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South Bay Welcomes Avian Columbia River Refugees

Price Point for Ecosystem Services

A Tiny Estuary with a Big Story on the Mexican Border

Elbow Room for Rivers Pushed by Central Valley Flood Board

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Special Issue Focus: Multi-Benefit Metrics, Credits, and Trades

ESTUARY NEWS

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ENDANGERED

Caspian Push and Pull

It's never easy (or cheap) to protect one species by manipulating the behavior of another. Nor is it always advisable. But there are times when it's worth a shot, especially when multiple agencies and states are willing to get involved. To jump into this bird story that turns out to be a fish tale, we'll start in the middle, when several years ago the US Army Corps of Engineers asked Don Edwards San Francisco Bay National Wildlife Refuge to collaborate on a plan to improve nesting habitat at the Refuge for Caspian terns. "It was a win-win for us," says Don Edwards wildlife biologist Cheryl Strong, who explained that the islands built for water bird nesting habitat in two ponds during the South Bay Salt Pond Habitat Restoration Project (ponds SF2 and A16) had enticed very few birds.

To lure Caspian terns down from the sky to Don Edwards, USGS biologists arrayed more than 500 tern decoys, some of which were painted by local students. They also installed Murremaid Music Boxes with MP3 Players that jam Caspian tern calls.

So far, the numbers are promising. In 2015, USGS biologists counted 224 pairs of breeding birds with 174 fledgling chicks in the ponds. In 2016, it was 317 breeding pairs with 158 fledglings.

It's a push-pull approach, says Corps fish biologist David Trachtenbarg. "We're essentially pushing terns out of the Columbia River Basin and trying to pull them to nesting habitat in other locations on the West Coast," he says. Why? The terns are eating too many endangered salmon.

Kids painting decoys. Photo: Crystal Shore

The Corps chose seven islands in these two ponds, five for the terns and two for snowy plovers to reduce potential nesting conflicts. The agency delivered tons of gravel and rock by barge and crane to enhance nesting conditions on the islands. To increase the chances that the birds would land, the Corps hired the US Geological Survey to entice them with bird calls and fake companions. Terns are colonial birds. As they migrate north on the Pacific Flyway after spending the winter as far south as Bolivia, these muscular, fish-eating, diving birds are more likely to stop when they see a colony of other terns.

It's not the first time that Caspian terns have been moved. In the early 1980s, they began showing up in greater numbers to the basin, including at Rice Island (river mile 21). With the ideal conditions of a sand substrate from dredging, good visibility, and no predators, the colony grew from 1,000 to 8,700 breeding pairs in a little over 10 years.

Simultaneously, more fish were being produced and tagged in an upstream hatchery. "That's when we found out that juvenile salmonids, and specifically steelhead, were being impacted by this bird population," says Corps biologist Paul Schmidt.

Biologists observed that approximately 90% of the terns' diet at Rice Island was salmonids. In 1999, NOAA required that the Corps do something about the birds. Reasoning that they would do less damage to the endangered salmon if they had a wider palate of fish to choose from, the Corps dissuaded the terns from breeding on Rice Island with fencing and human hazing techniques, and improved habitat at East Sand Island nearer the river mouth.

The birds complied, and they did expand their palates to include fish from the ocean. Nevertheless, the bird population continued to grow and they ate just as many fish. East Sand Island now has the largest breeding colonies of Caspian terns and double-crested cormorants in the world. NOAA required action to protect the fish again, and the push and pull plan for terns was implemented in 2006. The plan to redistribute the birds included improvement of eight acres of tern nesting habitat in Eastern Oregon, Northern California, and San Francisco Bay, and reduction of habitat at East Sand Island to one acre.

The pull is starting to work. The sites in Oregon and California have anywhere between 40 and 700 nesting pairs. The push, not so much. In their one-acre at East Sand Island, terns are nesting at higher densities than ever.

At Don Edwards, this is the third and final year of the social attraction and monitoring phase of the project. The Corps expects more terns to take a liking to Don Edwards because of the fish banquet, and because the species has a history of nesting in the South Bay. The Corps' goal is 100 to 1,500 breeding pairs. "There's still time for more Caspian terns to find these islands," says Schmidt. **AG**

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Don't miss the extended story with egg-hatch video online:
www.sfestuary.org/estuary-news/

Cover: Caspian terns by Rick Lewis

LANDSCAPE

Re-oaking Silicon Valley

Once upon a time, the southwestern corner of the Bay Area was a land of oaks. Open savannas and denser woodlands stretched from the valley floor to mountain ridgelines. The gnarled branches and spreading canopies of the genus *Quercus* were a signature of the region. Today, that area is known as Silicon Valley, and the oaks have largely been replaced by residential neighborhoods, urban centers and high tech companies.

The time is right to stage an oak comeback, according to scientists at the San Francisco Estuary Institute. Their new report, *Re-Oaking Silicon Valley*, shows that augmenting the region's urban forests with iconic native oaks can deliver major benefits to ecosystems and people.

The loss of oaks has been repeated all too often around the state, says Robin Grossinger, senior scientist with the Institute. From the 1800s to the early 1900s, "there are lots of pictures of people sitting in the shade of oaks and towns nestled in the trees. They were a resource valued for shade and beauty; they enhanced the livability and aesthetics of the place," he says.

Most of those oaks were felled to make way for orchards and farms. But the wheel of fortune may have turned again in favor of the trees. "As we have transformed these places again to be more suburban and urban, we want the trees back," Grossinger says.

The idea to bring back oaks caught fire when Grossinger and colleagues discovered that the density and spacing of today's urban forests are very similar to those of natural oak woodlands.

"We don't have to plant a dense forest over Silicon Valley to get an ecosystem that functions better for native wildlife," says Erica Spotswood, lead scientist on the report. Rather, as urban trees reach the end of their lifespans, cities and homeowners can replace them with native oaks.

"We don't have to buy any land. We can get a tremendous ecological lift without spending tens of millions of dollars on real estate," Grossinger says.

Oaks are the heart of the terrestrial food web — unsurprising in a region where 80 percent of the trees consisted of just three species of oaks. From oak moths to gall wasps to acorn woodpeckers to mule deer, native species have evolved to depend on this tree.

Oaks also offer many benefits to human communities. They're drought tolerant, store prodigious amounts of carbon, and give the region a distinctive look and feel.

"Right now the same few species of trees are planted in cities across the country. And no matter where you go, you see the same urban adapted wildlife, such as raccoons, pigeons, crows, and rats," Spotswood says. "California landscapes are beautiful. People think oaks are amazing. Re-oaking is an opportunity to bring that unique sense of place back to our cities."

The report offers many practical suggestions grounded in scientific findings to boost the ecological benefits of new oak plantings. For example, nodes of 20 or more oaks within 15 to 20 acres, all centered around a single large oak, could be enough to support a family of acorn woodpeckers. It's a model easily adopted by homeowners' associations and cities alike.

Oaks currently comprise just four percent of Silicon Valley's urban trees. Though maintaining high diversity among street trees reduces the threat of catastrophic diseases like chestnut blight, there's still plenty of room to add more oaks among the 400-plus species growing in the region today.

Re-oaking principles are already being incorporated into valley planting efforts. A notable example is at Google, which funded the report and is in the process of planting a small forest of oaks around the Santa Clara Valley.

The company is using both campus landscaping and nearby restoration projects to contribute to the overall ecological resilience of the region, says environmental design strategist Kate Malmgren of Google. "By re-oaking, we hope to reduce water consumption and attract associate wildlife species such as acorn woodpeckers, pollinators and beneficial insects."

In the Charleston Retention Basin, a Mountain View wetland, the company planted more than 1,300 native trees, 161 of them native oaks. At its new Charleston East campus, Google is installing valley oaks less than 500 feet apart, encouraging pollen dispersal and wildlife movement between tree nodes. And as part of other recent campus projects, Google has already planted 200 oaks and anticipates planting 300 more in the near future.
KW

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Resilient Silicon Valley
http://resilientsv.sfei.org/

Canopy: East Palo Alto tree initiative
http://canopy.org/our-work/tree-planting/east-palo-alto-tree-initiative/

Common name	Total CO_2 stored (kg/tree)	Annual CO_2 sequestration at year 45 (Kg/tree/yr)	Diameter at breast height (inches)	Tree height (feet)
Coast live oak	6,813	325	26.7	41.9
Redwood	6,689	358	37.2	94
London plane	3,204	146	23.1	54.1
Callery pear	2,683	81	20	39.4
Sweet gum	2,280	94	21.6	56.4
Velvet ash	2,236	134	20.2	48
Camphor tree	770	46	13.8	28.3
Magnolia	753	52	15.3	33.3
Ginkgo	574	34	13	35.6
Chinese pistache	568	17	12.4	33

E C O N O M Y

New Price Point for Ecosystem Services

How much is open space worth? A lot more than the land itself, when you add up increases to adjacent property values, direct income received through fees, and public health benefits associated with outdoor recreation. But as a series of reports on the economic value of Bay Area parks and natural lands confirms, it's their ecological values — like shorelines buffering against sea level rise or watersheds capturing runoff — that count the most.


Photo: Rick Lewis.

The latest report, released in April, tabulates the annual monetary value to local economies of the East Bay Regional Park District's 120,000 acres. Among its core findings: East Bay regional parks contribute at least $20 million annually in public health benefits, $65 million in property values, and $200 million in recreational values, the latter figure calculated by multiplying the district's 25 million annual visits by an average cost per day of $7.95.

But the biggest benefit had nothing to do with visitor spending, real estate, or exercise. A broad category commonly called ecosystem services, which can account for products obtained from ecosystems like food and water, benefits obtained from the regulation of ecosystem processes like climate regulation and pollination, and non-material benefits obtained from ecosystems like spiritual and educational values, was estimated to be worth $215 million per year — or about $1,800 per acre.

