

While scientists try to figure out how nutrients behave in the Estuary, the Bay Area's dischargers are already wondering if they can all afford to invest in nitrifying and denitrifying treatment upgrades like the Delta's Regional San. To answer this question, the region's clean water agency group (BACWA) has had a team visiting 37 treatment plants, reviewing their existing treatment processes and capacity, and looking for obvious opportunities to do more with less to remove nutrients.

"For each plant we identified equipment or basins that could be repurposed, as well as one to three emerging treatment technologies that might help if new regulations on nutrient discharges go into effect," said HDR's Holly Kennedy in her presentation during the nutrients session. The results of the study

suggest capital costs could run about \$7 billion regionwide to get a 60% reduction, and \$8.5 billion for 80%, among other conclusions. "Each plant is different, so there is no one-size-fits-all solution," she concluded.

After that, San Francisco Bay-Keeper's Ian Wren detailed alternative approaches to removing nutrients from wastewater including treatment marshes and vegetated levees which could do double duty as buffers to sea-level rise. "The East Bay shore offers the best opportunities for progress on this front, with its mix of potentially high nutrient loads and flood risk, and lands suitable for nature-based solutions," said Wren. "The biggest hurdle is to connect agencies and members of the public that don't really talk to each other. If we can get over that, everything will be great."

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OVERHEARD

"Aging wastewater treatment infrastructure, most of it built in the 1970s, presents multiple challenges. In the past we had federal money to help solve these challenges, but now that money has to come from ratepayers. [Estimates for addressing the Bay's] nutrient problem are coming in as high as \$12 billion, but that is just one [technical and engineering challenge] ahead of us. Triple bang for the buck is what we're looking for in every project these days. We need to solve all these challenges in tandem, or they will end up being in conflict."

JACKIE ZIPKIN,
EAST BAY DISCHARGERS
AUTHORITY, SPEAKER

Big Picture Review of Regional Science and Governance

PERSPECTIVE FROM JOHN HART, REPORTER

Offshore, kelp forests were dwindling. Outside, hillsides were burning. Inside the Scottish Rite Center in Oakland, scientists and policy people were sharing the latest findings concerning the vital shallows in between: the San Francisco Estuary. The patient pursuit of knowledge, essential to smart action in a changing world, had chalked up a fruitful two years. Of the action itself, there was rather less sign.

Felicia Marcus might speak to that better than anyone. As chair of the State Water Resources Control Board, she had coaxed along a nine-year process, mandated by law, to raise minimum flows in the major rivers that sustain the Estuary. The Board took the first of several wrenchingly hard decisions 12 months ago. Result: the process was put on hold, pending another round of stakeholder negotiations, and Marcus lost her job.

Marcus did not mention these facts in her Tuesday morning talk on how we must see and teach the interconnectedness of Bay, Delta, watershed, and the California water system as a whole. "Are we going to be the generation that loses salmon?" she demanded, concluding with a series of questions, a kind of call-and-response. "Can we give native fish a fighting chance?" Catching on quickly, the audience roared back the appropriate answers, about as well as scientists can roar. Then Marcus added a note of doubt and urgency "Can we? I don't know."

As if to back her up, a brief ceremony marked the addition of the Bay to Mission Blue's list of planetary Hope Spots, marine or estuarine areas that have gained, or at any rate deserve, a high level of protection. And Erik Vink of the Delta Protection Commission reported that Congress has designated the Delta a National Heritage Area. These distinctions are reminiscent of Barack Obama's Nobel Peace Prize: given less to honor past achievement than to spur the recipient on.

A spur seems to be in order.

In a Tuesday afternoon panel — "Panels and Engineers and Regulators, Oh My" — six well-situated people talked about how to organize the Bay and Delta regions for the larger actions that are going to be required, notably to meet sea-level rise. How can we confront the regional effects of rising tides, for instance on highways and low-lying sewage treatment plants? How can we ensure that local actions, like seawall building, don't simply shove the impacts around? Can every place, asset, or island be defended, and for how long?

