San Francisco Estuary Partnership

Stormwater Regs Used to Shift Homeless Away from Creeks and Towards Services

Options for Relocating or Preserving Orphan Species

Smelt and Salmon Starved for Habitat and Food

Not So Spot-On Flea Controls

ESTUARY NEWS

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Election Silver Lining

Although the results of the 2016 general election have created a stormy outlook for countless federal environmental programs and policies, Bay Area environmental advocates are slightly cheered by a handful of successful state and local initiatives that promise to benefit the Bay and local waterways.

The big win was the passage of a statewide ban on plastic grocery bags, which often make their way into the Bay and ocean. The state legislature had approved the ban in 2014, but it was put on hold when a petition sponsored by the plastics industry acquired enough signatures to put an alternative measure on the ballot. With the passage of Proposition 67 the ban will now go into effect. "This will have a huge impact," says Allison Chan of Save the Bay. "We are talking about millions of plastic bags."

In the Bay Area, voters approved several measures that will benefit the Bay, says Chan. Alameda, Santa Clara and San Mateo Counties all passed affordable housing measures that proponents say will help to reduce pollutants flowing into the Bay from homeless encampments and the stormwater pollution generated by long commutes, as well as alleviate public pressure for urban sprawl. The Alameda-Contra Costa Transit District and Santa Clara County approved measures to fund transportation improvements, and a $3.5 billion bond to upgrade BART also passed. Advocates hope these measures will get people out of their cars and reduce their carbon and pollution footprint. Berkeley and Oakland voters also approved bonds to fund investments in infrastructure, including housing, streets and sidewalks, parks, and the use of green infrastructure, such as permeable pavement to help filter stormwater, and rainwater capture and reuse.

"I think this is a hopeful outcome," says Chan of these election results. "Despite what's happening at the federal level, voters showed that we are going to support our quality of life and our environment here in the region." **CHT**

MORE INFO: http://blog.savesfbay.org/2016/11/election-2016/

IMPRESSIONS

A Harry Potter View of SLR

As a recent graduate entering the climate workforce, I have realized that choosing a climate change focused career is like choosing to be Harry Potter. You are accepting a mission to save both the climate in-the-know and deniers from an evil so dangerous all could be lost. Like Harry, we must acknowledge that working together produces stronger results. Climate change work should reflect the interdisciplinary collectivism needed to save our planet, whether it's supporting public transportation or negotiating global carbon emissions agreements like the 2015 COP21 Paris Agreement. Attending an event like the annual meeting of the Bay Science Collaborative this past September gave me hope that we can create a better future than the bleak one I spend my days trying to understand.

This year's theme was *Sea level rise: communicating and connecting science to the design of nature-based adaptations.* The structure of the collaborative event, now in its second year and organized by the Romberg Tiburon Center for Environmental Studies (RTC) at San Francisco State University, included lightning-round seven-minute talks followed by speaker-led round table discussions (see video). It offered a forum for scientists, policymakers, journalists and students to share their research and thoughts on climate change in the region, in essence connecting specific fieldwork to a network of Harry Potters.

I arrived at the RTC, which sits on the edge of the Tiburon Hills, in time to see the beautiful golden morning light awakening the Bay. On that day, the RTC became the Hogwarts of bay-delta science and communication on sea level rise. The morning coffee room was quiet yet full of people not sure what to expect. This sleepy nervous energy soon became electric as the coffee kicked in and the morning session got off to a running start.

The opening talk left a lasting impression on me. In it, Andy Gunther described using maytagging, or the sense of impending doom when a monster wave approaches surfers, to communicate about carbon dioxide levels and climate change to elected officials from San Diego. I am not a surfer, but this visual example helped me understand exactly what he meant. Gunther emulated Remus Lupin, known for wise communication and talent as a Hogwarts professor.

I spent the rest of the day listening to a dozen other talks and slowly piecing together the connections between the who's who of the Bay Area climate adaptation world. To go back to my Harry Potter analogy, I did feel like an incoming first-year who hasn't been sorted yet into a Hogwarts House (their equivalent to fraternities) by the Sorting Hat. Luckily, I did feel the collaborative format encouraged socializing and discussion, helpful in my quest to settle on a climate change focus.

Ellie Cohen's Dumbledore-esque concluding talk also deeply inspired me. Cohen encouraged scaling up climate smart solutions and taking risks in order to speed up the transition to a clean energy future. Cohen laid out current climate science, pointing to recent photos of once white, but now black, mountain peaks in melting Greenland. However, she also oozed optimism and enticed us with climate solution news headlines from sustainable futures in 2046 and 2066. Just as Harry needed Dumbledore for support and guidance, we need people like Cohen to be our Bay Area climate cheerleaders.

Attending the 2016 Bay Science Collaborative reinforced my sense of urgency to act and adapt. Now more than ever, it seems this Harry Potter analogy has become our reality. Our bay will rise; in response, we too must rise. Let's not let divisions and setbacks ruin our drive to create an equitable resilient future. **TO**

Author Tira Okamoto is 23 and interested in climate justice.

Video of Event Sessions: youtu.be/qv6YGcERBZw

STORMWATER

Urban Jungle Inspires Unique Regulatory Tack

California has nearly one-quarter of the nation's homeless people—the most of any state by far—and thousands of them live in the Bay Area. Many are in outdoor encampments that lack basic services most people take for granted, including clean water, sewer hookups, and garbage collection. Human waste and the pathogens in it are untreated, and refuse piles up and escapes.

And, out of all the social and environmental costs of homelessness, the trash that blows from encampments into waterways may help spur a solution to this problem in the Bay Area. Under a new resolution by the San Francisco Bay Regional Water Quality Control Board, trash from homeless encampments now falls under the stormwater permit that requires Bay Area cities and counties to get storm drains virtually trash-free by 2022.

"I was personally shocked that the homeless problem was going to be addressed through the stormwater program—that this was the strongest regulatory driver," says Brett Calhoun, a Santa Clara Valley Water District (SCVWD) water quality specialist.