That's a conservative estimate, especially when it comes to benefits around adaptation to climate change and sea-level rise, says Teifion Rice-Evans of Oakland consulting firm Economic & Planning Systems, which prepared the report. "I do think that as awareness is growing around climate change and people do more studies on this issue, people are probably going to find that we're undervaluing the overall ecosystem services," he says.

Furthermore, limitations to the current state of the science of valuing ecosystem services meant that Economic & Planning Systems divided the park district's diverse lands into just three types of land cover: grassland, woodland, and "other," grouping wetlands, water bodies, shrubland, rock, and cropland into a single category. This again means that the sea-level-rise-absorbing capacity of natural wetlands and water bodies may not be fully appreciated.

Previous reports across the Bay Area using slightly different methodologies have come to similar conclusions. In 2014, the Santa Clara Valley Open Space Authority published *Nature's Value in Santa Clara County*, which valued its 835,000 acres of open space in terms of ecosystem services — such as cleaning the air and water, providing wildlife habitat, and moderating storm events — at $1.6 billion to $3.9 billion every year.

Such reports pave the way for cities and counties to think of natural lands as a form of infrastructure, says Santa Clara Valley Open Space Authority General Manager Andrea Mackenzie, which should in turn help make the case for continued and increased investment in conservation and restoration — even as land values across the Bay Area continue to rise.

"This is the direction that conservation is going," Mackenzie says, "though it doesn't in any way discount the invaluable aspects of nature and open space for its beauty and recreational value."

Other Bay Area municipalities to recently take stock of the economic value of their parks and open spaces include the cities of San Jose, in 2016, and San Francisco, in 2014 — both in partnership with the Trust for Public Land. Jessica Sargent, Director of Conservation Economics for the San Francisco-based nonprofit, says in the past nearly ten years she's helped write 25 such reports for cities across the country, including three already this year: Los Angeles, Colorado Springs, and Plano, Texas. They add to a growing body of evidence around the economic value of natural lands to critical services like stormwater management and carbon sequestration.

Still, maintaining and increasing those values requires ongoing funding, regulation, and policy support — rarely an easy task. "What we have found is that there is a misconception that conservation is a luxury and not an investment," says Sargent. "The economic-benefits research can show the tangible dollar values that are provided by conserved lands, and how important it is to conserve these lands to get that benefit. If you like to breathe clean air and drink clean water, you should care about conservation. We don't think of those things as a luxury." **NS**

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Municipality	Year study completed	Acres of natural lands	Annual value of ecosystem services*	Value per acre*
EBRPD	2017	120,000	$215 million	$1,800
San Jose	2016	13,213	$7.61 million	$576
Santa Clara County	2014	835,186	$2.74 billion	$3,280
San Francisco	2014	5,500	$5.04 million	$916
Santa Cruz County	2014	286,107	$1.5 billion	$5,243

**Please note each report defined and calculated "ecosystem services" differently, meaning these figures are not directly comparable from one study or municipality to the next.*

INFRASTRUCTURE

LA Drainage Goes Native

Citydwellers are accustomed to rain water being whisked down a drain and out of sight. While those who live on the edges of concrete flood control channels may have marveled at an occasional torrent in winter, or dreamed of skateboarding down these dry riverine chutes in summer, the general idea of getting the water away from the people prevails. Esther Feldman thinks otherwise.

"We're so rich in water-moving infrastructure in our cities and so poor at tapping it where it could do the most good," says Feldman, director of a nonprofit called Community Conservation Solutions.

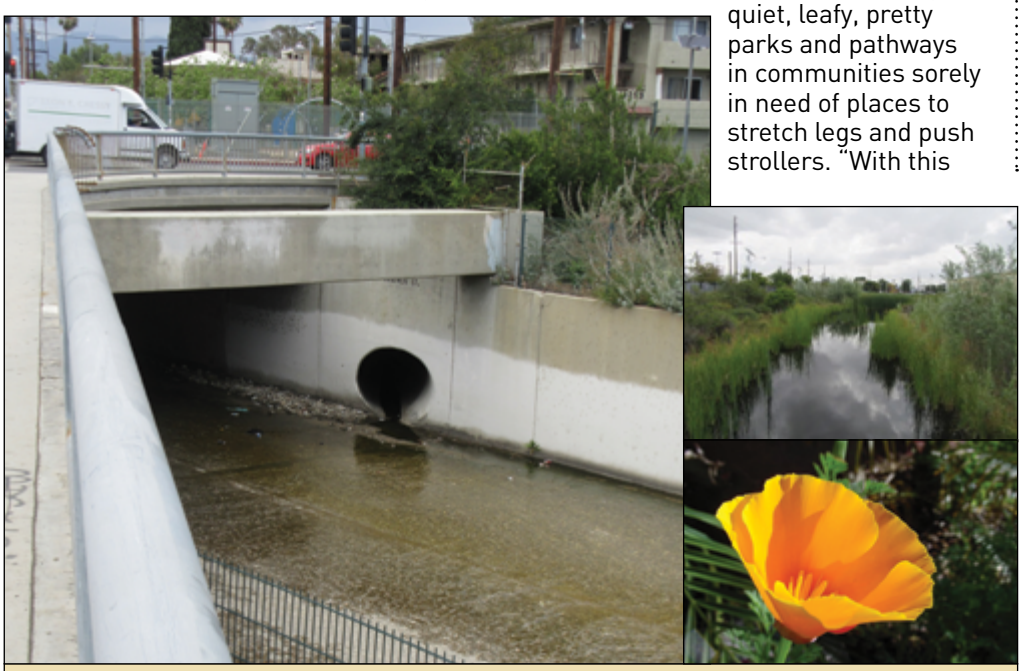
This summer, Feldman's organization is piloting a new analytical tool that not only taps an untapped local water supply — the 969 miles of metropolitan storm drains in Los Angeles — but also has the metrics to earn carbon credits for doing so.

"It's very practical, you just stick your straw in the local water source rather than pumping it into the city from hundreds of miles away," says Feldman. This local water can then be used to irrigate and vegetate the urban ecosystem, and to recharge groundwater.

Decades of ups and downs in Sierra snowpack, California's go-to water supply, capped by five years of drought, continue to inspire big picture thinkers to come up with greater efficiencies, especially in Los Angeles, where 90% of the supply comes from Northern California, the Owens Valley, or the Colorado River. Moving water from north to south and east to west takes energy and produces greenhouse gases. In an era when climate change impacts on water supply are coalescing around deteriorating infrastructure in still growing cities, finding enough water for the future isn't simple any more. It's all about sharpening our focus on where the water is and how to use it.

In Los Angeles, county public works projects capture enough rainwater to serve the annual needs of 1.5 million residents, but with the right projects, officials think they could double or triple that amount. And it's not just rainfall that's whisked out to the Pacific. In the upper Los Angeles River watershed, people hosing down hardscapes, washing cars, and irrigating greenery produce enough dry season runoff (affectionately known as 'urban drool') every 48 hours to fill the Rosebowl.

According to the pilot Green Solutions tool, there are many promising spots on public property in the upper Los Angeles River watershed where stormdrains could be tapped to irrigate quiet, leafy, pretty parks and pathways in communities sorely in need of places to stretch legs and push strollers. "With this tool you don't have to start from scratch and you don't have to buy land. It tells you what the best projects are to do and in what order," says Feldman.



A stormdrain and flood control channel in Tuyunga Wash, an early stormwater recapture project; South Los Angeles Wetland Park. Photos: Tira Okamoto & Wikimedia (poppy)

When Feldman explained the new Green Solutions tool to me, it took an hour to cover all its bells and whistles. In very basic terms, the tool identifies likely stormwater capture sites on public lands and then prioritizes them based on how close they are to a stormdrain, as well as community need and carbon footprint, among other variables. The process has sorted 453 projects within 500-1500 feet of a stormdrain or flood control channel, and identified 87 of highest priority.

The water and energy use analysis is particularly interesting. Apparently, implementing all 453 projects would generate enough new local water supply, and aquifer recharge, to serve 52,000 homes and replace nine percent of the imported supply used in the watershed. Tapping water already in the local system, meanwhile, would reduce the greenhouse gas emissions associated with long-distance delivery by an amount equivalent to travelling 1 billion vehicle miles.

"As funding becomes scarce, it makes no sense to do projects that only achieve one outcome," says Sean Vargas of VS2 Consulting Inc., consulting engineer on the Green Solutions team. "To do multi-benefit projects, we need to choose and prioritize. The good thing about this tool is you can 'twist the dials.' You can balance environment, money, and people equally as you 'squeeze the water balloon,' or you can favor one at the cost of the other. But no matter what you do, the tool will help you deliver a better project."

Ramona Gardens is high on the tool's priority list. When we arrived at this 1940s era cinderblock affordable housing development, the first thing I noticed was the sound of greenhouse gases being produced by thousands of combustion engines. Twelve lanes of highway and a rail line barrel past these homes just a few steps away from the bedrooms of 700 children.

"Most families in our community are used to being told this is what you get, and you should be happy about it," says Lou Calanche, who grew up near the 500-unit housing project in Boyle Heights, one of the three most polluted neighborhoods in California. Calanche now runs a youth leadership and

continued on next page

LA DRAINAGE, *cont'd from page 10*

education program called Legacy LA. "Our youth dream about a tree buffer between their homes and the highway to filter the noise and fumes."

This summer, local youth working for Legacy LA will go door-to-door to get residents' opinions on Green Solutions proposals to improve the long linear strip of space between their homes and the freeway. The bones of this proposed greenway include two and a half acres of native plant habitats around a newly created stream, all filled and irrigated by cleaned stormwater or dry weather runoff. The tool estimates the proposed project would develop 80 acre-feet of new water supply every year, replacing potable water now used to water lawns and ballfields while also irrigating new habitat. The project would also sequester 2,300 tons of CO_2 within the plants and trees in 20 years; reduce greenhouse gases by 2,900 tons in the same period; and cost $5-$10 million.

"This is an opportunity to change our environment, and it's not just about aesthetics, but also about creating places where people can congregate in positive ways rather than in the negative ways we're known for," says Calanche, referring to the neighborhood's reputation for gang violence and police tension.

