

Sustaining a living estuary like San Francisco Bay is no cakewalk. You've got to jive with unpredictable things like invasive clams, seasonal flows, climate change, and restoration budgets. And you've got to power through the twists and turns of politics and land use debates. The prize might not be as obvious as a lupine in the spring sunlight. But it sure beats sitting out the last dance....

SCIENCE • RESTORATION • WATERSHED • POLITICS • SPECIES • BAY

ESTUARY



NEWS

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IN
BRIEF**OVERBITE CLAM NOT SO SALINITY SENSITIVE**

— Biologists are learning more about the habitat constraints of the overbite clam (*Corbula amurensis*). The local range of the invasive mollusk was assumed to be limited by salinity, with reduced metabolic rates where salinity is low. However, a recent article by Nathan Miller of San Francisco State University's Romberg Tiburon Center and Jonathon Stillman of UC Berkeley in *Marine Ecology Progress Series* calls that into question. Sampling clams from Suisun Bay, Miller and Stillman found that salinity explained very little of the metabolic changes observed in different seasons. Their study included the spring of 2011, when unusually high fresh water depressed salinity. Another surprise: overbite clams may filter more phytoplankton from the water column — and thus compete more with native species — in winter and early spring, when their metabolic rates are lowest, than in summer.

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NEW NATIONAL ESTUARIES LEADER

A well-known Southern California wetlands advocate is heading to Washington to chair the Association of National Estuary Programs (ANEP.) Shelley Luce, director of the Santa Monica Bay Restoration Commission, was tapped for a two-year term with the national organization. She'll help coordinate 28 local programs (three in California — San Francisco, Morro, and Santa Monica bays) and foster collaboration among them. Luce says a key goal will be increasing public understanding and appreciation of local estuaries and the NEPs that protect them. Her background includes a UCLA doctorate and experience with large-scale wetlands restoration projects and community-based greenway planning. "Shelley Luce continues the tradition of strong, smart, and hard-working ANEP chairs we've had over the years," says the San Francisco Estuary Partnership's Judy Kelly. "She's engaging and passionate about Santa Monica Bay and has a good relationship with Los Angeles County, which helped get things done." **JE**



Cover photo: Spring bloom of lupine in the Mt. Tam watershed by Jacoba Charles.

O P I N I O N

Move on.delta

Retired USEPA biologist Bruce Herbold reflects on decades of impasse and challenges ahead.

The Delta has been altered, manipulated, exploited, and fought over to such an extent that it is now probably California's most important and intractable problem. As an immensely valuable transport corridor for commerce, water, waterfowl, and major fisheries, and as a landscape that supports local agriculture, recreation, resident fish species, and municipal property, the Delta has been the focus of much planning over the last 20 years. Past efforts have included CalFed, the Delta Vision process, the Delta Risk Management Strategy, the Delta Plan, and presently the Bay-Delta Conservation Plan.

But planning is usually based on history, which may no longer be so relevant. At a series of talks in January 2013, Professor Geoff Petts of England's University of Birmingham repeatedly made the point that climate change has rendered the climatic history of Britain useless for planning water management and ecological restoration. Britain sits on the cusp of the Gulf Stream and, as tropical and polar conditions vary, conditions in the UK vary enormously. Last year Britain had the driest winter on record, followed by the wettest summer and fall.

Also in January 2013 an article by Mike Dettinger and Lynn Ingram in *Scientific American* described how, even without climate change, California's climate is at the whim of trans-Pacific atmospheric rivers. A 2012 study by USGS estimates the damage of a flood substantially smaller than the worst flood in California's history would be devastating; more so than comparable earthquake analyses. The tremendous flood of 1861, that was the basis for the analysis, had come after a 20 year drought. No one agrees on how climate change will affect California's flood and drought pattern but no one expects the unusual stability we enjoyed from 1938 to 1975.

Seven years ago UC Davis and the Public Policy Institute of California raised awareness of how climate change and earthquakes posed a significant threat to the sunken 'islands' of the delta. This sparked an intensive study of levee vulnerability and a

watershed-wide planning effort focused on flood control. Little of that effort is being implemented.

Also seven years ago the collapse of fish populations brought a surge of scientific work that greatly deepened our understanding of the ecology of the Delta and how various factors interacted. A three-year drought (2007-2009) showed how low flows intensify the impact of factors like predation, entrainment, and contaminants. High flows in 2011 allowed intense scientific study under very different conditions. We know a lot more than we did 10 years ago; enough to take bold action with a reasonable expectation of rescuing our fish and the people they support. Instead we are continuing with legal wrangles.

