San Francisco Estuary Partnership

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Research

RANKING DAMS

Water managers face hard choices—among them, balancing managed flows on dammed streams with the needs of native fish. Three University of California scientists —former Davis postdoc Theodore E. Grantham (now with the US Geological Survey), Merced engineer Joshua H. Viers, and Davis fish biologist Peter B.Moyle — have developed an analytic tool to aid that process.

In a *BioScience* article, they stress the need for environmental flows—releases from dams for environment benefits — to protect endangered fish species and maintain California's rich piscine diversity. By federal regulation, some California dams are required to make such releases. Most of the state's 1400-plus dams are not, a gap addressed so far by piecemeal litigation.

Grantham and his co-authors provide a framework for ranking the importance of environmental flows, filtering by the significance of the dam, the flow patterns below it, and the presence of sensitive fish species (salmon, sturgeon, lamprey and others.) From a set of 753 large dams, they identified 181 with flows too low to support healthy populations of those fish.

Some candidate dams were on the small end of the range but significant for biodiversity: the one at Lake Anza, in Tilden Regional Park, affects 16 fish species. Huge storage dams like Shasta Dam on the Sacramento , New Melones on the Stanislaus, and Don Pedro on the Tuolomne also made the final cut. Several other Sacramento River dams and three rubber dams on Alameda Creek scored high in species richness. Only 38 of the 181 are subject to federal flow regulations. This leaves room for more vigorous enforcement of California Fish and Game Code Section 5937, which mandates releases sufficient to keep downstream fish "in good condition." The take home message, from Grantham, Viers, and Moyle: "Understanding the relative importance of dams from an ecological perspective can help set management priorities and guide the strategic conservation of freshwater ecosystems." JE

Rubber dam on Alameda creek. Photo: ACWD

CCMP CORNER

Revisionist Future

Local scientists, resource managers and agency leaders spent the last six months regrouping around a revision of the San Francisco Estuary Partnership's 1993 *Comprehensive Conservation & Management Plan* (CCMP). The CCMP was, and remains, the only comprehensive plan ever negotiated to tackle the ecological health of the entire watershed of the San Francisco Bay Estuary. It offers 205 actions to save not only the Bay, but also the rivers and delta that flow into it. But twenty years since it's first version and six since its last update, both estuarine conditions, and the political and economic context of resource management, have changed. As such, some of the CCMP's first framers have been meeting with next generation leaders to launch a new collaborative planning effort.

"Climate change and population growth are the big drivers of estuarine health and stressors this time around," says SFEP senior planner Caitlin Sweeney who is directing the revision. "This version of the CCMP responds to these drivers and focuses on the future, on what we want to see in 2050."

Committees have already met twice and discussed goals and objectives for habitat, living resources and water. The project has also begun public outreach to the larger watershed community to solicit diverse opinions about possible priorities.

"Everything is a priority for somebody, but we don't want this CCMP to take the kitchen sink approach like the last one. The biggest challenge for this version is to be strategic and focused on a smaller number of actions," says Sweeney.

Asked why this planning effort is unique, if at all, Sweeney had this response: "The Partnership enjoys broad, non-regulatory planning authority over both the Bay and the Delta. So this is an opportunity to address the entire estuary, not just pieces, and to figure out what's not getting enough attention and also what's already underway that needs more support." Sweeney says the new CCMP will flesh out some of the recommendations in the forthcoming *Baylands Ecosystem Habitat Goals Update*, for example. The CCMP revision is scheduled to debut by spring 2016. For more info: www.sfestuary.org/ccmp-revision ARO

WETLANDS DAMP WAVES

The role of salt marsh as a buffer against storm waves has been spotlighted by a unique experiment, recently reported in *Nature Geoscience*. Marshes, like dunes, mangrove swamps, and other coastal features, had been recognized as wave and tide barriers potentially important for flood protection, but hard numbers were lacking. To quantify the marsh effect, scientists from the United Kingdom, Germany, and the Netherlands, led by Iris Möller of Cambridge University, transplanted a chunk of tidal marsh from the North German coast to a 984-foot-long flume tank in Hamburg, then measured how well the vegetation — a mix of wildrye, seaside alkali grass, and fat-hen — attenuated wave energy.

They documented wave dissipation of up to 18 percent, and found that marsh plants accounted for up to 60 percent of wave height reduction. Even when waves broke and flattened the vegetation, it continued to protect the simulated marsh floor from erosion. The results, the study's authors write, "[support] the incorporation of salt marshes into coastal protection schemes, such as the Dutch 'building with nature' approach." The study strengthens the case for tidal marsh restoration in the San Francisco Bay-Delta in the face of rising sea levels and increasing extreme weather events.

The British have already responded to last winter's devastating coastal flooding by recreating salt marshes in Somerset and elsewhere. JE

SPECIES

Owl Under the Radar

While Suisun Marsh is best known for its waterfowl and tule elk, the 58,000-acre wetland is also home to an eccentric bird of prey, the short-eared owl. Grizzly Island in the heart of the marsh is the only place in the San Francisco Bay Estuary where these owls are year-round residents. Elsewhere in the region they're semi-nomadic winter visitors, tracking the voles and other small rodents they prey on. Declines in other parts of their California range have made them a state Species of Special Concern, and that seems consistent with a continent-wide picture. In a recent article in the *Journal of Wildlife Management*, a working group of US and Canadian researchers reported a uniform downward trend based on Breeding Bird Survey and Christmas Bird Count Data and state- and province-level conservation assessments. Travis Booms of the Alaska Department of Fish and Game and his co-authors recommended better definition and protection of short-eared habitats, more effective monitoring, and planning for the species' management.

That would mean managing a moving target. Biologist Matt Larson of the Montana-based Owl Research Institute, one of the article's authors, uses radiotelemetry to study short-eareds' seasonal movements, rigging females with solar-powered transmitters. Previous telemetry work in Alaska, Canada, and New York suggests that some individuals make migratory round trips like normal birds, while others don't return to their last breeding grounds. "There's probably a mix of movement strategies, nomadic wandering versus fixed migration patterns, as well as variation in local and seasonal abundance," Larson says. "They can travel great distances and show up anywhere there's suitable habitat and food." Stable populations like Suisun's appear uncommon. "There are plenty of indications that populations are closely tied to populations of voles and other small mammals," he adds.