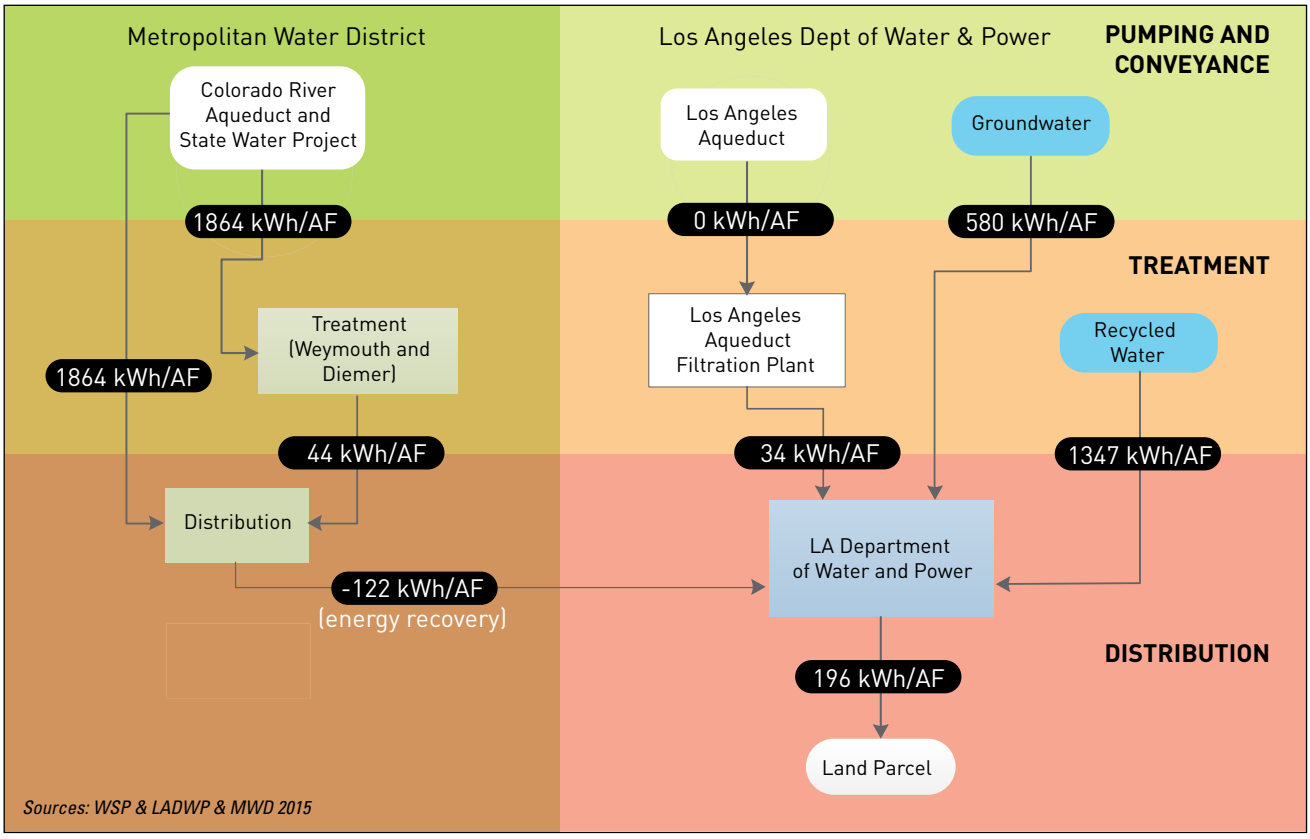
Though Calanche says the community has been focused on environmental justice, she thinks the new project can expand their conversations to include water. "Maybe it's time to change policies so we can have front-yard vegetable gardens instead of green grass, which the housing authority is still watering. There are no brown lawns here, but it is a food desert," she says.

The Green Solutions team and their funders, which include the Santa Monica Mountains Conservancy and the California Coastal Conservancy, made an active choice to work on Ramona Gardens, according to Vargas. "Other projects in other places might be easier to implement, but true sustainability has to include people," he says.

Vargas is no tree hugger, but he's seen the results of making this kind of choice to work in a tough neighborhood first hand. He was the lead engineer for the South Los Angeles Wetland Park (see photo p. 5), now maintained by the City of Los Angeles Bureau of Sanitation. This award-winning project transformed a disused maintenance yard for buses and rail cars (a former toxic brownfield) into a lush wetland park in the midst of the infamous "South Central" area. The project pulls 14,000 gallons of dry-weather runoff (40,000 in wet weather) per day out of an adjacent stormdrain and passes it through three constructed wetland treatment cells. It then returns any excess, much cleaner, to the drain before it flows out to the Pacific.

The community was shocked when they saw the plans for the project for the first time. "When we said 'stormwater treatment' they imagined an ugly black building with smokestacks smelling of sewage," says Vargas. Instead the community ended up with a parkland of pools, boulders, bridges, flowers, and cattails and bulrushes now so tall they have to be regularly trimmed. "Every morning when we open the gate at 7 am, people flood in," says Vargas.

ENERGY CONSUMPTION OF LOS ANGELES WATER (LADWP)



"In a high-desert Mediterranean climate like Los Angeles, you get rain for 4-5 months then nothing," says Vargas. "So our technical challenge was how to find the water to keep our urban wetland alive year round. We developed a water budget that used urban slobber when it wasn't raining, and also had the capacity to treat the first flush of the dirtiest water when the wet season starts."

The regulatory hammer on storm water pollution prevention has been over the heads of California cities and counties since the most recent update to the Clean Water Act. In 2014, fueled by the Green Solutions' vision of multi-benefit stormwater projects, California took it to another level. Senate Bill 985, championed by Senator Fran Pavley, offers a framework and incentives for regional land and water managers to do more complex and connected projects.

LA River Greenway Trail (above) and Ramona Gardens (p. 6).

"Right now we have a very disjointed water management system, both in LA and in other major cities," says Feldman, lamenting the lack of logic in choosing where to do multi-benefit projects, which was a big impetus for development of the tool. "We wanted to come up with a prioritized way to do the best projects and get the most water."

The project Feldman is most excited about is the LA River Greenway Trail, which opened to the public this June. The day of our visit, we slip past a striking metal gate, a welded work of river art, and down a path the Green Solutions team has created along the river. This half-mile project connects two other popular riverside trail projects to create four miles of continuous bike and walking path. For years it was the "missing link," says Feldman, because it was such a challenging stretch of riverbank to drain and plant. On the opposite bank, all we can see is rocky armor. But on this side grow more than 3,000 newly-planted native trees, shrubs, and flowers.

The team doesn't use just any plants, they use a very specific mix, density, and spacing of native species modeled on local habitats long since paved over. By organizing them into something they call "habitat tiles," this planting design offers a scalable unit of upland and riparian species. The unit can be applied to any parcel and then quantified, in terms of the amount of greenhouse gas each tile's 105-251 trees, shrubs, grasses, and perennials can trap and store.

To get these numbers, the Green Solutions team began by computing the impact of a single tree, and then layered it into the appropriate species mix and spacing across 5,000 square feet. "The habitat tile is a useful communication tool to help people understand how we're breaking down this problem of quantifying greenhouse gas benefit into a replicable unit," says Tim Kidman of WSP.

Kidman and co-consultants from ESA Associates were responsible for developing all the metrics necessary to calculate the carbon footprint of each potential Green Solutions project. Calculations looked not only at sequestration in plants, but also water delivery distance and onsite energy use for irrigation.

"At the end of the day, it's the weighting of all the metrics, and the chance to create an intersection of this information for decision-making, that's innovative about our tool," says Kidman. The hope is the strong metrics will help these kinds of ultra urban forestry projects become candidates for cap and trade credits in the climate change mitigation market. **ARO**

Don't miss the extended story online www.sfestuary.org/estuary-news

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LA Green Solutions Tool:
http://gsp.conservationsolutions.org

TOOLBOX

Bay Area Kit Streamlines Flood Control Choices

The Flood Control 2.0 Project's new online toolbox offers a comprehensive, six-section kit for planning multi-benefit flood control projects.

1. **Channel Analysis** includes an interactive map illustrating historic and current information for 353 creeks, information on channel sediment dynamics, and high level management concepts for 33 major flood control channels.
2. **Implementation Projects** presents reports and data on three flood control channels that flow into San Francisco Bay—lower San Francisquito Creek, lower Novato Creek, and lower Walnut Creek.
3. **Regulatory Analysis** assesses the current flood protection infrastructure in the Bay Area and its maintenance and repair needs, analyzes the challenges that come with implementing multi-benefit flood control projects, and offers case studies.
4. **Economic Analysis** provides a tool for a cost-benefit comparison of traditional flood control vs. multi-benefit flood reduction approaches.
5. **SediMatch** provides an online database to match dredged sediment with bayland restoration projects that need sediment.
6. **Podcasts** providing personal perspectives from scientists and managers.

TOOL: floodcontrol.sfei.org

INTERVIEW

North South Lessons from Two Estuaries

An engineer, a scientist, and a historian went into a bar… After a few beers, they found they all had something in common — two California estuaries. These two estuaries, one large, one small, one on the border with Mexico near Tijuana, the other in the heart of Northern California, were quite different but in some ways the same. The same physical processes continue to shape them, river flows, rain, tides, sediment shifts, plant growth. The same human activities have also played a role in their current health, including diking, draining, farming, urbanization, sewage discharge, the military, and more recently, environmental protection and ecosystem restoration. Both are National Estuarine Research Reserves (Tijuana NERR 1982 and San Francisco Bay NERR 2003). This June's publication of a new investigation into the historical ecology of the Tijuana River Valley by the San Francisco Estuary Institute offers a glimpse into just how similar and how different these two estuaries are. So ESTUARY asked the report's lead author, Sam Safran, to have a conversation about the two estuaries with consulting engineer and hydrologist Jeff Haltiner and restoration ecologist Joy Zedler.