In addition, we live in the most invaded estuary in the world and we have a very clear idea of what the next major invader will be and what it will do. Freshwater mussels, which can clog and block water pipes and bedevil aquatic ecosystems, spread rapidly across North America to Lake Mead and thence into San Justo Reservoir (roughly 25 miles from the Central Valley). We have done nothing to prepare for these invaders, and they are not addressed in any current planning effort.

How does one plan for an uncertain, dramatically different future? Downstream, in the San Francisco Bay, a great deal of work is underway to develop plans to adapt to the impacts of climate change and invasive species on both ecosystem values and human infrastructure (integrated planning includes such ideas as placing wetlands to minimize the impacts of storm surge on levees). Serious scientific, engineering, and policy discussions proceed over what we can expect, what can be done, what losses are unavoidable, and which tools we can afford.

The Delta needs a similar comprehensive, open, imaginative, and realistic discussion that uses and integrates all the planning done to date. We need goals supported by science that recognize the limited ability we have to manage resources in the face of major unavoidable impacts. Wishful thinking, hubris, fear, greed, and expecting-the-future-to-be-like-the-past have dominated Delta discussions to date. Fortunately, the intractable nature of the problem lies with us, not with nature. There are many "sure bets" we can pursue now while we develop broad public support for long-term action.



Clams Muddle Delta Restoration

Boosting phytoplankton growth is a key part of the Bay Delta Conservation Plan, as the supply of these tiny algae at the base of the Delta's food web has plunged over the last few decades. According to conventional wisdom, the best way to increase phytoplankton is to create shallow, slow waters to give algae plenty of light, as well as the chance to build up over time. But recent research upends this approach for ecosystems that, like the Delta, have been invaded by exotic clams.



"For many, this is a new way of thinking," says US Geological Survey engineer Lisa Lucas, who reported this work with colleague Janet Thompson in the December 2012 issue of the journal *Ecosphere*. "Clams flip the ingrained model on its head."

The phytoplankton decline is mirrored by fish declines in the Delta, suggesting that the two are linked. Phytoplankton are eaten by zooplankton, and in turn these tiny animal-like organisms are eaten by small fish including threatened Delta smelt and young salmon. However, non-native clams can muck with this food web by sucking too much phytoplankton out of the water. Indeed, in much of the San Francisco Bay-Delta ecosystem, phy-

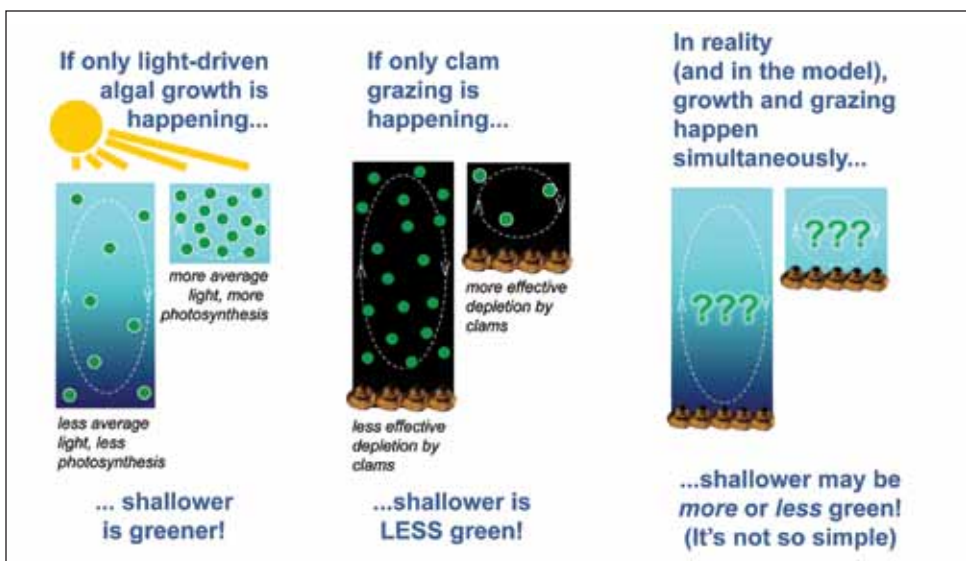
toplankton is overgrazed by two small invasive clams.

The half-inch overbite clam, *Potamocorbula amurensis*, is infamous for grazing voraciously in the saltier zones of the Estuary. In the fresh waters of the Delta, however, the culprit is the roughly 2-inch Asian clam, *Corbicula fluminea*, which was introduced in the 1940s.