Bay Area efforts to keep trash out of storm drains, and so out of streams and the Bay, began in 2009. However, cities soon recognized that homeless encampments are another major source of trash in waterways. "Creeks have become a haven for homeless people to hide from society," says Tom Mumley of the regional water board. "If you pick a stream adjacent to an urban area, you're generally going to find an encampment there."

But it probably won't be obvious. Take the stretch of Coyote Creek that winds along Wool Creek Drive in the City of San Jose. From the curb, it looks like a nature reserve. It's thick with oaks, sycamores and willows, and birds sing high above. But a single step into the ribbon of trees is all it takes to see what they hide: a homeless encampment. Rough stairs cut into the ground, leading to a tent site carved into the stream bank, resembling a small cave. The earthen wall provides shelter from the elements and hides the site from view of the elementary school grounds across the street.

The land slopes steeply down to the creek, and a sycamore stands between the tent site and the slope. While this makes the site feel more secure, the tree's unseasonably brown leaves say it's dead or dying. The understory plants, which shelter salamanders and other ground-dwelling animals, are gone. And the stream bank is badly eroded. One good rain will wash loose soil down the slope and into the creek, where it will clog and bind gravel like cement. Steelhead in the creek need loose gravel for laying eggs as well as for overwintering fry habitat.

This encampment is vacant, except for the eye-popping amount of trash left behind. Layer upon layer of food containers, cardboard boxes, fabric, plastic bags, and refuse too matted and weathered to recognize. The stream bank is littered all the way down to the water, so that heavy rain will also wash plenty of trash into the creek.

Due to a combination of open waterways and sizeable homeless populations, streamside encampments are particularly common in Contra Costa County, Oakland and San Jose, and all three municipalities are addressing the issue. Contra Costa County cleans up encampments in flood control channels along streams, for example, while Oakland closes more than 100 encampments per year and prioritizes those within 250 feet of waterways. So far, however, only San Jose is participating in a formal plan to clean up trash from homeless encampments under the stormwater permit's new provision, along with partners including the SCVWD and Santa Clara County.

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Trash in Walnut Creek and stormwater channel. Photo courtesy Contra Costa Flood Control and Water Conservation District.

The San Jose area also has the largest homeless population of the three municipalities. According to the Annual Homeless Assessment Report to Congress, in 2015 Santa Clara County was number eight nationwide for homelessness—6,556 people lacked housing during the cold of winter—and number three for chronic homelessness. Most of the county's homeless live in San Jose, where the relentless rise in rent drives people out of their homes, according to a 2014 report by the San Francisco Center for Economic Development.

The two waterways that meander through the heart of San Jose —Coyote Creek and the Guadalupe River—are a haven for the homeless. "The city has a small urban core that's bookended by riparian corridors, which let people stay out of sight," says Ray Bramson, who manages San Jose Housing Department's Homelessness Response Team. He has worked to help the homeless since participating in AmeriCorps in North Carolina right out of college: "People were living on the streets—I saw a terrible need."

Historically, when the city cleaned up encampments along creeks, people moved right back in. "Just going in and picking up garbage doesn't go to the core of the issue for keeping creeks clean," Calhoun says. "Source control is a better approach." So officials sought a long-lasting solution to encampments. "The question was how to get homeless people permanently out of creeks," Bramson says.

In 2011, City of San Jose began testing a possible answer: combining encampment cleanup with social services for the people living there, including individualized help, job placement, and housing. The million-dollar pilot program, funded largely by a grant from the U.S. Environmental Protection Agency, took four years and focused on the largest encampment in San Jose and, according to news reports, the entire country.

Dubbed the Jungle and notorious nationwide, this encampment initially had 176 people living along a stretch of Coyote Creek that runs between two large parks. Once the people were out of the riparian area and into the social services system, it took more than two weeks to deal with the mess they left behind. Cleanup crews removed 618 tons of debris; 2,850 gallons of bio-waste; 1,200 needles; and 315 shopping carts. The final step was keeping homeless people from moving back in: park rangers, who are police officers, patrol the area to deter entrenched encampments.

Crews clean up a San Jose area encampment. Photo courtesy City of San Jose.

Building on this successful approach, City of San Jose and its partners established an encampment cleanup program under the stormwater permit. It's a big job. More than 1,200 people lived along the city's waterways in 2013. While that was down to fewer than 800 last year, it's "still an enormous number," says Bramson. Last year workers cleaned up 158 encampments along the city's 140 miles of waterways.

Just a mile from the encampment with the cave dug into the streambank, cleanup is underway at another encampment along Coyote Creek near Tully Road. It's flanked by a community garden on one side and by a library, elementary school, and baseball diamond on the other. The streambank is terraced into two levels of tent sites, which extend through the trees far along the creek. There are also toilet pits. The air smells sour and jumbles of trash are everywhere. Take-out cups, cereal boxes, bread bags, sheets, foil packets, wads of paper, tarps and so much more. It's overwhelming.

A crew wearing gloves and heavy boots hauls furniture—mattresses, metal bedframes, an olive green couch, a black office chair—into a sanitation truck. Paramedics stand by in case of injury, needle sticks, or exposure to human waste. Park rangers and their police vehicles stand by in case of trouble.

At the far end of the encampment, a man and woman have packed what they can into crates but have yet to vacate. Dozens of other people stand in a nearby parking lot, surrounded by bicycles, and trash bags and shopping carts full of belongings. "They'll move right back in," Calhoun says. A park ranger says that as the program reaches homeless people who want help, encampments can become concentrated with difficult cases. This encampment, he adds, is hyperconcentrated with methamphetamine users who have refused social services.

To understand the homeless population better, the Contra Costa County Flood Control and Water Conservation District commissioned a 2013 UC Berkeley study on encampments along waterways. "We wanted to know why people were setting up camps in our creeks under bridges," says hydrologist Mark Boucher. Perhaps surprisingly, the study found that privacy rather than water is the main draw. "Usually when they don't bother people, people don't bother them," he explains.