Most owls are reclusive, but short-eareds are extroverts, sometimes hunting by day and engaging in spectacular display flights. They're the owl family's answer to the harriers: long-winged, low-cruising predators of tidal marsh and other wetlands. In flight, they can be distinguished from brownish female or young northern harriers by their dark wrist patches and the absence of a white rump. If one alights on a fence post, you can appreciate its richly mottled plumage and the black feathering around its eyes that suggests, as Hans Peeters writes in *Field Guide to Owls of California and the West*, "an exuberant application of mascara." The eartufts, technically plumicorns, are rarely seen unless the bird is in an agitated state.

Photo: Ashok Khosla

Atypically for owls, short-eareds hover while listening for concealed prey. They take the dawn and dusk shifts, flying more daylight hours when they have nestlings to feed and when high tides flush mice out of hiding.

Their courtship flights are also reminiscent of harrier displays. Males execute dizzying aerobatics, punctuated by wingclaps whose sound has been likened to the crack of a whip. Short-eareds are among the few owl species that actually build a nest with grass and feathers rather than just laying their eggs on the bare floor of a tree hollow or cliff.

The first three Suisun nests were documented in 1985. Following changes in grassland management practices in the state-owned Grizzly Island Wildlife Area, at least 39 pairs nested in 1987. Numbers have fluctuated over the years, rising with rodent booms after El Niño winters; in 2008, only five nests were confirmed. The only other known resident population in California is in the

continued on back page

THE MONITOR

Bloom Watch

More phytoplankton blooms might sound like good news for the Bay food supply at first. But some blooms can cause fish-killing dead zones or red tides, and others can churn out nasty toxins, making shellfish poisonous for people to eat, and deadly to marine mammals and fish-eating birds.

Misty Peacock, a postdoctoral fellow at UC Santa Cruz, is developing a streamlined means to identify phytoplankton toxins. She's working in concert with the U.S. Geological Survey, which will provide her with water samples from their regular monthly monitoring cruises of San Francisco Bay.

"We want to observe the seasonality of harmful algal blooms, to better understand their points of origin in the hopes of identifying management strategies for monitoring toxins in the Bay," Peacock says.

Peacock will fish for some 15 phytoplankton toxins. Her most wanted list includes domoic acid, the source of periodic sea lion and pelican deaths; microcystins, which can cause liver problems; and saxitoxin, the source of paralytic shellfish poisoning. Saxitoxin is the reason California has put out shellfish warnings since the 1970s.

Not all phytoplankton blooms are bad news. Of the roughly 4,000 species of phytoplankton, less than 10 percent grow fast enough to attain red tide densities. Of these, even fewer — around two percent — manufacture toxins.

No one knows for sure why phytoplankton make these metabolically expensive molecules. Theories range from a response to environmental stress to defenses against their zooplankton predators.

Peacock will be testing Bay water samples collected as far back as 2008. She'll collect the algae on filters and break open their cells to release any toxins inside. She'll then separate the toxins from other cell contents using liquid chromatography column, and verify their chemical structures via mass spectrometry.

"We're looking for toxins we might routinely see so we can design better monitoring programs and make optimal use of our boat time," Peacock says. The more successful she is, the safer swimmers, seafood eaters, and others who take sips of the Bay will be. KW

RESTORATION

Offers They Can Refuse

The numbers are daunting: 8,000 acres to be restored to fish-friendly tidal habitat in order to comply with federal wildlife agencies' Biological Opinions; another 65,000 if and when the Bay-Delta Conservation Plan is implemented; more still if you add in mitigation for levee operations. Where will that acreage come from? State agencies and other public entities already own some parcels suitable for restoration, but not nearly enough: the rest will need to be purchased from its current owners or covered by easements. (Eminent domain is not on the table; it's not even clear if it could be invoked for habitat purposes.) And legal constraints make buying land in the Delta harder than you might think.

Dennis McEwan of the Department of Water Resources Fish Restoration Program explains the process: "When there's a property of interest, we have a separate state agency, the Department of General Services, do an appraisal. They come up with one, we communicate it to the owner, and it's a matter of take it or leave it. We can't negotiate a price with the landowner owing to state regulations." Potential sellers often choose to leave it.

Land for restoration must be appraised at fair market value based on its current use — as cropland, pasture, a duck-hunting club in Suisun Marsh — rather than its potential for restoration. "Anything above fair market value is a gift of public funds," McEwan adds.

"The appraisal industry hasn't caught up with the restoration industry," notes DWR's Gail Newton, of the department's FloodSAFE Environmental Stewardship and Statewide Resources Office. "If the value of the property is as a duck club, that's not very much," says Carl Wilcox of the Department of Fish and Wildlife, another major player in Delta restoration. "People aren't standing in line to buy duck clubs. Someone who thinks they should be getting more has a tough time accepting that."