A lot of good people are working on such problems. A staple of conferences these days is the "spaghetti chart" showing how many partner organizations are involved in any big issue, and we saw a couple of these. "We don't have a government



Local garter snakes demonstrate seamless connectivity. Photo: Amber Manfree

gap," Bay Conservation and Development Commission (BCDC) planning director Jessica Fain remarked. "We have a government abundance." But getting all those levels and agencies to pull together where it counts remains the headache it always has been. Veteran water reformer Phil Isenberg was quoted: "Everybody's involved, no one is in charge."

Who, if anyone, should be in charge? BCDC seems the logical lead agency for threatened Bay shorelines, as many "policy actors" agree. BCDC itself seeks no added authority but is

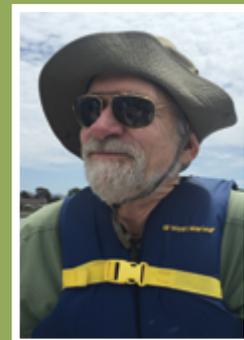
pushing local governments and other powers to converge on a Regional Adaptation Strategy. The goal, said BCDC's Fain, is to "start to create some conversation about best practices."

That conversation, she acknowledged, might lead to "hard choices" some time in the future. No one seemed in much hurry to get there.

Drawing on the results of an extensive survey, Mark Lubell of the University of California at Davis reported, "Everybody wants a plan, nobody wants to establish a new authority." And anything that impinges on land-use control by local governments is a "non-starter."

Lubell did point to a nearby model, the Delta Stewardship Council. Back in 2009, faced with a similar logjam in the Delta, the Legislature came up with an ingenious solution. Agencies and governments whose work affects the Delta must "certify" that actions of certain types comply with an overarching vision, the Council's Delta Plan. The Council can overturn such a certification on appeal, effectively blocking the decision or project from going forward. (The Council staff's refusal to bless California WaterFix was one of the last straws for Jerry Brown's two-tunnel plan.) In the Bay Area, such a mechanism might backstop an agreed-upon Regional Adaptation Strategy. But at the moment, even this indirect form of supervision seems politically out of reach.

Can there be a plan without power? Can a blueprint be developed and carried out on a purely cooperative basis? One lever toward unity is the competition for funding. Maya Hayden of Point Blue had earlier reviewed the discouraging outlook



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Photo: Amber Manfree

for San Mateo's bayshore marshes. In the governance panel, Erika Powell told how the need to make a common pitch for federal grants led the county and its 20 cities to launch a Flood and Sea-Level Rise Resiliency Agency. It comes into being on New Year's Day 2020. It will not, of course, impinge on land-use autonomy.

In the end there seemed to be a surprising convergence on two points. First, the present system isn't working. Second, no one who is part of that system is in a position to rock the boat. Indeed, on the panel, it was the representatives of agencies with the most direct clout — BCDC, the Stewardship Council — who spoke most soothingly to their governmental colleagues.

GREEN DIET, *cont'd from page 16*

The Regional Water Board's Keith Lichten agreed. "Make sure the contractor knows what you're trying to do, [they often don't understand all aims of GI projects. There's a lot of badly built projects out there," he said in an earlier plenary.

Other challenges still to be addressed in the push to soften the hardscape include "extending the life of storm drains and improving water supply resilience," said Lichten. Apart from pushing for more strategic multi-benefit approaches to green, blue and grey infrastructure, he and the regional board are also keen to weave these source control measures more deeply into conventional transportation

Mark Lubell noted: "It often takes a crisis before you have that unification of political will." Perhaps the best we can do, he suggested, is have a good plan ready for the moment when an undeniable emergency shocks open the doors to action.

There may be another route, however. Several panelists noted how strong leaders, above or outside

the local establishment, have made things move. Governor Schwarzenegger's Delta Vision Task Force started the ball rolling for the Delta Stewardship Council, and ex-Assemblyman Phil Isenberg kept it moving. In San Mateo County, it was Representative Jackie Speier and Supervisor Dave Pine who championed the new flood agency. Mike Mielke of the Silicon Valley Leadership Group gave Diane Feinstein credit for starting the push toward Measure AA; Jim McGrath of the regional water board gave her similar credit for purchase of the Bay's salt ponds. The list can be run backward all the way to the three founders of Save the Bay. Without their grass-roots insurgency — a major insult to local government privilege — we might still be reading learned papers about the effects of recent Bay fills.