Along with job loss and skyrocketing housing costs, substance abuse and disabilities are common causes of homelessness. For all the complexity of the causes, however, homeless people obviously have something simple in common: they need homes. Demand far outweighs available resources but new funding is in the works. A state initiative called "No Place Like Home" was signed into law in July and will provide $2 billion for housing for people who are chronically homeless due to mental illness. And Bay Area voters authorized several measures in November that will house the homeless. A sales tax will provide $1.2 billion for homeless housing and services in San Francisco, and bonds will provide $580 and $950 million, respectively, for affordable housing in Alameda and Santa Clara counties.

Last year's Homeless Census & Survey found that 93% of respondents in Santa Clara County want permanent housing. "We need to help these people live a better life than along creeks," says Calhoun. "It's not where they want to be either." **RM**

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H A B I T A T

Banking Fish Food?

Delta smelt and Chinook salmon living in one of the world's most productive agricultural regions are not getting enough to eat. Scientists now believe this shortage of food is a significant factor in both species' dramatic decline in recent decades. But a pair of experiments designed to improve food supplies for the fish have shown promising results to date, and could soon be implemented on a larger scale.

The problem is a simple one. Confined between levees and disconnected from its historical floodplain, the Sacramento River has few opportunities to slow down, warm up, and promote the growth of algae that fuels the food web. "Levees cut off the river and Delta aquatic ecosystem from its food supply, which is primarily made on shallow floodplain and tidal marsh habitats," wrote California Trout senior scientist Jacob Katz in an email.

The two experiments aim to ameliorate this ecological insult and curb population decline by diverting flows from the main river channel onto the Yolo Bypass between Sacramento and Davis, where the water can spread out and spawn a phytoplankton bloom. While this has been demonstrated so far only on a trial basis, Katz hopes more permanent changes are on the horizon.

"There is widespread acknowledgment among scientists working in the field that endangered fish populations like salmon and smelt are literally starving," he wrote. "But it takes a while for the science to penetrate into policy."

Just this fall, scientists assessing the state of Bay-Delta science concluded that the Delta's aquatic food web bears little resemblance to that which existed prior to 1850 and no longer sustains native species. In a science summary for policymakers called *The Delta on Fast Forward*, the authors suggest "any actions to improve conditions must be taken in light of this new food web structure."

The Delta smelt may not have much time left. The species is on the brink of extinction, with only thirteen adult individuals identified by the California Department of Fish and Wildlife (CDFW) in its most recent spring survey. The 2015 survey identified 88, itself a record low. The next few years are likely to bring either the turning of the tides or the fish's complete disappearance.

In a last-ditch effort to save the smelt, this June a coalition of California and federal agencies — including the CDFW, California Department of Water Resources (DWR), U.S. Fish and Wildlife Service, and U.S. Bureau of Reclamation — announced an ambitious new plan called the Delta Smelt Resiliency Strategy.

Designed to be implemented more or less immediately, it recommends a variety of measures to improve smelt habitat and survival, including removing invasive aquatic weeds, reducing toxic algae blooms, and adding sand to spawning areas. It also calls for augmenting summertime food supplies by diverting pulses of water released from Lake Shasta through an extended wetland and tidal slough corridor to promote plankton production.

Over two weeks in July, agencies and water districts cooperated to send 12,000 acre-feet of water from the reservoir down the Colusa Basin Drain, through the Yolo Bypass, and into the Delta. Scientists led by Ted Sommer and Jared Frantzich of DWR measured phytoplankton levels in the Rio Vista area of the lower Sacramento River and discovered a tenfold increase associated with the water pulse.

Researchers count juvenile salmon to be placed into experimentally flooded rice fields in the Yolo Bypass (background). Photo: Carson Jeffres

"This was a very different and creative approach to target specific habitats to generate a food bank," Sommer says. "We know that food is a key issue for this fish, so this opens the door to really targeted management." Yet finessing and expanding the program in the future will hinge on getting more water, Sommer says. "We have evidence that we can generate a positive benefit, even if it only happens in some years."

Elsewhere along the bypass, on rice fields left fallow over winter, a second project has had similar success generating food for hungry fall-run Chinook salmon on their way to sea. The idea is to leave floodwaters on certain fields — 18 acres and counting, as more rice farmers opt to partici-

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FISH FOOD, *cont'd from page 7*

pate — for an extra two or three weeks to allow plankton to bloom and fish to fatten up before returning to the river.

Dubbed the Nigiri Project for its marriage of salmon and rice, the project is grounded in research Sommer began on the Yolo Bypass 20 years ago and is administered by DWR, California Trout, and UC Davis. Experiments to date using hatchery fish and managed floods have proven the concept not only sound but wildly successful. This past February, in the program's fifth year, a cross-sectional experiment comparing zooplankton density and fish growth at three river locations — the rice fields, the main channel, and one place in between — showed the fields coming out far, far ahead.

Juvenile fish that are larger when they enter the ocean have better odds of returning as adults, said Carson Jeffres, leader of the UC Davis research team. "Ultimately our goal is to have wild fish recruited onto these fields during natural floods that happen more frequently."

Rains last winter led to the project's first natural flooding event — and thus the first opportunity for non-hatchery fish to benefit — but additional modification of river and bypass infrastructure could eventually allow migrating salmon easy access on and off the rice fields at multiple times each winter.

"The Nigiri Project's findings are simply summed up as, 'The fish food is on the floodplain,'" noted Katz. "That take-home is the same for Delta smelt, Chinook salmon, and many other fish species in Central Valley rivers and the Delta that are starving." **NS**

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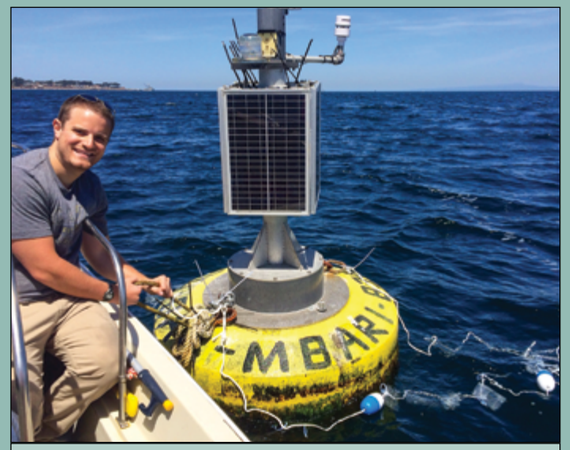
HARD SCIENCE

The Olfactory Trap

As plastic waste accumulates in the world's oceans, more seabirds have been swallowing it. UC Davis researchers say the avians are deceived by chemical signals that reliably led their ancestors to tasty krill and other crustaceans.