AN ENGINEER, A SCIENTIST, A HISTORIAN

***Jeff Haltiner** is a retired consulting engineer and hydrologist, formerly with Philip Williams and Associates and ESA, who has worked on several hundred river, beach, and estuarine restoration projects along the California coast. He collaborated with Zedler between 1986 and 2000, and was on the board of SFEI for 10 years.*

***Joy Zedler** is the Aldo Leopold Professor Emerita at the University of Wisconsin-Madison. She pioneered adaptive restoration while working in the Tijuana Estuary. She serves on Wisconsin's Nature Conservancy Board of Trustees and California's Delta Independent Science Board, and helps edit the journal,* Restoration Ecology.

***Sam Safran** is an associate environmental scientist at SFEI working on projects that inform landscape-scale ecosystem restoration in the Bay and Delta. He is also the lead author of the* Tijuana River Valley Historical Ecology Study.

What is the biggest difference between the San Francisco and Tijuana Estuaries?

HALTINER: The Tijuana River estuary is the most dynamic estuary I've worked on in my entire 45-year career. It's just a wild place, where everything happens amazingly fast, in terms of the movement of water and sediment. When there is a flood, the estuary just gets smashed around, water and sand everywhere. It's an incredibly dynamic place with mind-blowing variety of physical factors at work. By comparison, San Francisco Bay is like a giant freighter, very big with a lot of inertia, so when things happen, they happen over a long time and system response is slow. Even though it has a huge watershed draining the Sacramento and San Joaquin Rivers, the relative effect of these rivers at any given time is really small.

ZEDLER: I did a little calculation, the San Francisco Estuary is 820 times bigger than Tijuana.

HALTINER: Half the state drains into San Francisco Bay, but Tijuana is more of a river valley with a tiny estuary at the very bottom, subject to coastal processes and riverine processes. It's really the barrier beach at its mouth that creates the estuarine component. Imagine somebody building a dam at the mouth of Golden Gate, and then seeing the Bay shift to a freshwater system with no tidal action as Tijuana has at times.

ZEDLER: It's very dynamic the way sand moves around the mouth of the Tijuana Estuary. Big storms leading to dune overwash have been responsible for this kind of change since the 50s, when people began degrading the stabilizing vegetation. I was astounded to see how the mouth has migrated over time a couple hundred meters in several different directions in Sam's report. You'd never see such movement in San Francisco Bay.

What's the sediment situation?

HALTINER: In the Tijuana Estuary both freshwater and sediment inputs are so episodic. I found that 90% of the sediment movement had occurred on six individual days over a 90-year period. So nothing, nothing, nothing then BOOM! the whole estuary changes shape.

SAFRAN: The two estuaries have opposite sediment problems. The Tijuana Estuary is struggling with too much sediment eroding from the watershed, and San Francisco is struggling with too little to feed its marshes. Looking at the different watershed/estuary size ratios you see why these two different situations might exist.

HALTINER: The dammed versus undammed portion of the watershed is also significant for the two systems, because dams trap sediment. All the major river systems draining into San Francisco Bay have dams on them. But for the Tijuana River, only 40% of the watershed is dammed. The difference also stems from the wave of Gold Rush sediment we experienced moving through San Francisco Estuary. When I first started working in the Bay, there was plenty of sediment, which really helped with restoration of tidal marsh habitats. Down in Tijuana, they have too much sediment and they have a hard time maintaining the open water portion of the estuary with the reduced the tidal prism.

What does land use history tell us about their evolution?

SAFRAN: In the Delta, you had fresh water and peat soils, prime conditions for agriculture, so the upper watershed remained relatively undeveloped for a long time; in San Francisco Bay, you had saltier baylands that weren't as good for crops, hence the urban and industrial development in the lower watershed.

The Tijuana Estuary escaped most of these changes, which is why it's such an important estuary in southern California. There's something intrinsic about the shape of the river valley and the mesas that made the highway go inland, and about how flashy and powerful the river can be that dissuaded farming and development in the valley. Tijuana's bi-national boundary did, however, manifest some real physical differences in the two parts of river valley: a channelized river on the Mexican side and an undeveloped forested river on the US side. In more recent cultural history, the US side had the military and a strong environmental movement protecting the Tijuana Estuary. All of these things add up to why we still have an intact estuary there today.

ZEDLER: The Tijuana River was a sewer for decades because the Mexicans never treated their wastewater. It wasn't until we built a treatment plant on the U.S. side of the border that they cleaned up river. Twenty five million gallons a day of sewage and wastewater now pass through the plant and enter a pipe under the valley that goes to the ocean. But the plant still exceeds capacity now and then, and untreated sewage does pass through the river and out into the estuary. There was a huge leak earlier this year when the mouth was actually closed due to the wet winter. The Tijuana Estuary filled up with fresh, non-saline sewage water, which killed a lot of the invertebrates and biota. On the other hand, there have been [some forward thinking] efforts to reuse wastewater on the Mexican side. Our laws did not allow us to spray sewage on road cuts but Mexico's did, with some positive benefits [in terms of fertilizing vegetation and preventing erosion into the river valley.]

HALTINER: In SF Bay, we basically dealt with sewage problem in 50s and 60s and then with secondary treatment in 70s, so from water quality perspective we weren't dealing with raw sewage in Bay. But it was and is a huge issue for Tijuana.

How is working on restoration in these two estuaries different?

ZEDLER: We developed the whole idea of adaptive restoration working in the Tijuana Estuary, and it's now finally being considered more seriously for San Francisco Bay and the Delta. The idea was to reduce uncertainty by doing phased restoration as an experiment and simultaneously vegetating the site. In the first phase, we planted 87 experiment plots on one acre, using different species combination. We learned that we didn't need to plant pickleweed, it propagates itself. In the second phase in 2000, we planted a model marsh on 20 acres, and experimented with adding tidal channels. We wanted to know how the physical morphology of a marsh and its ecosystem worked, not just the plants. We learned that adding tidal channels has real benefits, as an aerial photo in Sam's book really shows.

I've been trying to get the people managing the Delta to adopt our adaptive experimental approach to restoration, but there are all kinds of excuses for not doing so, most of which have to do with very different governance and agency responsibilities. Maybe it's too big a system to do something innovative. With 1,100 miles of levees prime for riparian restoration, and the state's Eco-Restore program calling for 30,000 acres of habitat restoration overall, it seems some fraction of this area would be easy to set aside for experimentation. I would start with restoring riparian vegetation along shores and on levee setbacks. There would be different construction and stabilization and vegetation techniques to test.

continued page 12

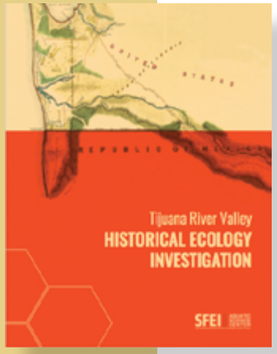
WATERSHED COMPARISON

Tijuana Estuary (top) looking south to Mexican border. Photo: Phillip Colla. San Francisco Estuary (bottom). Photo: Heather Davis.

	Tijuana Estuary	San Francisco Estuary
Watershed	1,100,400 acres	41,026,430 acres
Estuary circa 1800	970 acres	907,950 acres
Ratio of Watershed to Estuary Area	1135 to 1	45 to 1
Tidal Prism	0.3 million m^3	1,590 million m^3

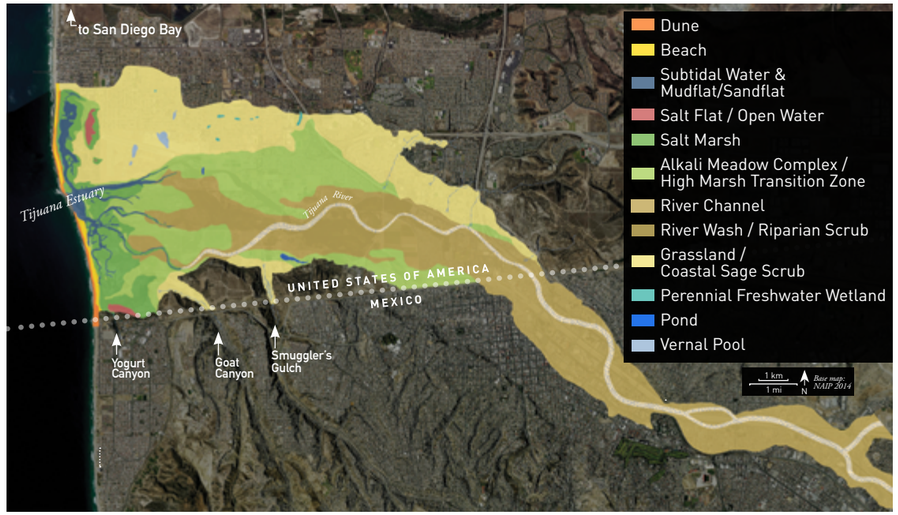
Tijuana's Tiny But Dynamic Border Estuary

Though the upper Tijuana River is now mostly confined to a narrow concrete channel in Mexico, it was once a broad expanse of sand and willows that reached close to a mile in width. The river was usually dry, but occasionally carried tremendous floods that had the power to uproot vegetation and reshape the valley floor and lower estuary (see historic channel courses below). The river flows northwest through Tijuana's high rises and freeways before crossing into farms and fields on the US side of the border. A dense riparian forest flanks the river till it opens into salt marshes, sand dunes, and California's southernmost estuary. Here the extent of salt marsh, critical for supporting the endangered light-footed Ridgway's rail, has declined by more than 40% (see the change from historic to modern conditions opposite). Pronghorn antelope, California condors, and sagebrush-loving Bell's sparrows once thrived in the valley, but landscape changes have resulted in species loss over time. The history of the river valley can be found in an intriguing new report www.sfei.org/projects/tijuana