While it makes intuitive sense that phytoplankton will increase if there is more optimal algae habitat, Lucas and Thompson found that this can backfire in parts of the Delta that have been invaded by the Asian clam. This species can actually graze too fast for phytoplankton to keep up, even in the shallow, still waters that favor algae.

To see if the conventional wisdom held when Asian clams were present, the team developed two simple mathematical models. One represented the hypothesis that shallow water produces more phytoplankton (dubbed "shallower is greener"), and predicted algal growth over a range of depths. The other model represented the hypothesis that slower water produces more phytoplankton (dubbed "slower is greener"), and predicted algal growth

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Clam invasions throw a spanner in the restoration works.

Source: Lucas, Lisa V., and Janet K. Thompson. 2012. Changing restoration rules: Exotic bivalves interact with residence time and depth to control phytoplankton productivity. *Ecosphere* 3:art117.

<http://dx.doi.org/10.1890/ES12-00251.1>

Stalking the Tiger Beetle

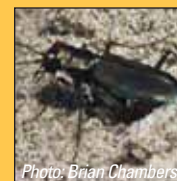


Photo: Brian Chambers

As you walk along a muddy creek-bank or the edge of a salt pond, life-and-death struggles may be happening almost underfoot. Tiger beetles, small (up to 15 mm long) voracious predators, haunt these habitats. The speedy adults capture solitary bees, brine flies, ants, and smaller beetles. Larvae are burrow-dwelling ambushers, popping up like lethal Jack-in-the-boxes. In turn, the beetles are eaten by snowy plovers and burrowing owls. Their shiny metallic coloration has won them a following among beetle enthusiasts. But they've been hit hard by development, and today the Bay's tiger beetle community is on the edge of extirpation.

Wes Maffei of the Napa County Mosquito Abatement District, who based the tiger beetle account in the 2000 *Bayland Ecosystem Species and Community Profiles* on his local surveys, says four species once inhabited the Central and South Bay's margins. Some locations, notably Bay Farm Island and Lake Merritt, had more than one species; US Fish and Wildlife Service biologist Chris Nagano calls this a strong indicator of habitat quality. Today only two remain: the senile tiger beetle (*Cicindela senilis senilis*), so-called for its thatch of white hairs, and the wetsalts tiger beetle (*C. hemorrhagica*). Their populations are small and scattered, often on unprotected land. There are also remnant colonies of hairy-necked tiger beetle (*C. hirticollis*) near American Canyon and on Point Reyes. In coastal conifer forests, the California night-stalking tiger beetle (*Omus californicus*) appears to be holding its own.

"Local populations in many different parts of the country are being challenged, even though their species may have a wide distribution," adds Maffei. The Ohlone tiger beetle (*C. ohlone*) of Santa Cruz County is listed as endangered. A Sacramento Valley subspecies of the hairy-neck is extinct, a victim of the Oroville Dam on the Feather River; the dam cut off the sediment supply for the flood plains where the beetle lived, and sustained flooding disrupted its life cycle. **JE**

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How Wild Should Drakes Estero Be?

A stunning, multi-fingered inlet called Drakes Estero lies on the coast of the Point Reyes National Seashore. This sparkling bay on the San Francisco estuary's outer ocean coast is the home of raptors, seals, beds of eelgrass—and also a 70-year-old oyster farm.

It's a bucolic scene, but beneath the beauty lurks a deeply-rooted bone of contention. For nearly a decade, the future of the Drake's Bay Oyster Company (DBOC) has been at the heart of a heated battle between fans of wilderness and advocates of sustainable agriculture. Last November, Secretary of the Department of the Interior Ken Salazar decided not to renew the farm's lease; now oyster advocates are suing the Department, which manages the National Park system, for the farm's right to remain open.

The oyster operation, which has been open since the 1930s, is one of 17 historic farms and ranches that have operated under lease since the park bought them in 1962. The waters of the Estero, where the bivalves are grown on wooden racks, were declared a potential wilderness area in 1976. With Salazar's decision to close the business, the inlet joined Abbotts Lagoon and Estero di Limantour to become the third aquatic wilderness within the Point Reyes National Seashore. But the farm's owners have been fighting for a delay, arguing that the historic farm is valuable in its own right and ought to be preserved.

"I liken it to a boundary dispute," says John Hart, author of a recent book on the history of the Point Reyes National Seashore. "There is a part of Point Reyes that is pretty definitely slated to remain in agriculture, and



A worker prepares strands of widely-spaced shells for oyster clusters to grow on.
Photo: Jacoba Charles.

there is a part that is already in the wilderness system. This is an area that is perched in between and has aspects of both—the question is, which way is it going to tip."