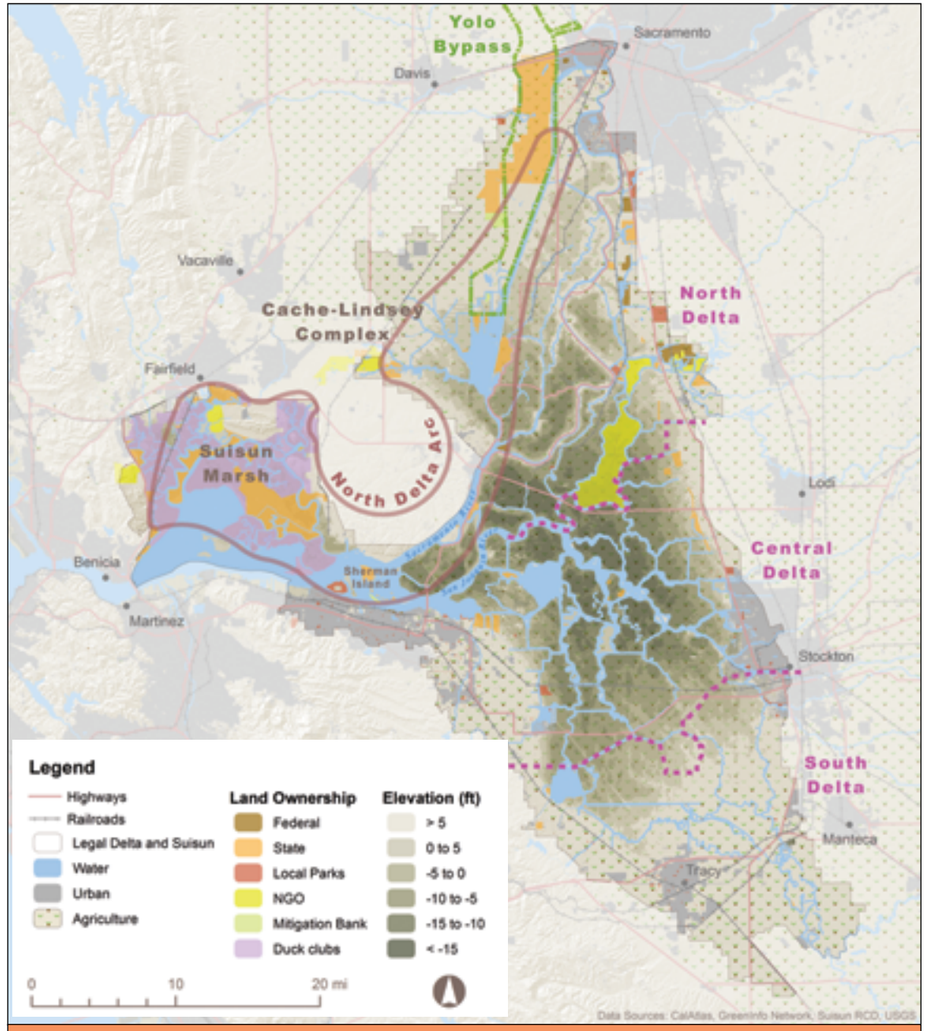
That limits options for DWR and DFW, the two largest players, both with new pots of money for restoration from Proposition 1. Land trusts and other nonprofits have a relatively limited role in Delta land acquisition. The Nature Conservancy is no longer actively seeking properties there, and other nonprofits have funding issues and liability concerns. The Delta Conservancy, a product of the 2009 Delta Reform Act, does not yet own or manage land, although that may change.

Agencies looking for land have encountered the perception that the state already owns enough acreage to meet current restoration targets. But not all Delta land is equal. "People ask us why we don't put the restoration on Sherman Island, since we own it," says McEwan. "You'd get a fifteen-foot-deep lake, not tidally influenced marsh and subtidal habitat. It's too subsided." Wilcox concurs: "There's quite a lot of publicly owned land that could be restored, but it would be expensive because of subsidence or the long-term processes involved." Other complications include proximity to infrastructure (railroads, highways, gas wells) or flood liability concerns for adjacent properties. The state agencies are also focusing more on priority areas like the North Delta Arc, including Cache Slough and the Lower Sacramento River.

Mallard Slough in Suisun Marsh (also cover photo which shows research vessel in the slough at king tide when water levels exceeded bank-full and flooded the marsh surface at Rush Ranch). Sunset below at Cache Slough. Photo credits: top & lower left: Matthew Young; middle aerial and cover Andy Bell with Phantom quad-copter.

Land purchases by private mitigation banks like Westervelt and Wildlands may have complicated things by creating unrealistic expectations of what the state should pay. "Mitigation banks do recognize the restored value of the property," says McEwan. "We can't compete with them." For agencies, buying mitigation credits from a bank could count toward restoration goals. With banks charging up to $60,000 per acre that would be another expensive proposition.

Some sellers may have nonpecuniary issues. "We haven't had anyone say, 'We'd like to sell but we don't like DWR because of the tunnels,'" McEwan comments. "We haven't seen that." The Delta Conservancy's Campbell Ingram sees distrust of state-agency intentions as a factor, though, at least in some parts of the Delta: "If you as a landowner opted to sell land for restoration, you might not be viewed favorably within that community." Such resistance is a particular issue in the South Delta, with "more larger-scale agriculture and more disbelief that it ever was tidal habitat."



The North Delta Arc. Fish friendly," in terms of the 8,000-acre restoration target, means intertidal and associated subtidal habitat. DWR defines subtidal as "permanently flooded shallow-water habitat lower than intertidal." The Delta Plan refers to "habitat for resident and rearing migratory fish". Map by Amber Manfree.

Suisun Marsh, not part of the statutory Delta but included with it for some planning purposes, is a special case. Seventy-five percent of the marsh is privately-owned, and duck clubs, some with a century of history, account for almost all of the that. There's been speculation for years that club owners, with aging memberships and high maintenance costs, would be anxious to sell. Some clubs are in fact on the market, and one that recently changed hands is being restored by the State and Federal Contractors Water Agency. There's no wholesale turnover, though. "I don't see the decline," says Steve Chappell of the Suisun Resource Conservation District. And owners might not even be attracted by higher prices: "They're tied to the land, invested in these properties. It's not like selling a tract home in the suburbs. Some were their grandfathers' property, and they cherish these places," says Chappell. Also, duck club properties are already being managed for wildlife; conversion to tidal wetland would be a change in habitat type, with concomitant winners and losers.

Where price is the sticking point, can anything be done to give the agencies more leverage? "It's a matter of working with the agencies to bring the value up significantly higher than agricultural value, while making sure it doesn't get out of hand and become a snowballing speculative free-for-all," says Ingram. "We're elevating the issue within our department, trying to come up with a potential solution," McEwan adds. "We think there might be some tools out there." Wilcox sees hope in market forces: "As time goes by and a market develops, there may be something that changes the comparable to where a little more can be paid."

Other sources of resistance may be amenable to dialogue and time. As a participant in the Delta Dialogues sponsored by Ingram's Conservancy to bring agency representatives and in-Delta community leaders together, Wilcox sees value in inclusive collaboration — and patience: "People in the Yolo Bypass get it and understand what's going on whereas in a lot of other places restoration is not really understood and viewed as threatening. Dialogue is not something that happens quickly. It requires a lot of engagement over a long period of time. People have been talking in the Bypass for 15 or 20 years, and we're finally getting to the stage where there's a lot of interest in multi-pronged projects that address flood issues in conjunction with providing fisheries enhancements and improved drainage for agriculture, all in one package." That, he suggests, might be what's needed in places like the South Delta. (See also "Defter Delta Restoration," *ESTUARY News*, September 2014.) **JE**

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STORMWATER

Beyond the Bag Ban

The other day I found myself turning out the closets for one last plastic bag. Dreaming of those white Safeway sacks as I searched for something to sequester what may well be the most toxic contaminant in the homes and cars of many a modern family: freshly used soccer cleats.