"What's missing here is political leadership," said Mielke. "Would the governor be interested in calling the region together" to confront sea-level rise, in something analogous to Delta Vision?

Mr. Newsom, how about it?

Photo: Noah Berger



planning. Some major transportation upgrades, like the Highway 37 work highlighted by MTC engineer Kevin Chin in another plenary speech, are starting to consider not just environmental impacts and stormwater management, as usual, but also sea level rise and habitat connectivity.

"When you start hearing transportation engineers talk about resilience, then we're getting somewhere," summed up Regional Board's Tom Mumley.

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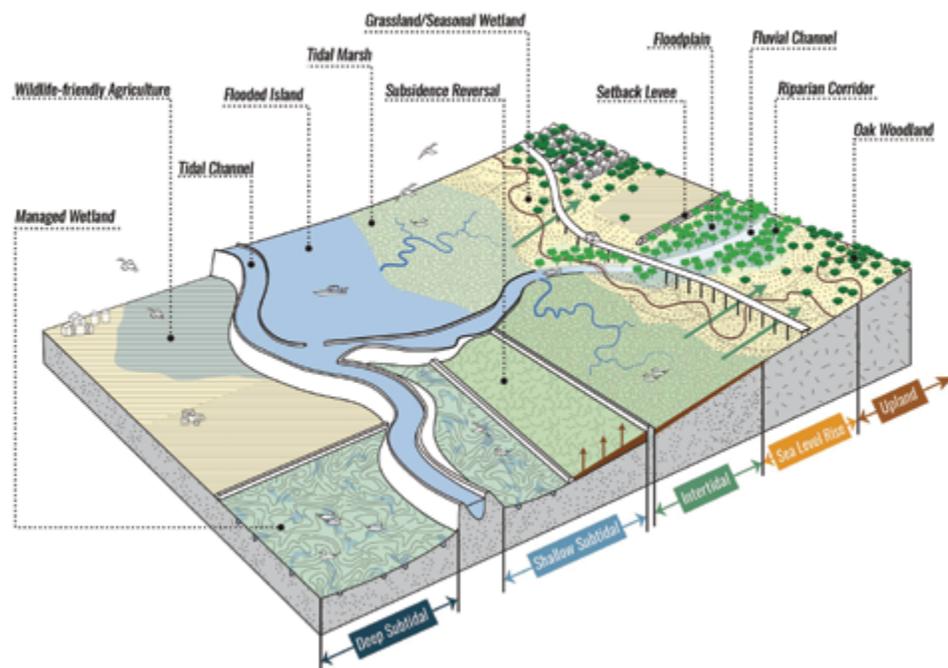
Flows and Ecosystem Function Dominate Delta Plan Amendment

CARIAD HAYES THRONSON, REPORTER

With the Delta lagging behind the Bay on four of the State of the Estuary Report's five indicators, the last long-range plan for restoring its ecological health abandoned, and the threats from climate change becoming ever more alarming, the need for a new regulatory vision for the region may never have been greater. A pending amendment to the Delta Plan, shared by Ron Melcer at the State of the Estuary Conference as part of a policy update session, is meant to provide that vision and the strategies to achieve it.

The amendment — to Chapter Four of the Delta Plan, which focuses on the Delta ecosystem — was developed in response to the state's pivot away from the 2013 Bay-Delta Conservation Plan (BDCP), said Melcer. "The Delta Plan was [originally] written anticipating that the BDCP would be adopted and then implemented," he said, "so the high-level objective of the amendment is really just putting a framework back on the landscape that thinks comprehensively about ecosystem issues and species recovery."

Delta Adaptation Zones



The amendment is based on three papers that synthesize the latest science on the condition of the Delta ecosystem, the effects of climate change, and ecosystem protection, restoration, and enhancement. It includes five core strategies and 15 specific recommendations to guide restoration projects in the Delta, with a view to establishing a resilient, functioning Estuary by 2100.