The basic debate that went from the local level to the highest halls of government was over a simple question: does the law require the Estero to revert to wilderness immediately upon cessation of the oyster farm's lease in 2012, or can its operation be permitted to continue?

Environmental organizations including the Sierra Club, the National Wildlife Federation, and the local Environmental Action Committee of West Marin argued that it couldn't. These advocates for immediate wilderness status fear that continuation of the farm sets a precedent for private industry to expand in wilderness areas. They also worry that the oyster farm boats disturb wildlife and habitat, and degrade the environment with debris and non-native species—namely the oysters themselves, and an widespread invasive tunicate whose only habitat in the Estero is the hard surfaces of the oyster shells and racks.

An eclectic group of supporters—including Senator Dianne Feinstein, chef Alice Waters, the county Board of Supervisors, and the three former Congressmen who originally helped draft the bill—assert that the law doesn't demand closure of the business. They say that the benefits of the farm, which provides jobs, a

CLIMATE CHANGE

Crops in Hot Seat

Certain fruit and nut crops are likely to decline in the future, because there won't be enough cold days for them to ripen properly, according to climate model predictions. Water shortages are likely to grow more severe as irrigation needs increase, and earlier ripening could impair the quality of wine grape harvests.

On the bright side, researchers are investigating how to sequester greenhouse gasses in the soils of rangelands and grazing pastures. And a number of laws passed in recent years now encourage the use of renewable energy on the farm—whether from solar panels or manure-powered methane digesters.

These were just a few of the topics discussed at the third annual California Climate and Agriculture Summit held at UC Davis in late February. The central theme of the event was that sustainable farming is good for the climate; while, conversely, climate change is going to be bad for farming. Over 200 scientists, ranchers,

students, and policy makers came together for the day of presentations, networking, and general intellectual cross-pollination.

"To have a broad perspective on this complex problem is essential if we're going to figure it out," says Renata Brillinger of the California Climate and Agriculture Network, which organized the event. "We need multiple perspectives on theory, practice, and policy. We set out to create those conversations and we succeeded."

Brillinger added that the sophistication of the presentations and the level of discourse have really evolved in the two years since the last summit—a sentiment that was echoed by other attendees.

"This is a new world to venture into," says Nancy Scolari of the Marin Resource Conservation District, who came to the conference specifically to learn more about how ranchers can sequester carbon by managing their rangelands better. "We've been restoring streams for a long time. Now it's time to restore our pastures—because in the end it all is connected." **JC**

INFO? <http://calclimateag.org/>

recreational destination, and over 30 percent of the oysters grown in California, outweigh those of immediate wilderness status. Some supporters also fear that if the Estero is converted to wilderness, then the historic dairy ranches in the same watershed also could be closed down in the future.

Complicating the debate has been the question of whether the farm has caused any significant environmental damage. Beginning in 2006, National Park Service scientists claimed their data showed impacts. But this was denied by the farm's owner, Kevin Lunny, and by local scientist Corey Goodman who accused the park of scientific misconduct. Multiple investigations ensued, including by the National Academy of Science, the Department of the Interior and its Office of the Inspector General. No official scientific misconduct was found, though "administrative misconduct" was. One report concluded that "in several instances the agency selectively presented, over-interpreted, or misrepresented" the available data. Another reported that NPS staff had deliberately withheld information from the public, but that there was no evidence the farm owners were being treated unfairly.

The February decision by a California appeals court seemed to echo those conclusions, in a decision to allow the oyster farm to remain open past the date set by secretary Salazar, until the court hears their case. The decision was made because "there are serious legal questions and the balance of hardships tips sharply in [the oyster farm's] favor."



Workers sort oysters at the Drake's Bay Oyster Farm. Photo by Jacoba Charles.

Shacks Mar Riverbanks

Travel down the main trunk of the Petaluma River and you might not see them. The ramshackle dwellings perch on the muddy banks of the tidal creeks and sloughs that braid through the surrounding marsh. Many are old hunting cabins that appear abandoned and rotting, making them a safety liability and source of contamination. Their age and the patchwork of land ownership make it difficult to determine who is responsible for them.

Now, after the million dollar effort undertaken in 2011, which pulled out 10 festering derelict vessels and their rusting, toxic hulls, regulatory authorities are turning their attention to the unkempt cabins.



Photo courtesy Sonoma County Sheriff's Office.