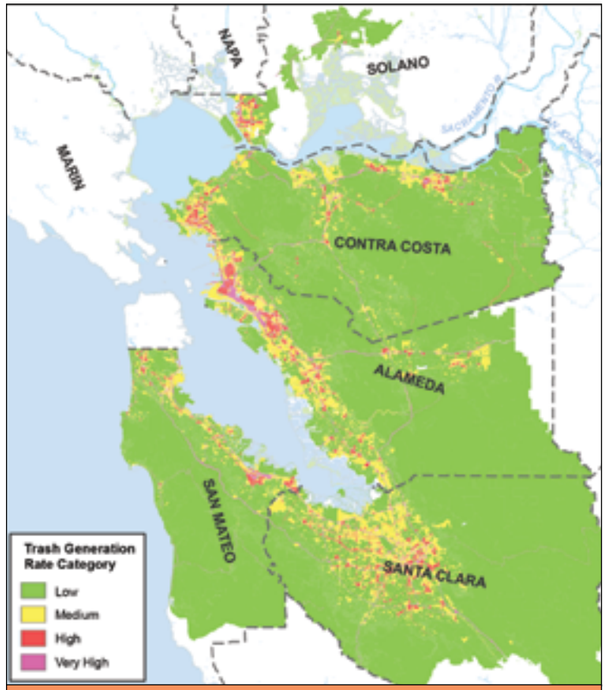
But a year into San Francisco's bag ban, there just aren't that many plastic shopping bags around our house anymore. All told, 60 percent of municipalities in the four most urbanized Bay Area counties have banned them, and 40 percent went as far as to outlaw their polystyrene counterparts, known as "clamshells" in the trade.

It's all part of a substantial endeavor by regional regulators and 76 local municipalities to stop several priority pollutants — litter, PCBs and mercury among them — from getting into our creeks and Bay via stormwater runoff. Their actions — from the bag bans to installing trash capture devices in storm drains, identifying PCB hot spots, and jackhammering concrete to make way for more absorbent greenery — have yielded measurable reductions in some pollutants. They've also yielded some lessons that could shed more daylight on stormwater management.

A San Francisco crosswalk and stormdrain during a November 2014 storm. Photo: Ariel Okamoto.

"It's no longer going to be an underground, out-of-sight, out-of-mind approach, we'll need to better integrate water quality concerns with urban redevelopment and aesthetics in the future," says Chris Sommers of EOA, Inc., a consultant for Santa Clara Valley's stormwater program.

It wasn't so long ago that the average local citizen had no idea the drain in their street led to the Bay. "Twenty years ago we were still focused on basics like controlling runoff from construction sites with hay bales and silt fences," says engineer Matt Fabry, who coordinates San Mateo County's water pollution prevention program. "We've learned a lot since then. Right now we're on the verge of another big shift in the way we think about managing stormwater. We're looking at redoing our entire urban drainage system. Since these systems took 100 years to build, we can't expect to change them overnight."



Bay Area trash generation areas. Map courtesy BASMAA.

"Municipalities and regional agencies are big ships, it can take decades to make significant changes in direction," adds Sommers. Fortunately, a major incentive in the form of the Clean Water Act forced agencies to start charting a new course.

Their first course correction began in 1990, when regulators asked municipalities to prepare urban runoff management plans and tend to tasks such as sweeping streets, inspecting drains and training city maintenance staff to go light on the pesticides. Next, the San Francisco Bay Regional Water Quality Control Board engaged them in doing their part to address regional load limits for trash, PCBs, mercury, sediment and pesticides.

Preliminary studies had shown that these pollutants were so ubiquitous across the urban landscape they required coordinated management under the nation's first ever "regional" municipal permit for the discharge of stormwater to state waters. Under the 2009 permit, 76 of the bigger urban municipalities (within Contra Costa, Alameda, San Mateo, Santa Clara counties, as well as the cities of Vallejo and Fairfield) attempted to collaborate on the task. Key to this collaboration was leadership on the part of the Bay Area Stormwater Management Agencies Association (BASMAA), support on watershed planning and trash capture from the San Francisco Estuary Partnership, and technical and scientific insight from the San Francisco Estuary Institute (SFEI).

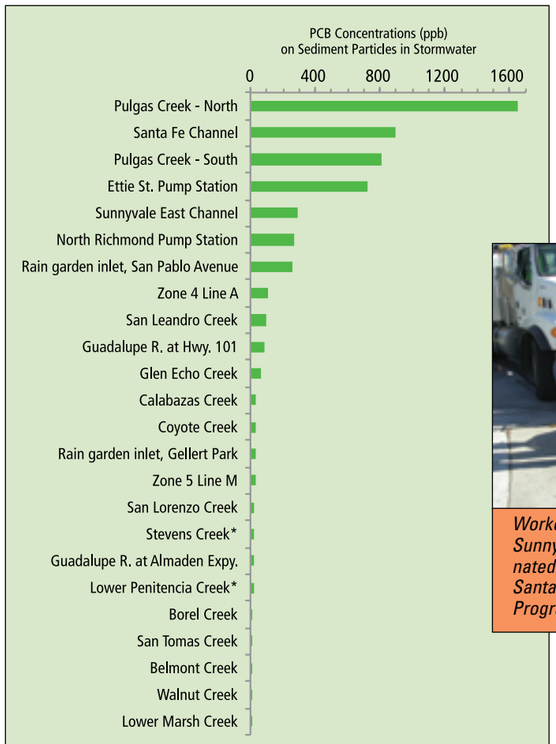
This winter, regulators are poised to propose a second five-year regional permit, now that they've seen "some but not enough" progress on staunching the flow of polluted runoff to the Bay, according to the Water Board's Thomas Mumley. "We've learned that an effective permit requires flexibility for the good actors and enforceability for the bad actors. The new permit will include more specificity and accountability."

Today, it's clear the Bay Area is both on the cutting edge of stormwater management nationwide, and faced with serious obstacles to compliance, the biggest of which may be money. "We'll give people time if they give us commitment," says Mumley.