The first two strategies focus on creating more natural flows and restoring ecosystem function. "We've been looking at it across several key attributes," said Melcer in a follow-up conversation. These include restoring geomorphic and biological processes, and reestablishing native vegetation, but also encompass scale and connectivity. "These projects



Subsided homes on Brannon Island. Photo: Amber Manfree

have to be large-scale," said Melcer. "You can't just do a project on a plot the size of your yard and expect the Delta ecosystem to recover."

Using the most recent analyses of Delta topography and tidal datums, fish migration routes, and other criteria, the amendment identifies areas where restoration is likely to produce the most benefit. "For the kind of restoration which is opening levees up and restoring tides to diked areas, the two most suitable areas are Suisun Marsh and the Cache Slough area," said San Francisco Bay National Estuarine Research Reserve's Stuart Siegel, who provided some of the analyses, in a follow-up interview.

The amendment also establishes a framework for classifying potential restoration projects into tiers, according to how relevant they are to the core strategies. "This is a really important distinction [from other plans]," said Gerrit Platenkamp of Environmental Science Associates, who also contributed to the amendment, in another interview. Restoration project proponents will need to identify which tier the project falls into, and the system will also help guide restoration funding.

Another core strategy is to protect land that is suitable for restoration. "There are places in the Delta where

continued on next page

OVERHEARD

“We have to decide what to let go of in the Delta, as levees fail, Delta smelt are lost to warming water, and snowpack shifts make it hard to maintain freshwater flows. Lives, fortunes, and sacred honor are all at risk in the Delta due to climate change. Our permitting structure is like a hall with a thousand doors, our State Water Project was never finished, is being called on to do more and is showing its age; thus, we can’t physically do what we want and need to do. No matter what we decide to do, there’s entrenched well-funded opposition to it. But our most intractable problem is the lack of trust; we no longer share a cohesive sense of community purpose, which makes every problem we face more daunting.”

MIKE GEORGE,
DELTA WATERMASTER,
PANELIST

restoration is possible, and because of subsidence there are also places where it’s not,” said Melcer, noting that the Delta is losing the equivalent of two football fields of land per day to subsidence. The plan includes regulatory policies and recommendations for protecting suitable land from development, and also for halting and reversing subsidence.

Importantly, the amendment includes performance measures

that set “quantitative ecological objectives for the landscape,” said Melcer. The measures include a goal of 65,000 to 85,000 acres of riparian and wetland restoration by 2050, many in “conservation opportunity regions” recently identified by the non-regulatory 2018 Delta Conservation Framework. “Those numbers are based on an analysis of existing conservation and recovery plans for the region and are on the scale of the BDCP,” said Melcer.

The final core strategy identified in the amendment calls for improving institutional coordination to support its other goals and strategies, echoing a theme highlighted by other presenters on the panel. The Coastal Conservancy’s Amy Hutzel introduced the new Bay Restoration Regulatory Integration Team (BRRIT), launched last summer. The group is charged with coordinating permits across agencies to accelerate projects in the Bay and allow marsh to be restored over the next decade.

Other presentations focused on the need for regulatory changes that respond to the inevitability of rising seas. Outlining the Bay Conservation and Development Commission’s long-term plans, Shannon Fiala noted that the Commission recently adopted Bay Plan amendments that address Bay fill for habitat projects, as well as environmental justice and social equity. The Bay fill amendment recognizes that more fill may be necessary for habitat restoration, and allows for more beneficial reuse of dredged material. Other plans with amendments in the works include the San Francisco Waterfront Special Area Plan and the Seaport Plan, while the Suisun Marsh Protection Plan will be reviewed in 2020.

The San Francisco Bay Regional Water Board’s Christina Toms outlined various ways that the Board is responding to climate change, including participating in the BRRIT and supporting the recommendations of the Baylands Goals Update



Ron Melcer. Photo Amber Manfree.

and San Francisco Estuary Institute’s Adaptation Atlas. She also noted that the Board is developing an amendment to the Basin Plan that will document the threat that climate change poses to Bay habitats and beneficial uses of the state’s waters, and identify preferred strategies for sea-level rise adaptation.