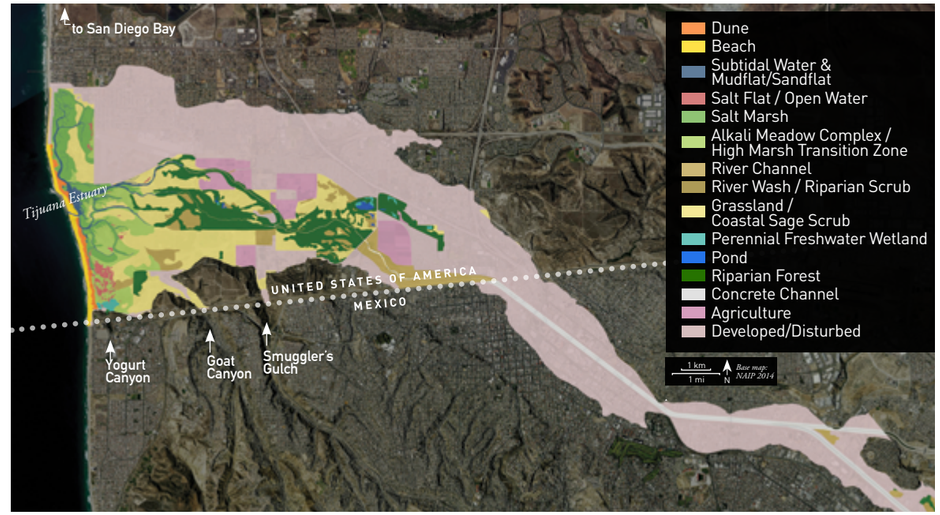


Source: Tijuana River Valley: A Historical Ecology Investigation, San Francisco Estuary Institute, 2017. www.sfei.org/projects/tijuana.

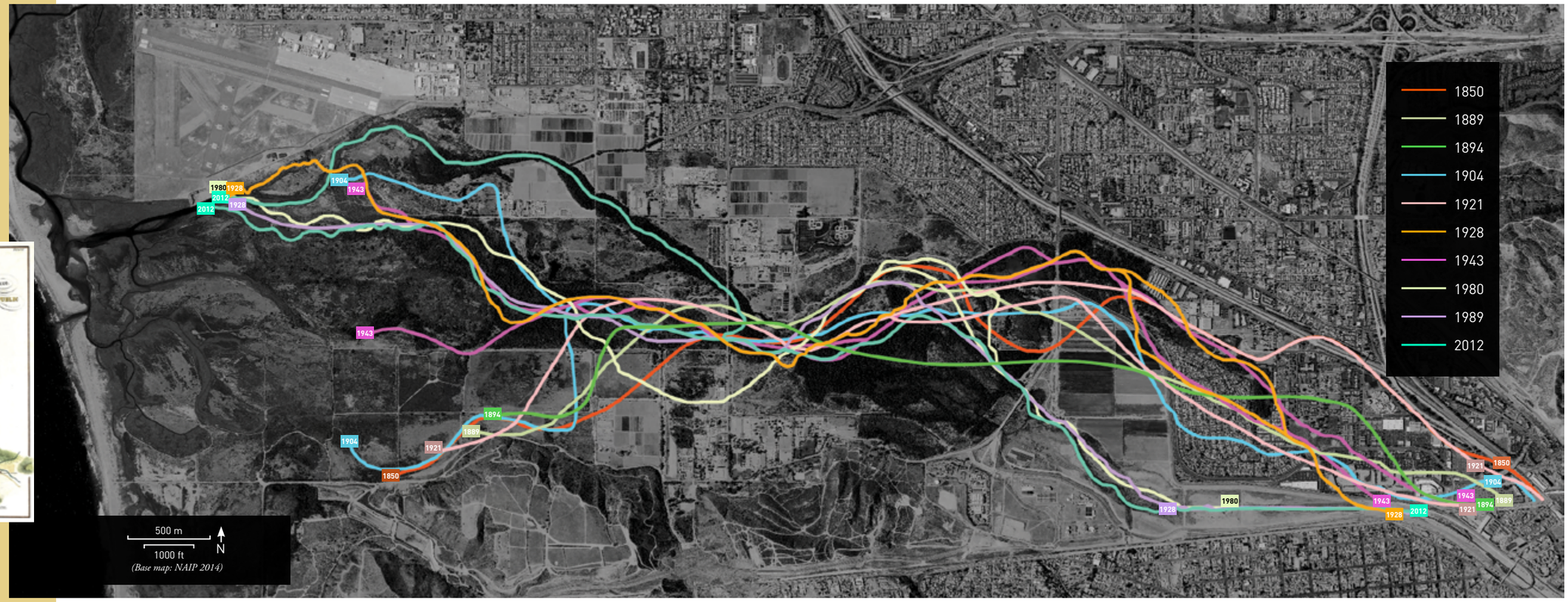
HISTORICAL CONDITIONS - TIJUANA RIVER VALLEY, CIRCA 1850



MODERN CONDITIONS - TIJUANA RIVER VALLEY, CIRCA 2012



HISTORICAL CHANNEL COURSES



TIJUANA, *cont'd from page 10*

Do management approaches differ?

ZEDLER: For Tijuana, [coordinated management] started around 1982, when the estuary became a NERR. That required a management authority, and then a stakeholder group, and then research coordination. The NERR even shared offices with US Fish & Wildlife and the State Parks manager. So essentially we had one small estuary, one management authority, one research entity, one advisory committee, and one plan for the estuary. This was a much more efficient operation that what you have in the San Francisco Estuary, where you have dozens of agencies and organizations and dozens of plans for different parts of the estuary.

HALTINER: Tijuana enjoys a coordinated and consistent vision. That's enormous. There are still some conflicts between agriculture and habitat restoration, but in terms of getting various stakeholders together in harmony over what direction to go, Tijuana has lot of advantages over the Bay. You're never going to get one vision for San Francisco Bay and the Delta from the gazillion agencies and stakeholders.

ZEDLER: From my perspective as a member of the Delta Independent Science Board, what the Delta really needs is a more comprehensive monitoring program with shared data storage and access, based on coordinated and complementary sampling. When I first started working in the Tijuana Estuary in the 1970s, a professor from Ensenada named Silvia Ibarra-Obando made contact. She'd heard about the way we were sampling salt marshes and she wanted to do it the same way in two other estuaries in Mexico further south. That's the kind of attitude we need more of — adaptive restoration.

Will rising sea levels affect these two estuaries differently?

SAFRAN: Most of the California coast's estuaries have highways and other structures right up against their wetlands. Tijuana is the exception. Down there, the highway is five miles inland, and you have continuous transition zone between the estuary marshes and uplands with undeveloped open space. That's the big difference between the two estuaries, the amount of undeveloped space available for estuarine migration inland in advance of sea level rise. It confers lot of resilience to the Tijuana estuary.

ZEDLER: San Francisco Bay marshes could move bayward if they had enough sediment.

SAFRAN: This last year's big El Niño offers a snapshot of future climate change conditions. Sea levels average higher during El Niño periods, and this year the Tijuana mouth closed for the first time in more than thirty years, with higher waves pushing more sediment up estuary. One of anticipated effects of sea level rise is more frequent closure events. Closures, combined with the nutrient and sewage problems in the river, can produce quick and severe detrimental ecological effects including low dissolved oxygen and fish kills. In the San Francisco Estuary, El Niño effects this year were higher precipitation, levee failures up in the delta, islands flooding with high flows. So El Niño gave us a taste of the climate change impacts on both systems.

HALTINER: El Niño and the wet winter also produced a phenomenally good year for fish in San Francisco Bay. The saltwater freshwater interface pushed way down into the Bay, instead of staying up in the Carquinez Strait, and we got a wonderful fishery. This highlights how the main problem for San Francisco Bay is still the lack of fresh water because so much is diverted.

ZEDLER: Sam's work also tells us the Tijuana system has been changing forever, and [plant and invertebrate] communities have moved around that river valley enormously over time. So although the estuary and marsh seem to be static they're actually not, and certainly can be restored to be flexible where they might occur.

What should we be thinking about in these estuaries in the future?

HALTINER: I have been working with the Southern California Wetlands Recovery Project, looking at the whole coastline from Santa Barbara to Mexico. There's land left in a lot of those southern California river valleys for wetlands to migrate inland. But are the owners going to be willing to sell? We've been trying to pinpoint which marshes in SoCal are ringed by cities, like San Francisco Bay, and which have migration space. Tijuana one of best places, because there's room for marshes to move inland. In San Francisco Bay, the battle will be with everyone wanting to put up sea walls, and the marshes, with no place to go, will disappear.

SAFRAN: The trick is to use historical ecology to look forward, not back. It shouldn't be about getting this marsh in this exact place and holding it there indefinitely.

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Tijuana Report, www.sfei.org/projects/tijuana#sthash.smZQUvrj.dpbs

COMPETITION

Sites & Smarts?

Concerned about climate change and how it will affect your Bay Area shoreline community? Ready to prepare for a more resilient future? Rather than wait for disaster, the Resilient by Design — Bay Area Challenge will help communities adapt before we feel the worst effects of rising sea levels, severe storms, and flooding while also improving the lives of community members today.

The Resilient by Design — Bay Area Challenge is hosting an open call for ideas to identify sites vulnerable to climate change impacts. Through July 14, 2017, the challenge asks local residents, community leaders, and organizations to submit site ideas. Final site locations will be chosen through a collaborative research process based upon community feedback and potential for creative and implementable design solutions. Solutions will aim to protect the Bay Area's most vulnerable shoreline communities while also addressing critical issues such as disparities in housing, income, and access to open space.

To submit a site idea, visit the Resilient by Design website at www.resilientbayarea.org/site-ideas.

To be considered for a design team visit www.resilientbayarea.org

To read more about how resilience applies to Bay Area habitats and restoration www.sfestuary.org/mainstreaming-resilience/

PLANNING

Flood Plan Boosts Floodplain

When the Central Valley Flood Protection Board adopts the 2017 Update to its Flood Protection Plan later this summer it be another twist in the serpentine evolution of California's approach to flood management. While the primary goal of the plan is to improve flood risk management, it emphasizes the integration of ecosystem functions and native habitats into the flood management system, as well as promoting multi-benefit projects.