When krill and other organisms start to graze on marine algae, the latter produces dimethyl sulfide (DMS): this alarm signal draws hungry birds. Graduate student Matthew Savoca says some of the algae is now growing on floating plastic, and generating DMS as they die. The resulting smell is an olfactory trap, leading birds to ingest plastic, Savoca and co-authors propose in a recent article in *Science Advances*.



Deploying experimental plastic debris at a buoy in Monterey Bay. Photo: Matthew Savoca

The underrated avian sense of smell can be crucial for birds that need to locate food sources at sea. Many species from the seabird order called procellariforms (or tubenoses) — which includes shearwaters, petrels, and albatrosses — have a particularly keen olfactory sense. Some birds also appear to recognize individuals by scent, giving olfaction a role in sexual selection and pair bonding.

To test the suspected olfactory trap, Savoca and Davis animal behavior professor Gabrielle Nevitt teamed with the Robert Mondavi Institute of Food and Wine Science. Savoca placed polyethylene and polypropylene beads in mesh bags off Bodega Head and in Monterey Bay for three weeks. The Davis food and wine lab, using equipment normally employed to detect the sulfide compounds that can make wine and beer skunky, confirmed the particles were giving off DMS. "What better people to collaborate with than food scientists who study how people make decisions about what they eat and drink?" he adds.

Results suggest that sooty shearwaters, the most abundant seabirds in the California Current System during the northern summer, are attracted to DMS. In addition to blocking their guts, a Japanese study suggests plastics can build up in the fatty tissues of shearwaters, causing sublethal damage. The sooty shearwater, despite its enormous

Photo: CSIRO

global population, is listed as near threatened by Bird Life International. Savoca says sooties could be picking up plastic almost anywhere along their immense annual circuit of the Pacific.

Results also suggest that the Laysan albatross, something of a poster child for plastic waste ingestion, is not DMS-responsive, using a combination of vision and other scent cues to home in on food. Laysans favor flying-fish eggs, however, which the fish often attach to plastic substrates.

It's not just birds: fish — including the gigantic whale shark — and marine mammals also use DMS in navigating the chemosensory seascape. With global plastic production doubling every 11 years and densities of 580,000 pieces per square kilometer in parts of the ocean, the ecological ramifications stink. **JE**

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Science Advances article (open access) http://advances.sciencemag.org/content/2/11/e1600395

E N D A N G E R E D

Options for Estuary Orphans

Off a bustling Delta highway, next door to a branch of the California Aqueduct, sprawls a tidy collection of shipping containers, humming pumps, and cylindrical tanks. Paved in cracked asphalt and encircled by chain link fencing, it resembles any number of light industrial sites at the margins of many communities.

In fact, this resolutely artificial place is devoted to preserving a disappearing piece of natural California: the Delta smelt.

"Our fish are a refuge population," says Tien-Chieh Hung. Director of the UC Davis Fish Conservation and Culture Laboratory, Hung oversees this two-acre facility on the outskirts of the tiny town of Byron.

Opened in 1996, the facility was initially charged with producing Delta smelt for experiments. It took a decade for researchers to replicate the fish's life cycle in captivity. "We joke that it dies if you look at it the wrong way," Hung says.

Now, with smelt production down pat—"we might have more Delta smelt here than in the wild," says Hung—the facility is shifting directions. That's why Hung has recently divided the facility in half; fish on one side are destined for science, while those on the other are what Hung calls "a living gene bank."

Another way to think about cultivated smelt is as an insurance policy. Should the unthinkable occur, and Delta smelt are no longer viable in the Estuary, this refuge population could someday be reintroduced to the wild. In that way, they would be like finny versions of the California condor, maintained solely in captivity for years until conditions were right to release them again.

PLAYING GOD — Maintained by humans outside of its natural habitat for conservation, *Hypomesus transpacificus* could be the first of a number of Delta species on artificial life support.

In this December's issue of *San Francisco Estuary and Watershed Science*, three eminent scientists report that "it is increasingly irresponsible to focus entirely on a policy of in situ conservation through habitat protection and restoration." Conditions in the Delta are so dire, write Michael Healey of the University of British Columbia, Michael Dettinger of the U.S. Geological Survey, and Richard Norgaard of the University of California, Berkeley, that "alternatives to conservation in place" should be explored for the Delta's most endangered native species. These so-called "orphan species" include winter-run Chinook salmon, green sturgeon, Lange's metalmark butterfly, and the salt marsh harvest mouse.

"The longer the delay, the harder the decisions, and the less likely they are to produce positive results" the authors warn.

"There's still this big desire to maintain species in the location that they currently exist. I'm all in favor of that, but it's time to start asking the 'what if' questions. What if we can't do that? What's Plan B?" asks author and salmon expert Healey.

Smelt culture tanks and director Tien-Chieh Hung at the UC Davis Fish Conservation and Culture Laboratory near Byron. Photos pp.7-8: Kathleen M. Wong

The "alternatives" they propose run the gamut from tame to radical. Some are extensions of accepted practices conducted for conservation purposes. Others require a level of human intervention that is nothing short of heroic. But all seem destined to become a hallmark of conservation biology in the Anthropocene.

"The ecosystems of the Delta are classic examples of a habitat totally dominated by humans. We're responsible for making it work, or not," says Peter Moyle, emeritus professor with UC Davis. "The only way it's going to be good for native fish is if we want to make it so. We can play God."

A POLDER FOR DELTA SMELT — With a refuge population near Byron, and a second backup population at the Livingston Stone Hatchery below Shasta Dam, Delta smelt might seem secure for the time being.