TESTING TESTING

Under the first five-year permit, municipalities began by narrowing down which areas deserved attention. Based on samples taken from 17 bottom-of-the watershed drains through the Regional Monitoring Program, as well as on-the-ground expert opinion, half a dozen watersheds were selected for PCB and mercury experiments with a variety of management techniques and five for deeper sleuthing in the search for hidden sources of contamination.

"Generally when we go looking, we find something, and anytime you find a true source of pollution it's good for the environment," says technical team leader Lester McKee, a geologist with the San Francisco Estuary Institute. "We needed to know where to apply management techniques, which techniques worked best, and what mass of our target contaminant we could expect to capture, remove, or mitigate with our efforts."



PCBs in small tributaries tested by RMP. Chart courtesy SFEI.

Existing land use offered strong cues for where to find the most mercury, PCBs, trash, and other bad actors. "An acre of old industrial is going to produce a lot more PCBs than an acre of new residential," says Sommers. "It seems like a no-brainer, but we didn't have the data to support management action in those areas until now."

In the meantime, the permit goal was to test a variety of management approaches including ID of source properties, treatment, and inspection of industrial materials and equipment. The success of some existing programs also came under more scrutiny. Ramped up monitoring has begun, for example, to assess the benefits of an experiment in which the City of Palo Alto is rerouting half a million gallons of runoff – the first dirty flush through the storm drain after a dry spell –to its wastewater treatment plant.

One place the push for source ID led the Santa Clara Valley program to was Leo Avenue. In the storm drain running down the middle of this industrial cul-de-sac in San Jose, scientists found very high levels of PCBs (10 parts per million, 1,000 times higher than levels typically found in the Bay). The avenue abuts an old Union Pacific rail line and a dozen private properties, among them auto wrecking and recycling yards. Testing in all these areas revealed that the PCBs were coming from the rail line and the mercury from the auto yards. Given the number of unmentionables spilled or spread along rail lines, in particular dust-suppressing oils, this is not surprising. The question now is how to approach the railroad, and to tackle a source that could well ring most of the South and East Bay, let alone one little cul-de-sac. In the meantime, the City of San Jose conducted two "in-line" test clean-outs of the storm drain to remove the most contaminated sediments. Going forward, "the trick will be to find enough problem properties to achieve the additional reductions in PCBs required by the new permit," says Sommers.

Workers vacuum stormdrain in Sunnyvale to remove contaminated sediment. Photo courtesy Santa Clara Valley Stormwater Program.

Some of the sleuthing for other more highly polluted watersheds turned up a surprise – a small tributary to Alameda Creek called Zone 5, Line M with unusually high levels of mercury and flame retardants. "This tells us there must be a source upstream, and helps to confirm that our sampling design is robust enough to sort out cleaner versus dirtier spots," says McKee.

For trash, land use also offered important cues. BASMAA found that high-density retail and commercial sections of cities produce the most trash, especially those in lower income neighborhoods. Municipalities collected enough data to actually map high, moderate and low trash generation areas. The high and moderate areas currently amount to over 170,000 acres (see map). With this information in hand, municipalities launched a range of actions, from outreach to fast food restaurants to engaging youth in creating trash awareness videos to "interception."

To intercept trash on the ground before it travelled further downstream, the region installed 4,003 trash capture devices, which now "treat" more than 20,000 acres. The program, managed by the Estuary Partnership, was underwritten by a $5 million grant from the American Resource and Recovery Act. And for all the bags and foam food boxes and water bottles that still, despite these efforts, did end up in our creeks and shorelines, permittees conducted clean ups and actively supported Save the Bay and Coastal Commission efforts on this front too.

While Sommers is pleased with all the progress on trash, he sees inefficiencies. "I worry that we're spending too much time and money operating stormwater treatment facilities and trash capture devices at a municipal level, as opposed to really getting back to locating sources and changing

continued next page

behavior," he says. The latter two activities promise to come into play in a bigger way when the region attempts to comply with the next five-year permit, which will ratchet the trash reduction target up to 70 percent from 40 percent.

"Ultimately we're not asking for pristine streets, we're asking that they take their very high and medium trash generation areas and manage them so that they are all low or better. That's trackable in terms of amount of area managed," says Mumley. Such tracking might benefit from a new trash app — where citizen monitors can survey local hot spots with phone cameras.

Green LID, Bransten Avenue, San Carlos. Photo courtesy Matt Fabry

GREENING THE GREY

As stormwater so indiscriminately collects whatever's on the street or lot or yard and delivers it to the Bay, it's no wonder everyone is so jazzed about turning the acres of grey to green. Whether you call it "green infrastructure" or "low impact development," the idea is to soften up the surfaces of our cities with more soil and plants. The beauty of these landscape interventions is they not only add greenery to our cities, but also slow down runoff, let water percolate back into the ground, trap sediments, and filter more than one kind of contaminant.

Designs for green LID range from bulb outs at street corners and tree wells in sidewalks to bioswales and raingardens. In technical terms, McKee describes this new generation of water collection units as "a hole dug in the ground, either lined or unlined, usually with a perforated sub-drain at the native soil interface that has a gravel layer, a compost layer, and mulch or soil media sitting on top where plants can grow, and which drains a streetscape or industrial site."

Under the first five-year permit, municipalities added at least ten pilot projects to the Bay Area's existing green infrastructure – most of them no bigger than half a block or a hole in the sidewalk. On Bransten Avenue in San Carlos, a light industrial area identified as having high PCBs, permittees created eight pervious new bulbs along the sidewalk. While a positive first step, these small green spots cannot begin to capture and filter the runoff from the much larger private properties around them. So while greener streets can be an easy first step in a public right of way, the next step must be onto private property.

In the meantime, preliminary tests confirm that this popular dual duty kind of landscaping delivers the intended result. McKee's team has been rushing out at the first sign of rain every year to sample the water and sediments coming down the gutter into these new units and also what's coming out the other end. According to McKee, our typical Bay Area green LID units are doing a pretty good job of capturing sediment, PCBs and pesticides, and even a little lead. They aren't capturing as much mercury, however, except in the worst watersheds. "When we put green LID in a dirtier place — a place that's more industrial or has higher concentrations in the source catchment — we get better performance," says McKee.