"It's an exciting time to be in flood control," says Diana Jacobs of the Sacramento River Trust, who has worked in the field since Governor Jerry Brown's first administration.

It's a remarkable evolution for the state's flood control efforts, which began in the 1800s when debris from hydraulic mining filled the valley's rivers and caused flooding. The state Reclamation Board was established in 1911 and spent most of the 20th century building levees and draining land for agriculture and development. In 2008, shortly after Hurricane Katrina demonstrated the devastating potential of floodwaters, a California court decision held the state liable for damage caused by the failure of local agencies to provide adequate flood protection. To reduce the state's potential exposure, the legislature reconstituted the Board as the Central Valley Flood Protection Board and directed it to adopt a long-range strategic plan for maintaining and operating the valley's complex, largely antiquated flood control system, to be developed by the Department of Water Resources and updated every five years. The 2017 update is the first since the initial plan was adopted in 2012. The Board will hold meetings and workshops on the update throughout the summer.

"The refinements, additional modeling, inclusion of climate change, and the new sections that have been added are moving us toward comprehensive management of a disparate and aging infrastructure that hasn't been carefully looked at in the past," says the Board's Executive Officer Leslie Gallagher. "We are recognizing that the flood system is also the water system is also the habitat for lots of endangered species. The goal is still safety first, but we recognize that the system is used for all these other purposes."

According to Board member Tim Ramirez, "There's nothing the state could do that would be more cost-effective or happen more quickly than expand the floodway corridors and allow for increased capacity, because in the end that's going to create better protection behind the levees, and also create more habitat for the species that depend on the rivers." Restoring floodplains can also help water supply management, both through groundwater recharge and by allowing reservoirs to store more water rather than maintain excess rainy day capacity.

Among the documents DWR developed along with the flood plan update is a Conservation Strategy that includes goals and measurable objectives for improving ecosystem functions by integrating restoration with flood risk reduction projects where feasible. "The Conservation Strategy is an amazing, fantastic compendium of where we are at," says Jacobs. "It picks up where CALFED left off on ecosystem restoration, adds a lot of new science on Central Valley rivers, and integrates it with floods."

At press time the strategy was not an official part of the update, merely a supporting document. However, Ramirez and others are optimistic that it will be included as part of the plan that the Board ultimately adopts. "The conservation community wants the Board, in its independent capacity, to make DWR go

continued to next page

SCHOOLYARD

Forest from the Trees

Traditional school days begin with a ringing bell. At Early Ecology, a forest school that holds class in parks in the Oakland hills, school days begin by gathering around a large tree and with students answering a coyote howl from their teacher with one of their own.

Early Ecology, founded in 2013 by Joanna Ferraro, gives preschool and kindergarten-aged children the opportunity to use the natural world as a classroom. Ferraro, who is trained as an early childhood educator and has an affinity for outdoor exploration, thought that Oakland needed a forest school. "Kids are excited about nature, she says, "but it can be hard to find in the cracks of concrete."

The forest school curriculum became organized as a movement in Europe in the mid-1990s. The outdoor-based learning philosophy is becoming more prevalent in the Bay Area and beyond, and the idea seems to have global appeal.

The curriculum, which encourages self-directed and unstructured play, addresses the negative outcomes for today's children of spending more time looking at screens and studying for standardized tests. The associated attention and health issues were popularized in Richard Louv's 2005 book, *Last Child in the Woods: Saving Our Children from Nature Deficit Disorder*. "It's really special to see children look at spider web and know what kind of spider made it, or walk down a trail and know what kind of tree they are seeing," Ferraro says. "Kids are so interested in the world around them. When they have this experience at two, three, or four and to be able to deeply know an ecosystem, it really changes everything for them.

A school day at a forest school is dominated by imaginary play, and natural history lessons such as plant and bird identification. "Children play differently. Instead of super heroes they play blue jays. They play about what they see in the world," Ferraro says. Classes generally meet regardless of weather conditions, and the learning environment can move seasonally to take full advantage of natural cycles.

Place-based education also connects kids to their local environment and gives them an understanding of how life unfolds. "The sheer number of hours outdoors is really healthy for both of us," says Kristie Wyndham about the time she spends with her school-aged daughter as one of the organizers of a group of homeschool families called the Acorn Wilderness Explorers. "Our home base is Joaquin Miller Park. It's been really exciting getting to know the watershed and watching the seasons change. It's a completely different sense than you would get just from the occasional hike." **DM**

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Photo: Acorn Wilderness Explorers

CENTRAL VALLEY, *cont'd from page 13*

the extra inch and say the strategy is part of the plan," says Jacobs.

The opportunities and incentives for reconfiguring the flood control system are colossal: most of it was built piecemeal more than half a century ago. The Army Corps of Engineers has designated large portions of the system as out of compliance with federal operations and management requirements, leaving the state ineligible for rehabilitation funding in the event of a flood.

As to how the Board will realize the plan's vision, "That's the billion dollar question," says Gallagher. The plan does not give the state any additional authority over local agencies, general plans, or zoning ordinances that would allow it to limit development in the floodplain. No problem, says Ramirez: "Obviously the valley's going to continue to develop over time but it needs to be done in places that don't put the state at risk for greater liability, and in the end that's our decision. The Board is a permitting agency like BCDC or the Coastal Commission; people have to come to us if they want to do something that's in the State Plan of Flood Control, and we can say no."

Initially, floodplain restoration efforts will focus on downstream areas. "It doesn't do any good to make floodplains at the top of the system if downstream capacity is limited," explains Ramirez. There are already projects in the works at the Yolo Bypass on the Sacramento River and at Paradise Cut on the San Joaquin River.

The update includes a financial strategy to meet the plan's price tag of $17-$21 billion over 30 years. "It's a big number," says Gallagher "If we want this level of protection we are going to have to pay for it and everybody's going to have to pitch in. These are very complex systems. When you have things as disparate as agricultural, urban and environmental uses in the flood plain, all attached together in a way that has to work, it's a big step for the state to be moving in this direction." **CHT**

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MORE INFO? http://cvfpb.ca.gov/docs/CVFPPDraftPlan/CVFPP-2017-CVFPP-Update-Draft%20%281%29.pdf

www.water.ca.gov/conservationstrategy/docs/cs_draft.pdf

Napa Survives Wet Winter with Dry Feet

The City of Napa has been under water so many times — every few years or so for more than a century — that it qualified for federal flood control funding. But that required a local contribution, and Napa voters repeatedly rejected projects from the U.S. Army Corps of Engineers. This despite the fact that in 1986 alone, flood losses were estimated at $100 million. Five thousand people were evacuated. And three died.

The problem was the Corps' original design, which would have channelized the Napa River to speed water through the city and into the Bay. "They were essentially treating the river as a storm sewer," says hydrologist Phil Williams. Instead, at the invitation of Friends of the Napa River, he helped design a more natural way to manage flood waters. Voters approved this "Living River" project in 1997, and it got its first major test last winter. Wet as it was, Napa did not flood.

The Napa River flows 55 miles from headwaters near Calistoga down to the San Pablo Bay, and the flatter the terrain, the more a river meanders. When the river reaches downtown Napa, it forms a charming, nearly-elliptical oxbow. The Corps originally wanted to complete the ellipse with a concrete channel that flowed year-round — but that would have left the oxbow stagnant when flows were low. "It would have destroyed the water quality and habitat of the oxbow during the summer," says Leslie Ferguson, who in the 1990s managed the Napa watershed for the San Francisco Bay Regional Water Quality Control Board. The Living River solution is a bypass engineered to be dry most of the year: the inlet is partway up the riverbank so water enters only during peak floods.

Ferguson was also troubled by the Corps' plan to stabilize the riverbanks with rip-rap rock. "It would have been an ecological desert," she says. "Where land meets river is one of the most productive environments — snakes and birds come to eat, and frogs and juvenile fish come to hide from predators." Instead, the Living River has mudflats and floodplains planted with native vegetation along much of the seven-mile project. This restoration is remarkable, given that the city crowds the river, and required buying property and cleaning soil contaminated by former industries.

The new, more natural edge gives the river room to move as well as a place to deposit sediment during flood flows. "You need to take into account how a river would naturally want to behave," says Williams, now retired. "They create their own form and change over time."

Photo: Jeremy Sarrow, Napa County

The design was also shaped by historical maps. "We went back in time to find the natural channel of the river before major human interventions," Williams says. The Napa River's behavior at its mouth is particularly complicated — and important to consider — due to tidal flows. "In the Bay Area, flood damage is often in the lower reaches where a river is meeting the tide," he explains. Both the maps and Williams' models pointed toward restoring tidal wetlands on a 900-acre diked hayfield south of the city. Besides lessening flood damage, the restored wetland is full of wildlife.

The Living River, which still needs strategically-placed flood walls to meet federal standards for 100-year flood protection, will ultimately cost up to $500 million and has taken 20 years so far. Rick Thomasser, operations manager for the Napa County Department of Flood Control and Water Resources, credits the Water Board's Ferguson with helping to keep the focus on the Living River vision along the way. "All too often the guidelines get forgotten in the nitty gritty of construction," he says.

Thomasser, who lives in Napa, enjoys the newly-transformed river. "There used to be a lot of trash," he says. "Now we have herons, beavers and otters right in the center of downtown." The Living River is a place for people too. Miles of walking trails follow the river, forming part of the Napa Valley Trail that will link Vallejo with Calistoga. And the new oxbow bypass, which is dry most of the time, has a concrete amphitheater that beckons young families. "It's primarily for slowing down flood water but is also great for scooters and skateboards," Thomasser says. "It's where my grandson learned to ride a bike."

Getting on the water is another way to enjoy a river. Last year Williams and a friend rowed up the Napa River when there was a little flood coming down, making it all the way through the city. He says it's easiest to go up on a spring tide, though. Then, like the Living River project, people are working with the river rather than against it. **RM**

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C L I M A T E

Amped Up on Blue Carbon?