But in a hatchery, smelt get domesticated fast. Its one-year life cycle leads to brothers mating with sisters. To keep the small population at the fish culture diverse, scientists genotype all candidate parents, breed many two-year-old fish, and catch up to 100 wild smelt per year for the program. Without a source of wild genes, says Moyle, "you wind up with a very domesticated population unless you quickly figure out how to reintroduce them into the wild, at least experimentally."

To maintain a wild smelt population, one option is relocating cultivated fish to a flooded Delta island, or polder. Isolated from predators, awash in food, this refuge population would serve as insurance should wild populations go extinct.

More interventionist yet would be intensive, landscape-scale habitat management. "We've failed trying to manage the entire Delta for smelt. So we want to concentrate our efforts on making this arc of habitat from Yolo to Suisun Marsh a more natural estuary, but not try to do that for whole Delta," Moyle says. With a number of restoration projects already underway in the

continued to next page

ORPHANS, *cont'd from page 7*

so-called North Delta Arc, this option could aid other native fishes such as tule perch, lampreys, and sturgeon.

CALIFORNIA SALMON...IN CANADA? — While ecosystem conditions threaten smelt, climate change poses the primary problem for far more species. As rain and snowpack decline, plants such as oaks and redwoods might see their ranges contract. A hotter climate will exacerbate drought conditions. And as sea levels rise wetland species like the salt marsh harvest mouse could get inundated.

Winter-run Chinook is one species considered at risk from a hotter climate. Spawning in summer when water temperatures are at their warmest, this salmon requires cool water from Shasta Dam for its young to survive. "Another five- to seven-year drought and there will be no cool water pool in Shasta Reservoir," says Healey. "They are really in a tenuous position."

To preserve this genetically distinct salmon, Healey proposed a case of assisted migration: relocating the fish all the way to the Arctic Circle. In virgin watersheds newly exposed by receding ice, it could access plenty of cold water. Certainly people have had lots of experience moving fishes to new areas; witness the longstanding programs to stock Sierra Nevada lakes with trout.

Healey argues the difference between assisted and natural migration is merely a matter of degree. "We're really talking about resisting a process that's going to happen anyway," he says. The Pacific is expected to serve as a corridor for anadromous species such as salmon and sturgeon to colonize cooler northern climes.

The time to act, the report scientists say, is now. "You need to generate the willingness on the part of the policymakers and all the people involved. Plus you need to develop the scientific foundation to carry it through. So if you wait until the last lonesome individual is teetering on the brink, it's too late," Healey says.

UNCHARTED TERRITORY — Not so fast, argue other scientists. "Alternative conservation" measures are phenomenally costly, raise a raft of ethical and political questions, and could even sap the public's will to make the Delta ecologically healthy again.

One issue with assisted migration is that it upends the idea of species being integrally connected to habitat. The Endangered Species Act defines each species in part by its "unusual or unique ecological setting." In other words, a species is inseparable from its habitat.

In the case of winter-run Chinook, fish moved to the arctic will be on a completely different evolutionary trajectory than their Delta relatives, and would no longer be considered protected under the current language of the ESA.

"What those objections ignore of course is that these habitats are changing dramatically as a result of climate change, and species already in the Arctic might not be able to survive that transition," Healey says.

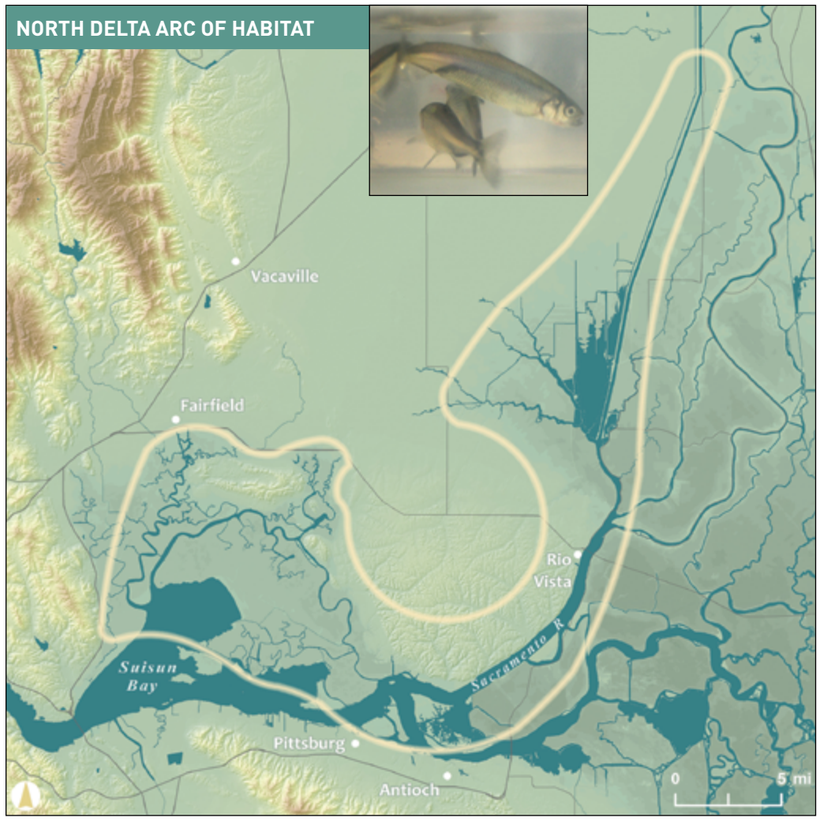
AN ETHICAL CONUNDRUM — Salmon and smelt are hardly the only organisms that could require intensive human intervention to survive. With a finite amount of political will and funding to devote to conservation, society will have to prioritize which to aid, and which to leave to their own devices.

"We probably won't be able to preserve every species unique to the Delta by any of these techniques. So there's going to have to be some triage. Which ones will we invest in and which ones won't we? These are going to be really hard discussions," Healey acknowledges.

"It goes right to the heart of what conservation is all about. Is it most important to save every species? Preserve the functioning of natural ecosystems? What is our objective?" says John Wiens, former chief scientist of The Nature Conservancy.