The Delta Plan amendment and other policy updates reflect the growing emphasis on geographic and agency integration. “This amendment to the Delta Plan’s Ecosystem chapter is the final link in a suite of regional plans to guide ecological recovery of the entire Bay-Delta system,” said Siegel. “With the stage now set, we as a region are ready to shift our focus to implementing these plans.”

To accomplish this shift, Siegel would have the region focus on ensuring adequate institutional capacity, acquiring necessary lands, permitting projects efficiently, utilizing best available science, and providing funding all the way through long-term land management. Also critical would be to bring the public along every step of the way.

“We have long known the value of ecological recovery as an essential element of achieving the Delta Plan’s co-equal goals. We now also understand these ‘nature-based strategies’ will help us adapt to climate change,” he said.

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Photo: Amber Manfree

High Speed, High Risk Science

ARIEL RUBISSOW OKAMOTO, REPORTER

Urgent action, risk-taking, scenario-building, science without strings, all seemed to be in the mix of remedies suggested during climate change sessions of the State of the Estuary Conference. Mark Gold made the ultimate comment in his opening plenary: “The age of incrementalism, and not moving forward in a bold way, is not getting it done in terms of climate change.” Gold, deputy secretary for ocean and coastal policy for the California Natural Resources Agency, outlined the state’s newly revised strategic plan for a bluer economy, coastal resilience to five feet of sea-level rise, and rapid response to fisheries emergencies (including zero whale and sea turtle mortality), among other targets. “Our focus has to be on infrastructure first, rather than managed retreat of individual homes,” he said. “It’s a better idea because people can get behind it.”

Following his talk, Geeta Persad of the Union of Concerned Scientists reviewed various challenges facing California. “Climate change is going to fundamentally transform where and when California gets its water,” she said. Persad went on to detail changes ahead, including warming air and water, salinity intrusion into the Delta as the sea level rises due to “icesheet feedback” (she mentioned up to 16 feet of sea-level rise), more rain and less snow, wetter winters, drier summers, and longer droughts. “Snowpack and snowmelt are going to be the part of our water supply most strongly transformed by climate change,” she said.

Later, the Delta Stewardship Council’s Yumiko Henneberry asked a panel of scientists about forward-looking science in such a rapidly changing environment. The panel included the Delta Independent Science Board’s Steve Brandt, the Ocean Science Trust’s Liz Whiteman, and the U.S. Geological Survey’s Jessie Lacy and Mike Chotkowski, as well as Delta watermaster Michael George (whose comments can be found on p.24). They began by defining forward-looking science as science that anticipates, rather than responds to management needs, and that embraces uncertainty.

Henneberry then asked for panelists’ top science priorities given current management questions.

“Identifying areas that might be refugia from warming and understanding how they fit together will be increasingly important as environment changes,” Lacy responded.

“End-to-end ecosystem modeling that narrows down driving forces, acknowledges progressive changes in natural variability, and puts current science into a more predictive framework,” said Brandt.

“Recognizing traditional and local knowledge, and investing in social science capacity,” said Whiteman.

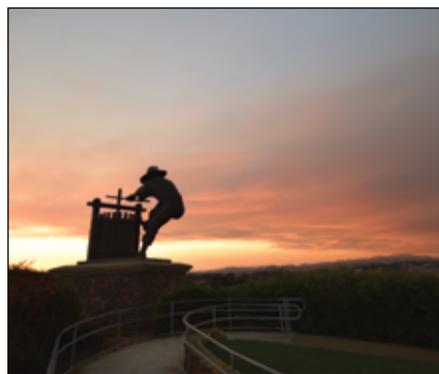
“Building a common vocabulary, we all use words like ‘resilience’ and ‘capacity,’ but we don’t necessarily have agreement on what they mean,” added Lacy.

Someone from the audience asked what could be done to overcome “regulatory constipation.”

Lacy replied, “Allow for higher-risk science. We need to create a system where scientists can take risks and have bold ideas.”