"During the 2011 clean-up it was brought to the attention of the Sonoma County Sheriff's Department that there were numerous old structures along the river in a state of disrepair," says Todd Thalhamer, an engineer with CalRecycle and the operations chief of the project. From the cabins, "They removed hazardous materials such as old propane tanks, batteries, asbestos, and other hazards." But many of the structures remain.

Meanwhile, also in February the Coastal Commission issued orders that the farm take immediate steps to come into compliance with state coastal laws.

At press time in late March, Congressional Republicans were proposing to include an extension of the oyster farm's lease in a draft energy bill that also includes oil drilling off the US coast and in the Arctic National Wildlife Refuge, and would expedite the Keystone XL pipeline. The bill is not expected to pass the Senate.

Thalhamer wants to draw attention to the abandoned shacks and is hoping to partner with other agencies or secure funding for their removal. The first step is identifying property jurisdictional rights by the many management agencies working in the area. "It's an absolute melee of ownership out there," Thalhamer says. No official inventory exists for dwellings. Tearing down the shacks would require significantly less resources than the previous river clean-up, Thalhamer says, because most of the work can be done by hand.

Some conservation organizations working along the river have done just that. After the 2003 purchase of a 180-acre parcel of land from Waste Management Inc, the company that operates the Redwood landfill next to Highway 101, the Marin Audubon Society began restoration work, including dealing with a cluster of old cabins along San Antonio creek. Audubon

members removed three shacks after attempting to track down owners with old deeds and meeting mostly dead ends. "They are just a bunch of junk falling into the creek," says Audubon's Barbara Salzman. **DM**

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Today, stakeholders and bystanders are waiting for the courts to review the case in May. Many stand to be disappointed, however the decision tips.

"Personally, my hunch is that Drakes Estero will be in pretty good shape whichever way it goes," says Hart. "It won't be the end of the world for the farm community if the oyster farm has to go. Nor would it be the end of the world for wilderness if it is allowed to stay." **JC**

E D U C A T I O N

Way-Cool Observatory

There's a new place to explore the Bay and it isn't an aquarium, a boat, or a model. It's an observatory, a square room perched high in the back corner of a San Francisco pier, where you can look out the window at the Bay or the city, or look into the Bay through a dozen, way-cool, exhibits. Here is a place that deciphers age-old relationships between moon and tides, sun and fog, shore and sea for you, and throws humans into the mix. And the new Bay Observatory in the new Exploratorium, opening April 17, does what the Exploratorium always did best, and now does better: gives you knobs to turn and scopes to squint through and maps to touch and shadows to chase. If there is a place where the frontiers of "interactive" exhibit are pushed, it is here, as always. But this new museum — moved from the historic Palace of Fine Arts to a designer, ultra-energy efficient space on Pier 15 — puts a finer point on it.

"The Palace was a dark hole with no windows, so trying to engage people in the environment didn't work well there," says Susan Schwartzberg, a senior artist at the Exploratorium. "Here we have the Bay on one side and the whole history of the urban shoreline on the other, from sunken Gold Rush ships and bay fill to downtown development, so

landscapes fill our windows. All of our Observatory exhibits are set up in relationship to the environment outside."

On the Bay side, you can watch giant ships lumber into port and also see them on a ship tracker screen at your fingertips — bright green arrows with tails tracing their recent routes. The ship tracker display uses the same technology captains consult on their ship bridges to check their position in relation to other vessels. On a table nearby spread the ridges and bays of the region's topography, carved in white wood. Turn a knob and suddenly the salinity of the water is projected in yellows and blues across what exhibit developers call a "visualization platform." "It communicates different aspects of the Bay, like tides or storm events, by projecting image skins on the platform," says geologist Sebastian Martin, who worked with the Observatory's team on science content. As we watch yellow water creeps upstream into the Carquinez Strait with a projected tide. "Our team hopes one might look at this and learn about tides, and then look out the window and search for signs of the same thing in the Bay," he says.



*Sediment samples from San Francisco Bay.
Photo courtesy Exploratorium.*

Indeed, the Bay is on the big screen everywhere in this beautiful room, in windows, on table displays, and on a state-of-the-art video wall. Nearby stands a tower of smaller screens revealing data from monitoring instruments in the water below and the air above. They're tracking everything from greenhouse gases to water quality and turbidity around the Observatory. "We're a wired pier," says Ron Hipschman, a self-proclaimed "geek" physicist. "We have more instrumentation here than most meteorologists have, and we're offering our location for science."