McKee's team is currently testing a new prototype device that could enable him to collect and test stormwater from 100 rather than just 20 problem watersheds in the coming years. This passive device could save both money and staff time chasing storms.

NO PAY DIRT FOR OVERHAULS

As the second regional permit takes shape there's growing buy-in among municipalities that green LID is the preferred path to compliance, says Mumley. The challenge will be to do more of it over bigger areas with less money. One promising frontier for growth is transportation, where there has been a flurry of activity around adding bike lanes, transit options, and high-density development to combat greenhouse gas emissions. Fabry would like to see these upgrades include more porous infrastructure. "We're going to have to go out there and retrofit our roadways, which are still one of the dirtiest parts of our impervious acreage," he says. "So with such limited local funding for stormwater, and more dollars for transportation, it makes sense to make this a *walkable*, *livable* communities initiative rather than just a *water quality* initiative."

The new regional permit will likely require green infrastructure master plans for each city and county. A new SFEI tool could help identify target streets and areas for green infrastructure based not only on pollution problems but also local hydrology, land use, and available right-of-way. "Nearly every city will need to develop a plan to integrate green infrastructure into their overall development practices and city general plans," says Sommers.

In the end, like most of the big infrastructure replacement and ecosystem restoration projects biding their time around the Bay margins, all of this will take big bucks no one seems to have in local pockets. Propositions 13 and 218 continue to limit county fundraising through property-related fees or taxes, and several local measures that would have pushed the envelope have foundered. "We're not going to be able to get this multi-decadal transformation if we don't have a big influx of outside money — federal or state funds," says Fabry. "We need to come in with our local pot of money and attach it to greenhouse gas reduction dollars and cap-and-trade revenue and get it all done at same time." At least climate change and the drought have given storm water a new look as an untapped source of scarce fresh water.

Experts believe that if any reshaping of how we fund big ticket items like water supply, flood control and stormwater management is going to happen on the state level it will be within the next four years while Governor Brown is still in office.

"It's time to move beyond just trying to get people to understand that their storm drains flow right into the Bay, untreated, to building a willingness in our communities to support green infrastructure initiatives, both in spirit and with dollars," says Mumley. **ARO**

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INFRASTRUCTURE

Two-Way Threat to Intakes & Outfalls

San Francisco's vulnerability to sea level rise is no secret. Entire neighborhoods are built on fill, only feet above current sea level. But just like Treasure Island and the rapidly developing Mission Bay neighborhood, less visible parts of the city — the pipes and plants that collect, treat, and whisk away San Francisco's stormwater and sewage — are also at risk. And this critical infrastructure could face a double hit from climate change in the coming decades: more severe storms dumping excess rainwater into the system on one end, and rising sea levels and storm surges inundating pipes and facilities on the other.

"If wastewater starts flowing into the streets or into people's homes, people are going to get upset really quickly," says Pacific Institute senior research associate Matt Heberger, who coauthored a 2009 report outlining likely impacts of sea level rise on the Pacific Coast.

The problem isn't confined to San Francisco and its combined wastewater and stormwater system. According to the Pacific Institute report, 22 Bay Area wastewater treatment plants discharging a total of 350 million gallons per day could be at least partially inundated by a 100-year flood event with 4.6 feet of sea level rise, which most current projections agree could happen by 2100. The region's five largest wastewater plants, processing 60 to 70 percent of our wastewater, are all located within a few hundred yards of the shore, says Mike Connor of the East Bay Dischargers Authority (EBDA).

Still, the Pacific Institute's analysis provides only a rough picture of potential impacts on wastewater infrastructure in the Bay Area, says Heberger. It's likely that plants that now appear to be at risk would later be protected by levees or seawalls. It's also likely that plants at higher elevations could still be affected if their pipes, storage facilities, or other components become flooded, whether routinely or from isolated storm surges and king tides.

Possible outcomes include accelerated corrosion of pipes from saltwater, reverse flows of bay water into outfall pipes toward plants and other facilities, reduced flow capacity of outfall pipes, damage to electrical components, and release of sewage and hazardous or toxic materials as treatment plants, storage tanks, and other facilities are inundated or compromised.

King tides at the furthest land accessible point on EBMUD's Bay outfall, a structure not usually surrounded by water. Photo courtesy EBMUD.

"Even if the footprint of the plant looks good, the pipeline and its ability to discharge may be vulnerable," says Sarah Richmond, a planner with the San Francisco Bay Conservation and Development Commission (BCDC). "So you've got these cascading vulnerabilities that you're looking at."

Potential solutions are equally diverse. They include adding new gates to pipe ends that prevent backflows, relocating pipes or facilities, discharging treated wastewater to upland areas of marshes instead of directly to the Bay, expanding recycled-water programs so that less water must be discharged, developing decentralized systems to distribute risk, replacing concrete pipes with less corrodible plastic pipes, and building old-fashioned levees, sand-bag barriers, and concrete ramps to protect sensitive facilities from extreme events.

With so many impacts and solutions on the table, it can be difficult to know where to start — especially since scien-

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WORK SHOP

Desal's Dark Side

As Californians continue to suffer through one of the worst droughts on record, many water purveyors have turned towards desalination as a new, potential water source. In the Bay Area there has been considerable interest in desalination technology, including a joint proposal by several Bay Area water providers for a $150 million plant in East Contra Costa County that would produce up to 50 million gallons of water per day. Though desalination may seem like the ideal solution to California's chronic water shortage, a closer examination of the environmental and economic costs suggests this may not be the case.

At the Bay Planning Coalition's recent Energy and Water Nexus Summit a panel debated the benefits and risks of large-scale desalination in California. While proponents of the technology praised how desalination provides a reliable, weather-independent water supply that can offset water loss during a drought, it is the most energy intensive and expensive way to produce clean water. Sean Bothwell, a staff attorney for California Coastkeeper Alliance, argued that premature investment in desalination would be a grave financial mistake. Bothwell recounted how Australia spent $9.2 billion to build six seawater desalination plants in response to a decade-long drought in the early 2000s. Today, four of the six plants are no longer operational due to the availability of cheaper alternatives.