“Encourage science with no strings attached,” said Chotkowski.

“Don’t stop at monitoring and evaluation. Follow up with ‘Okay, so now what?’” said Whiteman.



Statue of a vintner crushing grapes at the entrance to the Napa Valley against the orange smoky sky of the 2019 Kincaid fire, evoking the pall cast by climate change on Northern California’s future as a premier wine-growing region. Vintners are already using “forward-looking” science to adjust planting, varietal, and irrigation choices. Photo: Amber Manfree

Henneberry followed up by asking what role scientists should play in instilling a sense of urgency about climate change:

“Scientists need to let managers know they are no longer dealing with the same system they dealt with in the past, and alert them to possible actions,” said Brandt.

“The science community can advance discussion of the difference between local versus global action. We can define more carefully what can be done to protect local regions,” said Lacy.

“Scientists need to argue the cost of inaction, and provide a range of options and cost benefits,” said Whiteman.



Geeta Persad. Photo: Amber Manfree

More discussion culminated in a final question from the audience about how to make science more cost effective.

“Reframe the funding conversation to look for seed investments that amplify and achieve catalytic change,” Whiteman responded.

“Increase the emphasis on working in teams across institutions. One way people are adapting to changing funding is by making sure the same science isn’t being done in three different shops,” added Lacy.

More discussion of these and other issues related to how we navigate feedback from these melting icebergs and warming skies was threaded throughout the conference.

“The Estuary’s local climate is changing,” summed up Geeta Persad. “The hopeful thing is we know enough to act. But you all need to think, at every step, about how climate change should affect your decisions.”

CLIMATE, POLICY, RESILIENCE

Climate Science, Meet Neuroscience

CARIAD HAYES THRONSON, REPORTER

Developing effective communication strategies around climate change is a critical challenge of the climate crisis. Persuading people to change their behavior, and to support climate change solutions and adaptation programs requires that they both understand the problem and be motivated to solve it. But according to poet, behavioral scientist, and Exploratorium fellow Pireeni Sundaralingam, we are building these strategies on a false foundation.

Speaking on “The Brain and Observation: Towards a Language of Resilience,” as part of the State of the Estuary Conference panel Public Learning in an Era of Climate Crisis, Sundaralingam said, “it’s a critical mistake to approach communication about climate change with the assumption that humans are rational actors.” Behavior science, she said, “is the key if you want to make behavior change.”



Skyscrapers, seawalls, kayaks, and sea lions offer contrasting examples of the region’s future adaptability and resilience. Photo: Ben Botkin.

During the panel, and in a follow-up conversation, Sundaralingam explained some of the basic concepts of neuroscience. Extensive research has shown that the human mind tends to apply certain cognitive organ- izing patterns (heuristics) to incoming data. She likened them to “cookie cutters” that allow people to “chunk and process” the enormous amounts of information they are bombarded with during every minute of every day (“even before we get online,” she added). The key to persuasion, she said, is to understand the shape and type of heuristics that are at work. “If you’re trying to convince a human brain, it’s vital to know how information is going to be chunked and processed, otherwise your efforts are just wishful thinking.”

In an example of a failure to do this, Sundaralingam described the once-widely used “scared straight” campaign to prevent juvenile offenders from re-offending by showing them images of prison and other long-term consequences of crime. The idea was that having seen these images, no rational human would continue to commit crimes. However, instead of the intended effect, there was a 60% increase in juvenile offending among those who were exposed to the images. The architects of the campaign did not account for the cognitive structures at work: It turns out that due to a heuristic called “social norming,” when a person is exposed to an image of another person doing something, they are more likely to find that thing acceptable, “even jumping off a cliff.”

To avoid such unintended consequences, and generally be persuasive, Sundaralingam argued that efforts to develop messaging and alter behavior around climate change should include cognitive scientists. “If you are serious about communicating or climate change and changing behavior, you need someone who knows how the brain works and has the tools to dismantle those ‘cookie cutters’ so that there’s a better chance of getting that information to land.”