And science has taken them up on the offer. The Observatory is fast becoming a station for a number of Bay and ocean monitoring networks. Indeed, right off the inner pier, a red and white buoy owned by the National Oceanic and Atmospheric Administration will soon measure ocean acidification, and another pier device bounces high frequency radio waves off the water surface as part of a study of currents by San Francisco State's Romberg Tiburon Center. Kids and adults visiting the Observatory can see how scientists collect the field information they need to protect Bay health and commerce. "We're not a research entity, but we can provide a location, power, and maintenance for instruments collecting raw data," says Hipschman. The Observatory is even testing hydrocarbon levels in the water as spilled oil and fuel runs off city surfaces into the Bay. "Visitors can see on screen what happens after the first rain, and the second rain, and the third rain," he says.

The Observatory also presents what creator Bryce Johnson, calls a "library of mud" — two clear tubes of sediments from the bay bottom laid on their side for public perusal. One



2011-2012 tidal cycles portrayed in movable plexiglass layers. Photo courtesy Exploratorium.

“core” comes from the South Bay, and one from the North, and each reveals layers and layers of Bay history, from the white chips of broken oyster shells and the gold grains of sandy deposits to mining debris and the “fines” of our soupy, sticky, gray-green Bay mud. “Our mud library shows just how fast, and how slow, the landscape can evolve, and how humans have been part of that change over time,” says Johnson.

These are just a few of the way-cool exhibits in the new Observatory that are giving visitors a new window into the local environment, and shoreline history. You can see the sun’s movement through an “oculus” and identify buildings on the Embarcadero waterfront through an “alidade.” You can sit on a bench outside and watch solar shadows, or go on to the Life Sciences room for a close look at brine shrimp in a tank of salt water. There’s the upended, 13-foot tall, root mass of a 330-year old Douglas fir and geysers that spume

up into rafters. There is also of course the giant pier itself – the Observatory is just the eastern tip of an iceberg sparkling with Exploratorium exhibits invented through unique collaborations among local scientists, historians, artists and, of course, geeks.

This writer was struck by how much thought has gone into these spaces, how much passion into the idea of making physics, engineering, environment, light, even life itself, touchable, understandable. This is a place where all that is so obvious and exaggerated about contemporary American culture melts away, and we remember the subtleties of nature, and how we cannot help but be drawn into an intimacy with the landscapes we live in. As Schwartzberg puts it: “Our Observatory sits in a dramatic landscape with a rich human and natural history. We want to bring all the global changes in our environment home, and engage people in what’s happening here and now.” **ARO**



Bay Observatory at the east end of the new Pier 15 Exploratorium. Photo by Amy Snyder.

Slow it, Save it, Sink it

In the city landscape, rainwater pools quickly and then travels in torrents and sheets down roofs, sidewalks, parking lots, and roadways, all-the-while gathering volume and wicking pollution from encounters with countless sources of contamination. The water is going somewhere. Often it’s urban creeks on the way to the Bay. The hardened hydrology of the city means creeks are getting hammered.

That’s why the City of Oakland is advocating that citizens help to create a decentralized stormwater management system by retaining rainwater in barrels, and then releasing it slowly to mimic the function of the natural water cycle. “The goal, really, is percolation,” says Kat Sawyer, who works for the Watershed Project, the lead contractor for the City of Oakland’s Rain Barrel Program. “Slowing the water down allows it to get into the soil and not overwhelm the creeks.”

The Oakland Rain Barrel Program is in its final months of a three-year grant awarded to Oakland by the American Recovery and Reinvestment Act and the California State Water Board. City residents who signed up and filled out a participant agreement were given up to 620 gallons of rain barrel storage, depending on their needs. A little over 1,000 households obtained rain barrels through the grant, or the equivalent of 350,000 gallons of water storage citywide, Sawyer says.

Equipping homes with rain barrels fits into larger stormwater mitigation efforts called low intensity development (LID). “For the last 100 years the goal of engineers was to make straight channels to pave and pipe water,” says Scott Stoller, an engineer who works for the firm ESA PWA. “Recently we’ve been realizing that maybe that wasn’t the best thing to do.”

Instead, the new mantra for stormwater managers is slow it, save it, sink it.

Stoller and his colleagues, who partnered with the Watershed Project on the rain barrel program, are using

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W E T L A N D S

International Wet Spot

On World Wetlands Day, this February, San Francisco Bay became a Ramsar site. The Ramsar Convention is an international agreement for the preservation and wise use of wetlands, named for the Iranian city where a key conference was held in 1971. Credit the San Francisco Bay Joint Venture and its partners with making it happen. "This designation should be a point of pride for anyone living in the larger San Francisco Bay Area," says Joint Venture coordinator Beth Huning. "Despite intense urban pressures, San Francisco Bay endures as one of our country's great natural treasures."