There are also substantial environmental risks associated with the operations of a desalination plant including the disposal of highly concentrated salt brines. If incorrectly managed, this brine could drastically alter regional salinity concentrations and endanger sensitive wetland habitats in the Bay. In addition when desalination plants take in large volumes of seawater, they capture and ultimately kill an array of aquatic organisms. While the State Water Resources Control Board is developing guidelines to mitigate these potential risks, there has been very little research conducted on the long-term impacts of such operations.

As new desalination plants continue to pop up all across California, the take home from the BPC summit seemed to be that the state should exhaust all other water efficiency and recycling projects before bankrolling desalination. **MS**

WASTEWATER

Greenlight for Fish

Every day about 90 million gallons of raw sewage arrives at the San Jose-Santa Clara wastewater treatment facility. After processing, this blend of human and industrial waste meanders through the goosenecked Artesian Slough, meets up with Coyote Creek, spills into surrounding marshlands, and eventually becomes part of San Francisco Bay. The scale of the operation is so massive that for decades, regulators, environmental advocates, and the facility's operators have been investigating the ecological impact that level of prolonged discharge has on the nearby estuarine system. What they've found is not what you might think.

This past summer, for instance, a group of researchers from UC Davis spread trawl and seine nets across the slough to see what kind of organisms might be able to survive in the treated effluent. What they found were fish. Lots of fish. And they weren't mutant fish, or the cockroach equivalent of apocalypse-surviving fish, but species that signal a healthy fishery, such as starry flounder, bat rays, striped bass, pipefish and northern anchovies. In total, during the summer seining, researchers caught thousands of fish thriving in a slough filled with 100 percent effluent from the Bay Area's largest wastewater treatment plant.

Other ecological indicators, including more salt marsh acreage and increased populations of endangered species (which are often used, rightly or wrongly, as general indicators of healthy baylands), all point to improved conditions. Birds are prolific too. But maybe the greatest indicator of an optimized wastewater treatment plant is the proximity of people willingly recreating near it. Rather than gag reflexes and pinched noises, the former salt ponds around the facility are frequently visited by people in search of open space and fresh air.

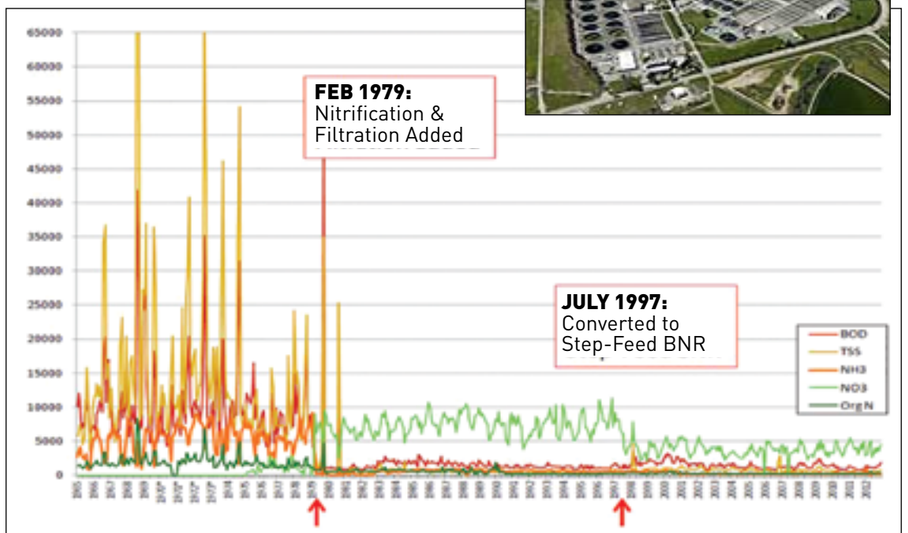
"Decades of concerns about the impact on marsh habitat resulted in the improvement of our facility to the point where the quality of our effluent is arguably the best of any wastewater discharging to the Bay," says Jim Ervin, regulatory program manager for the San Jose-Santa Clara regional wastewater facility, which processes the waste of 1.4 million people and 17,000 commercial and industrial enterprises.

Ian Wren, a hydrologist with the water quality watchdog, Baykeeper, agrees that the south bay's marine environment is improving. But about the daily freshwater flush from the treatment plant, he says, "It's obviously not a natural system, and there's been a lot of restoration in the area and that would likely play a greater role in improving the health of the Bay."

As it turns out the role played by the San Jose-Santa Clara wastewater treatment plant in the ecological health of the south bay is tied to a series of historical, economic, and regulatory changes that unfolded over the past half century. In order to better understand some of the changes over time, Ervin and his colleagues recently rescued 50-years worth of yellowing paper from a basement storage dump. On the paper were monthly records of dissolved oxygen, pH, temperature, nitrogen, and other parameters for water discharged by the facility, records dating nearly back to its opening in 1957, when its nearest neighbor was a pig farm.

"Most of it was about to be tossed out but instead we spent two years entering the information into spreadsheets," says Ervin. What they found is the slow return of basic marine ecological functions — which were pretty bad for fish in the 60s — with each plant upgrade. "Each improvement was like flipping a switch that made water quality better, and the data shows it. In the summers of the early 1960s, there used to be no dissolved oxygen downstream of the facility for weeks at a time. Now you never see that."

In 1979 the facility revamped its operation to process ammonium, a component of urine, and to increase filtration capabilities. Data from 1975 onward shows that toxic metals, such as cadmium, chrome, nickel, copper, and others, began a downward trend. Ervin attributes the pattern not so much to plant modifications, but to increased industrial regulations and a changing economy.



San Jose/Santa Clara water pollution control plant nutrient loads in effluent (kg/d), 1965 to present.

The last major upgrades at the San Jose-Santa Clara plant occurred in the late 1990s. The facility invested in biological nutrient removal, mainly targeting nitrogen and phosphorus, both of which can cause excessive algae blooms in the Bay, further robbing the marine system of oxygen. During the 1990s, regulations targeting the amount of phosphates allowable in detergents also had a huge impact on effluent quality.

Of course, the San Jose-Santa Clara facility has not been without its critics. In 1990 the State Water Board raised concerns that the facility had gotten so large and was producing so much freshwater effluent, that the output must be negatively impacting the brackish estuarine environment. For 22 years after that, or 17 studies total, the marsh surrounding the facility was documented using aerial infrared photography and then the images were ground-truthed by people. What the study found is that there are 400 more acres of salt marsh and 600 more acres of freshwater marsh than existed in 1989 (the study's baseline). "The new combination of clean fresh water and restored marshes seems to be working," Ervin says.