Carbon emissions are on the forefront of many conservationists' minds in the wake of the United States decision to drop out of the Paris climate agreement. On the national stage, a coalition of cities, states, and businesses have formed an alliance aimed at continuing to meet the accord's climate goals.

Locally, a new carbon sequestration protocol that was recently approved by the American Carbon Registry hopes to contribute to that goal in the Sacramento Delta. The protocol, which was awarded ACR's "innovation" award, offers three different methods for storing carbon, either by restoring wetlands or eelgrass beds, or by converting other forms of agriculture to rice cultivation.

The methodology, titled Restoration of California Deltaic and Coastal Wetlands, is one of several protocols developed in recent years that target what is being called the Blue Carbon Market—based on the management and trading of coastal wetlands.

"I think the main reason [we won this award] is due to its complexity—there are a number of different potential avenues for a project proponent to follow," says Steve Deverel, a founding principal with the consulting group HydroFocus and the lead author of the protocol. "But I think there was a patience factor too. We've been working on this a long time."

The Sacramento-San Joaquin River delta is undeniably complex. A patchwork of public and private property, scattered fragments of ecologically rich habitat, and one of the most important sources of drinking water in the California, it exists in a precarious structural state. Farmers look across their fields at channelized rivers running some 25 feet over their heads—and all of that space represents soil, and carbon, that has been lost.

"The western delta has about 250,000 acres of deeply subsided land," Deverel says. "It will be a slow process but we are optimistic that this is a method where we could begin to stop or reverse subsidence."

Wetlands — those reedy, fertile places — act as vast carbon sinks worldwide. Although they also emit greenhouse gasses such as methane, studies have shown that the long-term carbon sequestration benefits far outstrip the impacts. Though they cover less than 10% of the earth's surface, they are estimated to house up to 30% of the total carbon stored in the earth's soils.

Photo: Rick Lewis

Yet that percentage is rapidly dwindling, as wetlands and their soils continue to be lost. Since the 1800s, nearly all of California's wetlands have been drained, filled, and converted to other uses. That includes more than 90% of the San Francisco Bay Area's tidal wetlands. Drying of these wetland soils, and subsequent agricultural use, has caused the delta's landscape to subside by up to 25 feet below sea level. It also releases an estimated 1 to 2 billion tons of carbon dioxide each year, according to the Delta Conservancy, which has been a driving force behind promoting the new ACR protocol.

"Those soils formed over 7,000 years," Deverel says. "Once they were drained, the microbes basically went crazy and augmented their consumption of the organic carbon that is so rich in these soils. The estimate is that we have half of the organic soil that there was prior to 1850."

The first goal of the new protocol is to staunch that loss. "Once you re-wet the soil and keep it saturated, you basically stop or greatly slow down the oxidation process," Deverel says. But a long-term hope is that participants could both accumulate sequestered carbon and begin to reverse subsidence by rebuilding the soils.

"We see just a huge opportunity here but it is going to take some work," says Campbell Ingram, executive officer with the Delta Conservancy. "So we're trying to amass interest, get people asking questions, and gather technical resources."

The protocol, which is part of the voluntary compliance market, has crossed the first of several hurdles by being accepted by the ACR. The next step is finding a partner — either a curious farmer or, more likely, one of the public land owners in the area — to show that the methods don't just pencil out on paper, they also work in real life.

"It's certainly a bit speculative at this moment, with lot of unknowns," says Ingram. "Our biggest challenge is just to demonstrate with a pilot project that this protocol really can result in revenue."

The agricultural portion of the protocol, which Deverel says is the one most applicable to the delta, would give farmers carbon credits for converting current crops that demand dry, aerated roots — such as field corn, alfalfa, and row crops — over to rice, which survives in saturated soils.

The wetland restoration would be more costly—requiring, in most cases, construction of berms and other heavy-duty earth moving. But there are smaller ways to participate as well: a field that is too wet to farm could be ceded over to wetland, and a farmer could start getting a few dollars on the carbon market. "You could start with a field or expand to an entire island," Deverel says.

"Five years ago there were no tools for this kind of thing whatsoever," says Steve Crooks, whose consulting firm helps to design and implement blue carbon protocols around the world. "Now the tools are out there. What is slowing things down—the limiting factor—is awareness that they exist, and demonstration of how to use them." JC

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T O X I C S

Worrying Uptick in Blooms

When I was a kid, algae was fun. I would hunt through its shadowy aquatic cloudscapes in our local creeks looking for salamanders, crawdads, or small fish. I liked the cool feel of it when I wiggled my toes in the shallows; my friends and I would decorate our faces and bodies with this benign green "hair".

But no longer. Now, a bright green layer on the water can indicate a bloom of toxic blue-green algae, or cyanobacteria, which have been on the rise in the Bay Area in recent years, likely linked to climate change. Exposure to the cyanotoxins produced by blue green algae can cause serious illness or death in dogs, livestock, and wildlife — and potentially humans as well.

Right now, the main danger is from ingesting algae-tainted water during recreational activities like swimming and water skiing. But the increasing frequency of the blooms has people wondering if their tap water is safe (it is — for now) while water agencies are strategizing how to keep it that way in a future that looks like it will have more toxic algae than ever.

"Right now, the first thing we do is increase our monitoring," says Jarnail Chahal, engineering manager with Zone 7 Water Agency in the Livermore Valley. "Even if there is a bloom in [our source water], it doesn't mean that we are getting toxins in our treatment plant."

The current pattern of occasional blooms can be dealt with in a variety of ways, because water agencies obtain water from multiple sources.

"This is something we take seriously and are watching, but we are not really on high alert about," says Stefan Cajina, Chief of the North Coastal Section for the State Water Resources Control Board Division of Drinking Water. "A lot of times [the water agency] can change the depth from which they take water, or they can go to a different source, or live off of storage for a while. So they have some choices."

However, the longer a bloom lasts — or the more water sources become affected at the same time — the more likely it is that eventually water districts will have to remove cyanotoxins from water that is destined for the tap. This can be done with a variety of methods, but ozone is the most effective, according to a study commissioned in 2015 by three Bay Area Water Districts who use water from the South Bay aqueduct.

"We were going to upgrade to ozone in approximately 10 years, but we have moved it up and are starting [the process] now," says Chahal. "Treatment-wise, we need to be prepared."

But water districts often manage lakes, reservoirs or waterways that are also used for recreation, and those waters—many of which are not ever used to supply the tap—come with their own suite of management concerns.

Blooms tend to happen in the summer months, when water is at its warmest, and nutrients are least dilute, but they can occur at other times as well in some parts of the Bay Area. No one knows what impact this year's abundant rainfall will have on the blooms.

"This is kind of new territory—having high flows and high temperatures," says Lehman. "We just have to wait and see."

There are numerous types and species of cyanobacteria. "Scientists point out that these species are among the oldest types of living things on the planet," Cahina says. "They have been around a while, and there's nothing new about them showing up in water supplies, but there really does seem to be an increase in these out-of-control blooms in recent years."

Photo: EBRPD

"We want people to be very careful," says Peggy Lehman, senior environmental scientist with the California Department of Fish and Wildlife. "If they see anything that looks like a scum on the water do NOT go into it. Don't swim in it, don't water ski in it, stay out of it. It's very toxic to young children."

While no one knows for sure why cyanobacteria blooms are becoming more common, they suspect both climate change and increased nutrient inputs into the water.

"It waxes and wanes with the conditions in the estuary," says Lehman. "Temperatures in the delta have gone up every year, and that seems to be most directly related to the [blooms]."

For now, monitoring and communication are the strategies being used by water resource managers.

"The State Water Resources Control Board is doing more aerial surveillance, and they have developed signage and guidance levels to try to warn the public when they shouldn't be in the water," Lehman says. Water districts and parks departments also have programs for monitoring blooms, and updating the public. Already this year East Bay Parks has closed Quarry Lakes, a group of recreational lakes, and advised caution on two others.

An email update from East Bay Regional Parks, sent in early May, illustrates the level of monitoring

continued to back page

MARITIME

Ballast Headed Ashore?

With California's ballast water discharge standards set to be implemented in less than three years, the quest to develop treatment technologies that can meet them is gaining urgency. A study set for release this fall is evaluating whether shore-based treatment facilities might be a solution.

Ships take on and discharge vast amounts of water for ballast to keep them from being imbalanced. In this way, water taken on in foreign ports can end up in San Francisco Bay, along with thousands of exotic organisms that can damage local ecosystems. Under the California State Lands Commission's Marine Invasive Species Program, ships can prevent such invasions by exchanging ballast in the open ocean, where estuarine organisms can't tolerate the salty cold ocean conditions. Other approaches are also being explored, including shipboard and shoreside treatment. (For background see "Taking the Measure of Ship's Ballast," Estuary News August 2012.)

The state adopted ballast water discharge performance standards in 2006, but delayed their implementation on several occasions after reports concluded that there were no currently available ballast treatments that could meet the standards. Interim standards are scheduled for implementation in 2020, with the final standard — which calls for no detectable living organisms in ballast water discharge — on track for 2030.

Although there are no existing onshore ballast water treatment facilities in California—or anywhere else except Alaska, which has some facilities for treating oil-contaminated ballast water—they have, in theory, some compelling advantages over shipboard systems. "With shoreside treatment, vessels don't have to install special ballast treatment equipment," says Nicole Dobroski of the State Lands Commission, which is funding the study. "It's also easier to monitor the system and ensure that it's working properly." Some in the environmental community believe these advantages would make onshore treatment more protective of state waters than shipboard treatment, and are looking to the study to bolster the case.

However there are some issues with getting all the water onshore. "Ships ballast and deballast all the time," notes the San Francisco Estuary Partnership's Karen McDowell. "They might deballast as they are coming into port, for example, or if they have to go over a sandbar. They're not always at dock when they're discharging ballast." She also notes that vessels would probably need to be retrofitted to pump ballast ashore, which is unlikely to be practical for vessels that only visit California sporadically. Shore-based treatment may be feasible for some vessels but not for all. "That's a key question we hope the report addresses," says McDowell, who also works with two groups that are striving to create more uniform ballast water standards among the Western states.