More than 2,000 sites in 164 nations have been recognized since the convention took effect in 1975. "Wetlands" are defined to include seasonal pools, caves, and springs, as well as large water bodies. San Francisco Bay becomes the 35th site in the United States (along with Chesapeake Bay and the Florida Everglades) and the sixth in California (following Tomales Bay, Bolinas Lagoon, the Laguna de Santa Rosa, the Grassland Ecological Area in the San Joaquin Valley, and the Tijuana River Estuary).

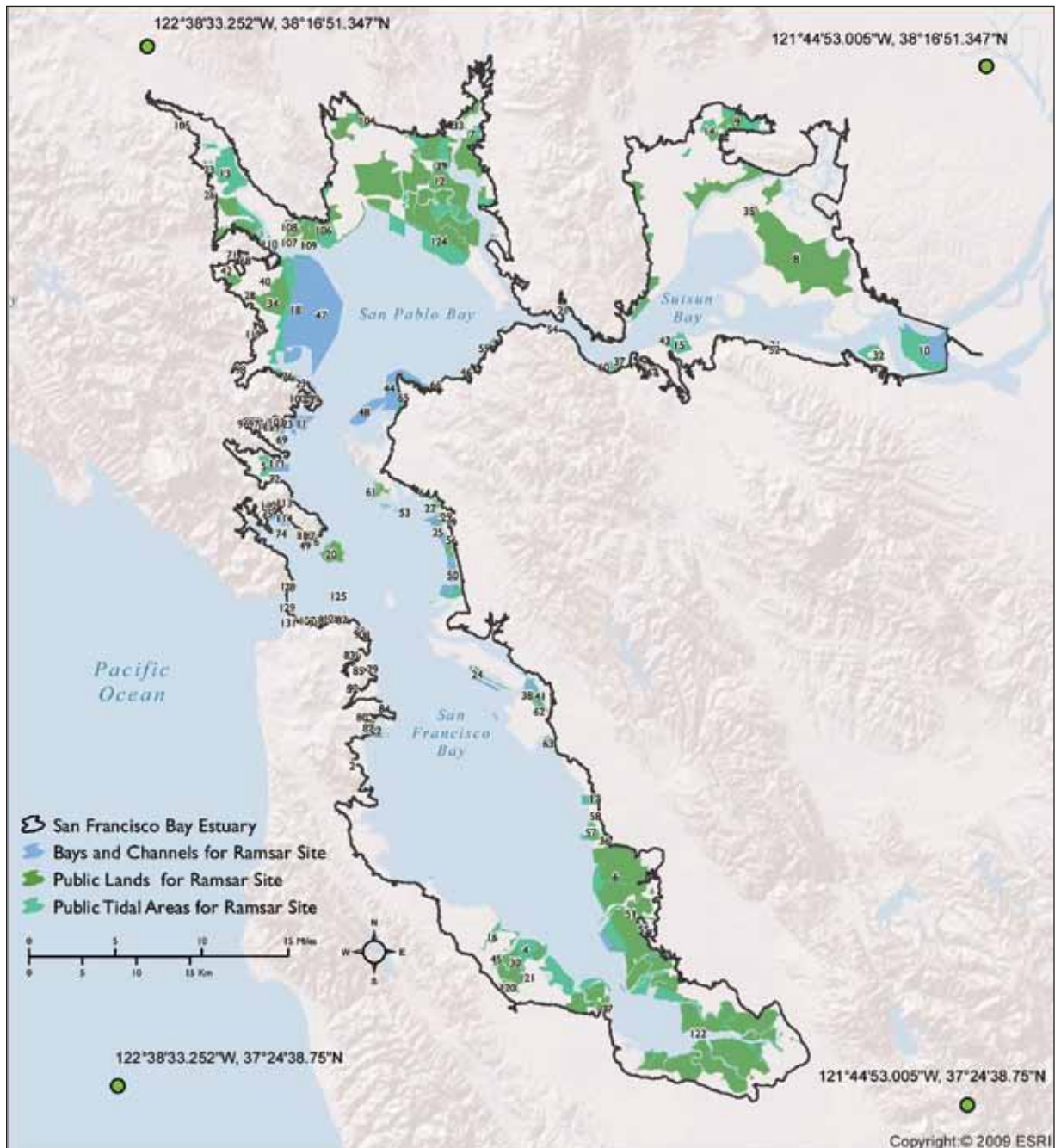
Making the Bay an official Wetland of International Importance was a complex four-year process. The Bay met all nine criteria for designation, but each had to be extensively documented. The Joint Venture also needed to bring a mixture of federal, state and local agencies and nonprofits on board. Unlike earlier, more global attempts, the focus this time was on protected lands with habitat value. The resulting patchwork quilt of

parcels totals 400,000 acres, one of the largest Ramsar sites in North America. Landowners who manage their properties for conservation purposes may be able to add their lands in the future.