Besides heuristics, Sundaralingam noted that the lexicon and metaphors used to talk about issues are important in not-always-obvious ways. “As humans we use such linguistic devices to capture a story,” she said. “A metaphor quickly offers up a whole story in one short phrase.” She referred to an experiment where people were introduced to the idea of ocean acidification using different types of terminology. “The phrase ‘ocean acidification’ may be emotionally neutral, maybe even kind of scary,” she said, but when the metaphor “osteoporosis of the sea” was used, “people were much more willing to listen to the issues around ocean acidification and want to stop it. The metaphor captured something that they were familiar with, something to which they could relate in a personal and embodied way.”

As part of her work with the Exploratorium’s Fisher Bay Observatory, Sundaralingam and Observatory director Susan Schwartzberg are developing a program on “Language and Landscape” pulling together climate scientists, poets, psychologists, social scientists, behavioral scientists, and philosophers to explore ways to influence behavior using an interdisciplinary approach. “We’ve run panels and workshops, and we’re designing different experiments and exercises to create strategy around how you can create behavior change,” Sundaralingam said. “There’s a real need for funders to see how groundbreaking and essential this transdisciplinary approach can be.”

Sundaralingam pointed out that the scientific concepts at work are not new discoveries. “We’ve been accruing this data for decades in behavior science, and it could be used to such great effect. I find it almost shocking that it has just been ignored.”

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In Other Conference News



The outer marsh edge at China Camp in Marin County captures about 24 tons of sediment per 200 meters annually, helping the marsh hold its own against rising tides. Jessie Lacy of the USGS said her group's studies found two factors that help the rim hold sediment: extensive bordering mudflats knock down erosive wave energy, and a fringe of cordgrass traps sediment well during the summer growing season. With sea-level rise, both assets seem likely to diminish. **JH** *Photo: Cris Benton*

Many contaminants are more toxic to aquatic organisms in warmer water, Kelly Moran of TDC Environmental told the session on contaminants of emerging concern. "That means pollutants will matter more as the climate changes." Indeed, over the last five to ten years, researchers around the world have already developed evidence that water pollutants including metals, pesticides, and a wide range of chemical compounds are significantly more harmful to fish and other aquatic life as water temperatures rise. The implications for the warming, already burdened Bay couldn't be clearer, underscoring panelists' calls to head off emerging pollution threats. **NS**

In front of the levee, the Bay rises; behind it, groundwater rises too, especially in about the first kilometer of flat terrain. G. Reid Fisher, Engineering Geologist, laid out what happens when soils that used to be mostly dry grow permanently wet. Roadbeds can crumble if the ground beneath becomes saturated; raising pavements in response reduces clearances to overpasses. Air-filled voids—basements, buried tanks, elevator pits—will tend to float upwards. Slab-on-grade buildings will get damper. And levees themselves may suffer if their footing gets wet from both sides. "Nothing is ever really waterproof," Reid cautioned. **JH**

While more sea walls may soon be necessary to adapt to rising seas, softer, greener, nature-based shorelines will also be important buffers for our cities and waterfronts. Wetlands, oyster reefs, eelgrass beds, and other natural features of shores and shallows figure largely in a number of ambitious, multi-partner restoration projects over the last decade. To date, more than 10 such projects have been or are being restored around the Bay, encompassing more than 200 acres of shoreline and nearshore areas. "There's a lot of policy support in California for living shorelines," said Marilyn Latta, Manager of the State Coastal Conservancy's Living Shorelines Project. "We're now working to translate science recommendations into on-the-ground projects and test them. We're really threading the needle between innovation and feasibility, and building capacity with marine contractors and design teams. Dynamic designs, with elevational complexity, are the path to resilience." Biologist Katharyn Boyer, of the Estuary and Ocean Science Center emphasized the need for speed. "We need larger living shoreline projects and we need them fast, so we need to experiment and learn before we scale up. We need to test methods, configurations, substrates, and timing of our restoration work on a scale large enough to see physical effects." **ARO**



OVERHEARD

"In the faith community we represent, all institutions believe in taking care of creation. Many are committed to going green, but how to do it often involves a new language for our members. We don't just want to plant trees, we want to help create the data our county needs to transform our community, to help us continue to build a beloved community. Listening is the most important thing we can do."