The on-shore treatment study is being managed by the Delta Stewardship Council, which will hold the last of three public meetings on the study in October.

Meanwhile in Washington D.C., the Commercial Vessel Incidental Discharge Act, which would replace state ballast water discharge standards with one federal standard, is working its way through Congress. "As currently written, the legislation could have significant consequences," says Dobroski, noting that California's standards are much stricter than the federal standards. "Under this bill our higher levels of protection would be pre-empted. States understand the unique conditions of their own waters best, and need the ability to run their own programs." The bill, which is backed by the shipping industry, would also delegate all enforcement and oversight to the Coast Guard. **CHT**

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MORE INFO?
http://deltacouncil.ca.gov/events/feasibility-study-shore-based-ballast-water-reception-and-treatment-facilities-california-1

FEEDBACK

Calling All Bright Ideas


Photo: Rick Lewis

It's nomination season in the Bay Area environmental scene. Nominate some environmental superstars or projects whose innovative actions have made the Bay Area more sustainable! Don't be shy or afraid to think outside the usual circles.

SFEP is seeking nominations of individuals for the Jean Auer Environmental Award. The award is given in memory of Auer, a beloved Bay Area environmentalist whose groundbreaking efforts were directed particularly at improving water management in California. The award will be presented at the thirteenth biennial State of the Estuary Conference, October 10-11, 2017, in Oakland. Nominees must have made a significant contribution toward improving environmental quality in the Bay-Delta Estuary, and those working on water-related issues will receive special consideration. Mail or e-mail nominations to: Darcie Luce, San Francisco Estuary Partnership, 1515 Clay St., Suite 1400, Oakland, CA 94612, darcie.luce@sfestuary.org (Deadline 7/28/17)

Friends of the San Francisco Estuary seeks nominations for outstanding environmental projects that benefit the San Francisco Bay-Delta Estuary and its watersheds. Projects with significant achievements will be featured at the conference. Nominated projects should further the goals of the 2016 San Francisco Estuary Partnership's *Estuary Blueprint*, which is available at www.sfestuary.org/ccmp. Please e-mail nominations to friendsofsfestuary@gmail.com, or send them to FOE, P.O. Box 791, Oakland, CA 94604. (Deadline 7/28/17)

Sport Fish Still Not Squeaky Clean

Toxic flame retardants quickly declined in Bay-caught fish, once banned, but legacy mercury persists, according to the most recent year of sampling. As the region's collaborative monitoring program for Bay contaminants — the RMP — arrives at its 25th birthday, its long-term commitment to consistent data collection for the purposes of targeted environmental management is showing its mettle.

The RMP has been catching and testing a wide array of species of popular sport fish, ranging from giant sturgeon to tiny sardines, since 1997. This June the program debuts the latest results. There's good news, bad news, and no news. PBDEs, those sticky flame retardants linked to cancer, and sprayed on fabrics and couches, have continued their steady decline over the last four sampling runs: the good news results of a recent ban. The bad news is stain and water repellants (PFASs), very widely used, are emerging as the next contaminant getting into our Bay fish in need of attention. "Consumer products used in our households and workplaces [are easier to target than contaminants added to the Bay over decades and settled in the sediments]," says San Francisco Estuary Institute scientist Jennifer Sun. "They can respond very quickly to management actions while legacy contaminants are tougher to control."

Striped bass. Photo: Jim Ervin

The forthcoming report also confirms that legacy mercury and PCBs aren't going away – the no change news. Bigger sport fish like striped bass and white sturgeon caught in the Bay continue to have enough mercury and PCBs in their bodies that the state Office of Environmental Health Hazard Assessment suggests consumption restrictions for pregnant women and children.

"Scientists used to believe PCB exposure was fairly distributed throughout the Bay but fish monitoring and sediment analysis indicate hot spots in industrial areas are contributing to what ends up in the food web. We need to focus on cleaning them up," says Baykeeper's staff scientist Ian Wren.

One PCB hot spot in San Jose – industrial Leo Avenue – is already getting some attention in terms of management to prevent runoff into the Bay. A mercury hot spot in the upper Guadalupe River watershed where the largest mercury mine in the world once operated, meanwhile, has also been the subject of management efforts – this time to reduce erosion. But as of the most recent RMP data, this heavy metal remains a particularly gnarly problem in the Bay's southernmost reaches. "We did see higher mercury in South Bay striped bass than striped bass from other sampling locations," says Sun.

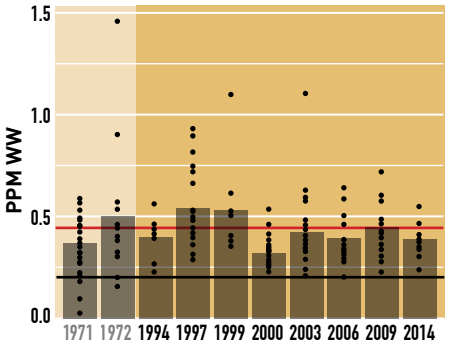
Also in the South Bay, the RMP collaborated with the San Jose-Santa Clara Regional Wastewater Facility on a new sampling location in 2015, Artesian Slough. "Slough conditions are dominated by effluent from the facility being discharged to an enclosed area, so we can get an idea of how that system compares to open waters of San Francisco Bay in terms of food web uptake of contaminants," says Sun, pointing out that this is one more example of the RMP drilling down into local nuances.

The North Bay has other problems, namely selenium accumulating in the food web via agricultural runoff from selenium rich soils upstream, which the invasive overbite clam mainlines into the Suisun Bay food web. White sturgeon eat the clams. As a long-lived, very large, bottom-feeding fish that ranges widely throughout the Estuary and its watershed, from Shasta Dam to the Golden Gate, this giant continues to be a focus of both sport fish monitoring and related studies. Two 2014 white sturgeon samples from Suisun Bay had selenium levels high enough to potentially impede reproduction, though not levels harmful to humans (see upcoming August ESTUARY News for details on the selenium-sturgeon-Suisun connection).

"This is the core work the RMP was created 25 years ago to do, and still does today," says Sun. "We provide data on water quality in the Bay, and the contamination of sport fish, that is actively being used by managers and regulators to make decisions about how to control contaminants. Its direct relevance to human health is motivating."

"We hope the regulatory agencies will create risk reduction programs with and within our most vulnerable communities," says Baykeeper director Sejal Choksi. "More protective standards need to be implemented so that our subsistence fishing families are safer." ARO

MERCURY IN STRIPED BASS



Mercury concentrations (ppm ww) in striped bass in San Francisco Bay. Gray bars show average concentrations and points represent individual fish. Black line references RWQCB mercury TMDL water quality objective; red line references OEHHA no consumption threshold.

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CONSUMPTION GUIDELINES:

https://oehha.ca.gov/advisories/san-francisco-bay

www.sfei.org/documents/contaminant-concentrations-sport-fish-san-francisco-bay-2014

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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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Caspian terns

ALGAE, *cont'd from page 17*

that agencies undertake. "The bloom at Quarry Lakes' Horseshoe Lake has blown to the southeast corner," the email reads. "On Monday, there were lightly suspended... colonies that delivered greater than 20 ppb of Microcystins from our test strip kit, but we did not see anything on Friday when the winds were really mixing the water along the shoreline. On Monday and Tuesday, there were a few small specs of cyanobacteria scattered along the boat launch, but by Friday the suspended cyanobacteria was more dense."

State recommendations are to close lakes to swimming with the detection of: 6 ppb of Microcystin toxins; 20 ppb of Anatoxin-A toxins or 4ppb of Cylindrospermopsin.

"It is a scary picture," Lehman says. "People are a little worried about what is going to happen." **JC**

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MORE INFO?

www.epa.gov/nutrientpollution/climate-change-and-harmful-algal-blooms

TRADEOFFS

Quality Credits

Projects implementing water quality trading are popping up across the country, but unlike carbon trading or other air pollution credits, water quality trading credits are tied to specific watersheds. Formalized by a 2003 EPA policy, water quality credits allow authorities charged with meeting the guidelines set by the Clean Water Act room to manage a watershed more holistically by evaluating all pollution-reducing opportunities.

Locally, a water quality credit trading (WQCT) program is operational at the Laguna de Santa Rosa. The watershed drains 254 square miles of Sonoma County, which is a blend of urban areas and large swaths of agricultural land. The watershed also receives the outflow from the Laguna Wastewater Treatment Plant operated by Santa Rosa Water.

The treatment plant, in this instance, is considered a point source of nutrients in the watershed, particularly phosphorus. But the plant is already maxing out its ability to remove any more of the nutrient. "Santa Rosa has a really good treatment plant," says Kari Wester, a Project Manager with the Sonoma Resource Conservation District (RCD), which works with regulators and landowners to develop and maintain the watershed's WQCT program. "They are already removing so much phosphorous that to do more would require substantial upgrades."

Instead, since 2012, the Sonoma RCD has implemented three credit-generating projects — which are funded by the wastewater district — within the watershed to improve water quality. Two projects involved reducing nutrient-rich runoff through pasture and manure control, while the third reduces erosion and sediment loads. The projects allowed Santa Rosa Water to meet regulatory requirements and created an opportunity for landowners to improve their property. In other locations, WQCT participants might actually generate income by selling credits, but in Sonoma County, so far, the credits have generated just enough revenue to cover the cost of improvements.

The WQCT program works for the Laguna watershed, Wester says, because of some key factors: "You need a regulatory driver, a point source that has a water quality limitation, and it needs to be cheaper for them to meet a limitation by buying credits rather than upgrading." You also have to have pollutants that are appropriate for offsets. If you are dealing with stormwater then you might not find controllable nonpoint sources. But phosphorus you can reduce in other ways, like agricultural waste." **DM**

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