Lila Tang, the Chief of Wastewater Control for the San Francisco Bay Regional Water Quality Control Board, says that probably a series of factors led to increased marsh growth and improved marine habitat over the past 30 years. She says the south bay's transition from manufacturing and industrial to technology firms; changed regulations (such as pretreatment that has reduced toxic pollutant inputs); the recycling of 10 percent of the wastewater; and overall consumer conservation have all led to reductions in effluent from the San Jose-Santa Clara facility, which in turn could have improved marsh habitat.

"To the facility's credit, they have a very high level of treatment and they go way above and beyond what they have to do," says Tang. "I wouldn't go as far as to say that they are enhancing the environment, but I don't think they are harming it either." DM

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RECYCYLING

Purple Pipes for Pacifica

The first phase of a new recycled water project concluded in Pacifica this fall, after a decade in development. The Pacifica Recycled Water Project reduces potable water use through the delivery of nearly 40 million gallons annually of treated wastewater for irrigation to parks, schools, and the 417-acre Sharp Park Golf Course. And it arrives just in time for the start of year four of the worst drought in state history, with California's reservoir and groundwater reserves at all-time lows.

The project is the result of a partnership between the San Francisco Public Utilities Commission and the North Coast County Water District, which provides water to the residents of Pacifica. Sharp Park, by far the project's largest user at 30 million gallons per year, is a retail customer of the SFPUC.

The $7 million infrastructure phase of the project, completed in 2012, involved building a recycled water pump station at the Calera Creek Water Recycling Plant, 17,000 feet of distribution pipelines, and a 400,000-gallon aboveground storage tank. Federal and state grants reduced the net cost to $4.6 million out of the pockets of local water purveyors.

With the basics in place, end users were responsible for retrofitting their pipes to accept the recycled water, which receives a tertiary-level treatment and ultraviolet disinfection. Fairway Park came online in 2013, then Ingrid B. Lacy Middle School earlier this year, and finally the east side of the golf course, representing four of its 18 holes, began operating in October 2014.

Still set to connect are Oceana High School, Sharp Park west of Highway 1, and CalTrans medians along Hwy 1. According to Steve Ritchie, Assistant General Manager for the SFPUC, an additional phase of the project could add more ball fields and schoolyards in town.

San Francisco completed its first recycled water project, at the Harding Park Golf Course, in 2012 after seven years of planning and construction. Today, the SFPUC is spearheading a number of similar projects: one for the city's west side, which would produce high-quality irrigation water for Golden Gate Park in three or four years; and one for the east side, which would irrigate landscaping around office buildings and multifamily dwellings in about ten years. Still others would bring millions more gallons of recycled water per day to Daly City and San Bruno — even if the current drought has long-since passed.

"You would like to think recycled water projects could be brought on line quickly in a drought," says Ritchie. Instead it's more a matter of planning for the next one. "Project development and implementation usually takes a fair amount of time. It's just the nature of the beast."

Meanwhile at Sharp Park, manager Mark Duane says golfers have been happy to see recycled-water signs posted on the course. And once winter rains wind down, the new system should be able to deliver some particularly beautiful greens. "Next spring will be the test." Thus far, he says, "it's all good." NS

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Sharp Park golf course. Photos courtesy SFPUC.

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OWL, *continued from page 3*

state's northeastern corner. Statewide, anywhere from 50 to 500 pairs may nest in any given year.

The working group sees loss of grassland and similar habitat as the primary threat to this wide-ranging species. Short-eareds will nest in agricultural fields as well as wildlands; alfalfa is acceptable, and, according to Napa-Solano Audubon's recently published *Breeding Birds of Solano County*, they once used the sugar beet fields in the Maine Prairie region. But overgrazed pasture, vineyards, orchards, and urban sprawl are unsuitable. The wrong kind of vegetation — like perennial peppergrass, an invasive exotic that's become a big problem in Suisun since the 1990s — can degrade breeding habitat. Short-eareds are also at risk from West Nile virus, one of only four native owl species affected.

Since it lacks official protected status, wildlife agencies aren't monitoring or managing for the short-eared owl, despite its evident decline and its potential importance as an umbrella species for grassland conservation. Its success in Suisun is serendipitous — but may provide valuable lessons as management plans take shape. **JE**

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THREATS, *continued from page 9*

tists still aren't sure how far the water will rise or when. Add to that the high cost of replacing wastewater infrastructure and its long lifespan, in some cases 100 years or more, and planning becomes even more of a challenge.

Local wastewater authorities are in the early stages of thinking about it, supported in part California Climate Ready grants and regional research efforts like the Adapting to Rising Tides (ART) project.

"All the agencies are going around finding what heights all their facilities are, and which things they need most to worry about, and how they might protect them," says Connor. But immediate retrofits are unlikely; instead, the preferred approach at EBDA, the East Bay Municipal Utilities District (EBMUD), the San Francisco Public Utilities Commission (SFPUC), and elsewhere appears to be to integrate sea level rise resilience into long-term maintenance and capital-improvement plans. Practically speaking, Connor says, the big question is this: "How do we build sea level rise concerns into our design while we're simultaneously dealing with other issues?"

According to EBMUD spokesperson Abby Figueroa, "All of the climate change concerns are something that the district has tried to build into its long-term planning. As [pipes and facilities] get upgraded, thinking ahead, how do you make them last for another 50 to 100 years?"

David Behar, climate program director for the SFPUC, says the city's recently adopted sea level rise guidance document outlines how to incorporate climate adaption planning into infrastructure and capital-improvement projects — without prescribing specific solutions.

"If you're investing in assets that are going to last 100 years, the picture of climate change 100 years from now is all over the map," he says. "What you need to do is account for what is prudent to plan for today while understanding what the long-term worst-case scenario might be."

The SFPUC is already beginning to witness how sea level rise could impair its 29 discharge pipes and stormwater overflow points on the Bay. "What we've begun to see now in a way that is a nuisance but not yet a major problem is backflow of saline water from the Bay into those overflow points," Behar says. "And we know that's going to go from being a nuisance to a problem, because sea level rise is only going in one direction." **NS**

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