"We need to stand back and have some thoughtful discussion about what we're really trying to achieve in conservation and management of these populations. Because if we don't do that, then we're going to get caught by the speed of change and find we haven't really used our resources wisely and achieved as much as we could," Wiens says. **KMW**

CHECK OUT our extended story online, including specific examples of alternative techniques. www.sfestuary.org/estuary-news/



Map: Amber Manfree

E N G I N E E R I N G

Fishway Under Freeway

When the state built the I-80 freeway in the 1950s, they put Pinole Creek in a 400-foot-long double box culvert below, creating an obstacle for migrating steelhead. After that, only a rare, super fish or two from the Bay could swim upstream to better spawning habitat. A resident population persisted, but the natural connection between the Bay and creeks for migrating fish waned.

"Every once in a while we'd see evidence of spawning," says Bert Mulchaey, East Bay Municipal Utilities District biologist. "We knew the problem was the culvert." His agency has been monitoring the mostly-resident steelhead population for 20 years within the Pinole city limits and EBMUD's property higher in the watershed. In 2016, the steelhead finally got a new low-low channel ("fishway") to take them through one of the twin culverts.

The fishway (another term for fish ladder) was one of the goals identified in a multi-stakeholder, consensus-based vision plan for the watershed in 2001, but the culvert had been on local watershed activists' and biologists' to-do lists for years prior. Feasibility studies and habitat mapping had to be completed to convince resource agencies and funders that both the habitat and the steelhead population were viable. And funding had to be cobbled together from several sources.

Ultimately, the Contra Costa County RCD stepped in to facilitate, raising the money and working with stakeholders to finesse the design. The price tag—including feasibility studies, design, permits from multiple agencies such as the Contra Costa County Flood Control District and Caltrans, and construction — came to just under $1 million, says the RCD's Ben Wallace. "There were a lot of cooks in the kitchen and several iterations of design over the years, but [the outcome] is a shining example of good partnership," he says. "It required everyone to go above and beyond their obligations."

Engineer Mike Love says there are two pieces to the fishway design. Downstream of the box culverts, he used boulders and smaller rock to create hydraulic diversity. This helps raise the water level at the mouth of one of the culverts and backflood the first half of the culvert. Crews then cut a 175-foot-long, low-flow channel in the concrete bottom to help fish navigate a tricky grade differential. The low-flow channel is a foot-and-a-half deep and five feet wide within the 10-foot-wide culvert (see photo inset). Angled baffles help slow the water and aid fish passage through the culvert. "The real challenge was that we didn't want to raise flood waters and reduce the capacity of the culvert," says Love. The other culvert was left in place to absorb very high flows.

The Friends of Pinole Creek, who formed decades ago out of concern for the creek's fish, will monitor the baffles and make sure nothing blocks passage. In the meantime, Mulchaey is hoping larger fish from the ocean will now make their way up the creek, helping bolster the resident population, which has been hard hit by the drought. "We'd like to see the steelhead from the Bay bring the energy they collect out in the ocean into the creek ecosystem," he says.

In addition, when steelhead arrive in any urban creek, people see them and want to protect them. "If we give these fish the opportunity they can persist in the Bay Area," says Mulchaey. **LOV**

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Dehydrated Estuary

Orcas probably aren't the first thing that come to mind when people think about the Estuary. But a new report called *San Francisco Bay: The Freshwater-Starved Estuary* highlights how the ongoing lack of freshwater in the system is causing whales off the coast to starve—and the entire estuarine food web to decline, ultimately affecting commercial fisheries and humans as well.

Orcas specialize on Chinook salmon, which are dwindling as freshwater flows into the Estuary decline. Similarly, forage fish like the smelt, salmon, and shrimp that are critical food supply for larger fish, birds, and mammals, including humans, are also collapsing.

"Flows affect productivity in the food web," says The Bay Institute's Jon Rosenfield, the report's lead scientist. Ongoing droughts have not helped, he says: the wet years that used to be somewhat common are now exceedingly rare from the point of view of fish and wildlife in the Estuary; the droughts that used to occur occasionally now occur almost 50 percent of the time, due to freshwater diversions upstream. "If you're a fish in the Bay or you're a bird trying to eat those fish, it has been a 1977-style drought for half of the last 40 years," says Rosenfield.

The report also analyzes myriad other impacts on the estuarine ecosystem caused by lack of freshwater flows, from pollutants and nutrients being overly concentrated in certain areas to increased toxic algal blooms. Other impacts detailed include damage to commercial and recreational fisheries and reduced sediment transport, via flows through the Estuary, which helps nurture wetlands downstream.

"We're spending a lot of money to restore and protect wetlands and beaches around the Bay. We're even bringing dump trucks of sand and sediment to these places. Mother Nature could do this work for us, but we're not letting her," says Rosenfield.

The new Bay Institute report, sponsored by the Estuary Partnership, was published just before the State Water Board released new documents related to its Bay-Delta Water Quality Control Plan Update. Phase I of the update focuses on flow requirements for the

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MONITORING

The Dirt on Flea Control

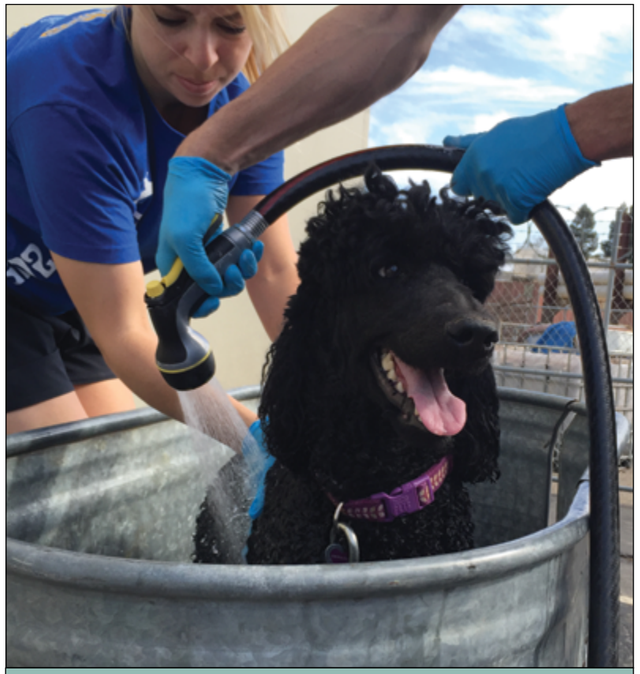
It's hard to go to the big box pet store and not stumble over the flea control displays. Most pet owners have dabbed or squirted Frontline or Advantage between their cat's shoulder bones or onto the back of their dog's neck, but who would guess this same chemical would make its way off our pet's fur, down the drain, through wastewater treatment, and into the Bay? Apparently all the petting and shedding and subsequent washing of hands, doggies, and floors is moving flea-killing chemicals into our household wastewater, and the treatment plants aren't getting it out again.