**GABBY TREJO,
SACRAMENTO ALL
CONGREGATIONS TOGETHER**

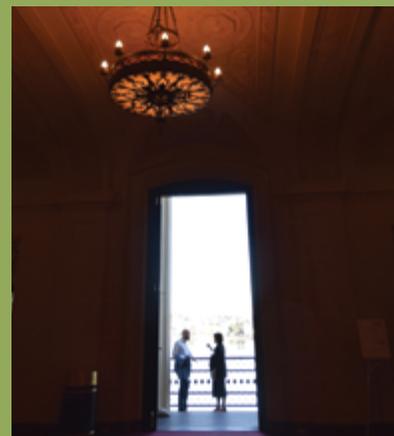


Photo: Amber Manfree

Conference attendees enjoyed maps, art, and artifacts about the Bay at a satellite field station set up in the poster room by the Exploratorium's Fisher Bay Observatory. Also at the conference, the Exploratorium's Susan Schwartzberg, Shawn Lani, and Heike Winterheld, shared lessons learned in public and civic engagement around the critical climate issues of our time. They see a new and emerging role for science centers as trusted information sources and agents of change in their communities.



San Francisco Estuary Partnership
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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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Salt marsh harvest mouse and researcher Katie Smith (see p.7)

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SENSORS, *cont'd from page 9*

use of satellite images than ever before. Dronova's job is to continue that progress. She works to develop new mapping methods and statistical and spatial tools that other scientists can use to measure things like carbon capture and greenhouse-gas sequestration in wetlands.

In another project funded last year through a NASA grant in partnership with the United States Environmental Protection Agency, she is poring over decades' worth of satellite imagery of 1,138 wetland sites from across the country to determine "whether they can be used to help us predict plant diversity in wetlands" — even though they are often too "coarse" in spatial resolution to depict individual species, let alone specimens.

"These remote sensing methods can't tell us everything, but they can complement field surveys," Dronova said.

In another novel twist, Mark Marvin-DiPasquale of the United States Geological Survey presented a method of using satellite data combined with boat-based monitoring of the Delta to measure mercury from space. The work hinged on finding an optical proxy within the satellite imagery for levels of dissolved organic carbon in surface water, which are in turn closely associated with methylmercury concentrations.

"We've been sampling out in the Delta area for 20 years, and there's just not enough manpower to cover enough distance and physically take water samples and get any real sense of how dynamic the system is," Marvin-DiPasquale said in an interview. "But once you start making those connections [with remote sensing data], the question becomes, how far can we take it?"

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CITIES, *cont'd from page 10*

is a biodiversity hotspot thanks to relicts that were never developed by the Army during its tenure there. "There are small patches of habitat including 300 different native plants, 22 special-status species, and six endangered species, all in the middle of the urban fabric," he said.

Chris Garvin, an architect with Biome Impact, said we can redesign cities to support human and environmental health. "We who live in cities have the power to create them with our actions or our inactions," he said. "We have an amazing capacity to create our own vision and implement that vision."

Garvin described a stormwater/wastewater treatment feature in Vancouver that doubles as a migratory bird sanctuary, and a stormwater park in

Portland that offers recreational opportunities for people and habitat for birds while cooling an urban heat island. The city of Singapore now requires designers to add green space on and around buildings in an amount that exceeds the footprint of the building. "Some buildings have green space climbing up and replicating the native ecosystem," he said, "all inside a city as dense as Singapore."

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DUCK CLUB, *cont'd from page 18*

impounded behind a dam, lose usefulness with sediment accumulation. Wendy Rush from Solano County demonstrated through photos the difference between a sterile working waterway and one that is vegetated with native plants and fenced off from cattle.

The rivers, sloughs, and irrigation ditches discussed by the panelists are all working waterways on altered landscapes. The waterways feed the Bay, and these organizations are working with care to ensure we are mindful of what we feed them, and to keep clean water rollin' on.

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