"Sewage treatment plants were not designed to treat and remove all the industrial chemicals we are now using in our homes," says Kelly Moran of TDC Environmental, one of a group of scientists, regulators, and dischargers collaborating on a new study conducted under the Regional Monitoring Program (RMP).

The study monitored two ingredients in common "spot-on" flea killers – fipronil and imidacloprid – during drought conditions at eight wastewater treatment plants around San Francisco Bay. Scientists tested both the "influent" and "effluent" of the eight plants, which ranged in size, location and treatment technology. Regardless of how advanced the treatment, very little, if any, of these pesticides were removed.

"Many of us had thought spot-on treatments were relatively benign," says the San Francisco Estuary Institute's Rebecca Sutton, the lead scientist for the project. "These results opened all our eyes to something that might need control at the source."

A few years ago, the RMP had flagged fipronil as a moderate concern for San Francisco Bay because it had been found in Bay sediment at levels that would kill freshwater invertebrates (toxicity tests in the saltwater environment are still in the works). In terms of overall levels found in untreated wastewater as part of this study, results varied, with total fipronil and breakdown products ranging from 20-120 parts per trillion (ppt), and imidacloprid from 58-310 ppt.



DPR captures doggie wash water post flea treatments for testing. Photo: DPR

To help pinpoint the source, researchers divided results per plant by population served. "Results were so ubiquitous, and of such magnitude, it helped us eliminate sources like occasional improper disposal or material tracked in from outdoor ant sprays," says Moran. Low daily variability in per capita contamination suggests widespread use.

Researchers and regulators are now scrutinizing other portions of this pollution pathway for more clues. The California Department of Pesticide Regulation (DPR)'s Jennifer Teerlink just completed a study in which they washed dogs 2, 7, and 28 days after spot-on treatments and captured and tested the wash water for fipronil and breakdown products. Results are still forthcoming. DPR is also conducting sampling throughout a municipal "sewershed" to see if homes, businesses, schools, or other facilities may be more or less important sources.

One interesting finding of the RMP study is that the San Francisco Airport treatment plant, a place where no one does much in the way of flea care for pets, had lower but still significant levels. "We checked pretty thoroughly that these particular chemicals weren't being used to spray for ants, or as pest control for shopkeepers," says Sutton. Since that was not the case, people must be bringing it to the airport on them, with them, or in them.

"People think that putting flea control on the outside of their pet is better for their pet because it's not inside the pet," adds Moran. Results suggest, however, that it could be getting inside of all kinds of things, perhaps even our own bodies.

While DPR is exploring the human health effects of topical products containing fipronil, pet pills appear to be a reasonable alternative. "It's amazingly timely that there are new oral meds on the market,' says Stephanie Hughes, a pollution prevention consultant for Bay Area wastewater agencies.

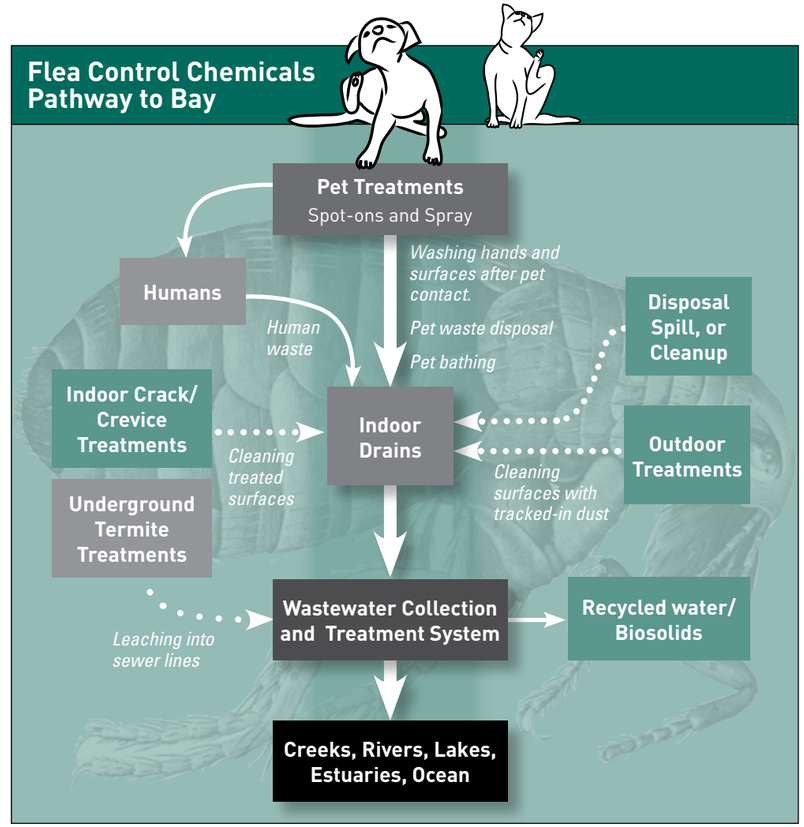
The switch could be tricky, however. Getting these pills will require a trip to the vet, and a prescription, not just tripping over the display at your local superstore. Big pharma is sure to have something to say about potential losses of such large outlets to smaller veterinary businesses.

DPR won't have any say over pet pills; that's a veterinary matter. They do have a lot of say, however, about pesticide pathways from more conventional sources. "If someone applies a pesticide to a field, we have a record, if someone applies it to a dog, we don't," says Teerlink.

While no one is suggesting home recordkeeping, more information about effective flea control could help, says Hughes. The scientific literature suggests that only 5 percent of the flea's life cycle is on your pet at any given time, she says. The other 95 percent mix of eggs, larvae, and pupa (which have a hard shell no flea bomb can penetrate) exists in a reservoir in your home. "Thoroughly and frequently vacuuming carpets, floors under furniture, cracks, crevices, the guest bedroom you never use, that's what's necessary," says Hughes. "You might not catch the fleas in the carpet fibers the first time, but with frequency, the vibrations will encourage the pupae out of their shells, and you'll get them the next time."

For now, Bay Area wastewater treatment plants have done their bit to unearth pathways to the Bay, and scientists, regulators, and pollution prevention experts have helped narrow the search. "From a science policy perspective, these types of collaborative studies with the wastewater community are really important," says Teerlink. "We're looking at data driven solutions, and having a large real world study is crucial." **ARO**

Research Article http://bit.ly/2gUtq2x



WATER QUALITY

Valley Version of RMP

"Buckets in the water and boots on the ground," is the current status of the Delta Regional Monitoring Program according to manager Phil Trowbridge of the Aquatic Science Center. While this effort to coordinate and synthesize water quality monitoring results from the Delta started actual sampling more than a year and a half ago, the Program is now poised to deliver its first data reports. Results on both pathogens and pesticides are due out in early 2017.

"We need to be able to tell the water quality story not just for this or that location, but for the region, and create a holistic picture," says the Central Valley Regional Water Quality Control Board's Adam Laputz, one of the co-chairs of the Delta RMP.

More than one independent science review of Delta management progress, as well as the 2013 *Delta Plan*, has called for coordinated monitoring, says the other co-chair, Linda Dorn of the Sacramento Regional San. "Monitoring required our plant's discharge permit (NPDES) is very specific to one location," says Dorn by way of example, "but that doesn't always help us make decisions in the context of the larger water body of which we are a part."

That larger water body is an extremely convoluted web of channels and rivers compared to the more open expanses of San Francisco Bay, adds Trowbridge, making design of the program and selection of the monitoring sites much more challenging. "In the Bay, you can move your sampling site 100 yards in one direction or another and find no difference in water quality; in the Delta, 100 yards upstream or downstream can bring a whole new set of influences on samples," he says.

The geographic complexity is mirrored by the number of entities already conducting monitoring, each for their own purpose. "We're a group of diverse stakeholders still learning to work together," says Dorn. "It will take time for us to develop the personal relationships and trust you can see in the Bay RMP after 25 years of collaboration."

Organizers stress that the Delta RMP is quite different from the Bay RMP, and the difference is not just geographical. In addition to dischargers and regulators several unique stakeholders are at the table, namely irrigated agriculture and water contractors that divert from, rather than discharge to, the Delta. "Meeting regularly to talk through and plan studies together, that's what's new here," says Laputz. "Instead of just being reactive to what we're finding, we can be more in the driver's seat."

With so many stakeholders and such a complex system, there are also a lot of competing needs for limited monitoring resources. "We can't sample everywhere all the time for everything, " says Laputz. "So if you're working in the Delta and doing monitoring, we'd like to partner with you."

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FLOWS, *cont'd from page 9*

San Joaquin River watershed and salinity in the southern Delta. Phase II will address flows in the other Delta tributaries, flows at the pumps, and flows through the Delta into the Estuary and San Francisco Bay.

For Phase I, says the State Water Board's Steve Moore, the staff's initial recommendation is to require that 40 percent of unimpaired flow in a given year remain in the San Joaquin River tributaries February through June, with an allowable range of 30 to 50 percent. Says Moore, "In the future, if non-flow measures help achieve biological objectives that are widely accepted by stakeholders, the Board could have discretion to require less percent unimpaired flow, or conversely, if the objectives aren't met, the Board could have discretion to require more percent unimpaired flow, up to 50 percent. There are also proposed October fall-flow requirements."

Rosenfield says those percentages don't come close to the magnitude of flows needed to save the species or the estuarine ecosystem: "The legal requirement is to restore salmon populations in the San Joaquin River watershed to a certain level, and we can show, and have shown the Board before, that 40 percent of the San Joaquin River's flow just won't do it." Fifty percent is the lower limit at which scientists begin to see the possibility of restoring salmon, says Rosenfield. "There are a lot of 'ifs'; the range should really include 60 percent."

In October, the Board released its draft scientific basis report for Phase II, which acknowledged the dire state of many Delta fish species, including spring-run and winter-run Chinook salmon, longfin smelt, Delta smelt, and Sacramento splittail, and recommends improving habitat and flows to support them, as well as more natural timing, distribution, and variability of flows. The report studies the effects of a range of flows into the Estuary (between 35 and 75 percent of unimpaired or natural springtime flows) from the Sacramento, Mokelumne, Calaveras, and Cosumnes Rivers.

San Francisco Estuary Partnership Director Caitlin Sweeney says adequate freshwater flows have always been—and continue to be—a great concern, especially with so many dollars devoted to restoring wetlands around the Bay. "Those investments are at risk unless we restore the physical processes that create and maintain habitats, and address the freshwater flow issue," she says.

Moore says the Water Board is planning to hold five public hearings between the end of November and beginning of January; written comments are due January 17. Says Moore, "I want everyone to have confidence that we are listening to their comments about the proposal and that we remain open to suggestions." **LOV**

www.thebayinstitute.org/sf-bay-freshwater-starved-estuary

www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/fs101916_phase2_factsheet.pdf

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RMP, *cont'd from page 11*

In the meantime, the Delta RMP is focused on pesticides, pathogens, nutrients and methyl mercury. Early accomplishments have been a regional level analysis of existing data on nutrients and a forthcoming technical report on pathogens. "The word is they haven't found any exceedances of cryptosporidium or giardia near drinking water intakes that would require a more advanced level of water treatment, so I'm excited to see the actual analysis," says Dorn. **ARO**