Ramsar has no legal force, but may draw more restoration funding to Bay projects — conferring extra points in some federal grant programs, for example. It may also inform future decisions

about use of wetlands. Huning sums up: "This international designation validates not only the natural and aesthetic values of the Bay, but also the investments we have made and will need to make in order to collaboratively restore it." **JE**

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San Francisco Bay/Estuary Ramsar site.

Graphic courtesy Audubon California and SF Bay Joint Venture. Data from California Protected Areas Database, 2012 (CPAD, www.calands.org) San Francisco Bay EcoAtlas, 2002 (San Francisco Estuary Institute) Map Produced April 2012 by GreenInfo Network.

Local Stamp on Art

Federal Duck Stamps have come a long way since cartoonist J.N. "Ding" Darling sketched a pair of mallards for the first duck stamp issued by the US Fish and Wildlife Service in 1934. Since that year, hunters must purchase and carry the postage-sized stamp as proof of a federal license required to hunt migratory waterfowl.



A contest to paint the artwork for the stamp began in 1949, and the artistry has advanced with the years. The winning portrait of a common goldeneye for the 2013 80th Anniversary Federal Duck Stamp is so real you can almost taste the brackish water on the duck's back. The winning acrylic painting is the work of San Francisco artist Robert Steiner, a longtime fan of "realistic illusion."

"I'm trying to do for ducks what Vermeer did for Dutch women," says Steiner in reference to the Dutch painter.

Steiner has built a career of painting waterfowl for duck stamps, and this is his second federal stamp. Steiner has also painted 82 winning state stamps for 17 different states, including 15 for California. To hunt waterfowl in California, a hunter also needs a California Duck Stamp, which funds wetland conservation here. On Steiner's stamps, northern pintails, mallards and lesser scaups flare their primaries for a landing, or American wigeons, canvasbacks and wood ducks float in rippled water against a realistic backdrop of wetlands, mountains, or stormy skies.

You don't have to be a hunter to purchase duck stamps. In fact, the purchase of duck stamps is one of the best ways to help save and pro-

BANK ROLL

Saving Wildlife on a Shoestring

The owl scanned the 25 people in the room, fixed on a tan man in a bill cap, and hissed (biologists call it "vocalizing" but it sure sounded like a hiss to me). Maybe it was because the man was the closest stranger; maybe he sensed the man's special interest in wildlife. Or maybe the flash of my earrings the next seat over caught his marbled golden eye, and gave him a start. Needless to say, a room in the Alameda County sheriff's office filled with more people than trees is not the natural habitat of the great horned owl.

The owl didn't make his debut at the February meeting of the Alameda County Fish & Game Commission until about 5:15. He'd remained silent in a box under the table while the group heard various pitches for small grants gleaned from fining those caught breaking state and local laws protecting fish and game. The Alameda Creek Alliance wanted some weed wrenches to pry up big invasive shrubs; a wildlife consultant wanted to get genetic samples from 30 whipsnakes, for example.

Other groups were after a little extra cash for their volunteer restoration or kid's science education projects. The Watershed Project described taking third graders into Chinese restaurants in Oakland so they could tell the owners in their native language not to empty their cooking oils, cleaning solvents, and other potential pollutants down the

tect wetlands. Ninety-eight percent of every dollar that goes towards buying a Federal Duck Stamp goes directly to purchasing or leasing wetland habitat in the National Wildlife Refuge System. Eighty years of sales have contributed \$750 million to the refuge system.

Federal duck stamp sales hovered around two million for decades until annual sales started to slide in the mid-1980s. "With the number of hunters going down and real estate prices going up, more conservationists need to buy them," says Steiner.

storm drain. "Who can say 'no' to an earnest nine-year-old?" said Diana Dunn, one of their fearless leaders.

A girl with a squirming ball of squirrel babies described her wildlife rescue center but the owl upstaged the blind hairless rodents. He'd come with two women from the Sulfur Creek Nature Center asking for new gloves – the heavy, leather, up-to-the-elbows, lace-up kind used to handle birds with lethal talons and beaks. The center rescues wildlife like Tesla, who was found with a string tied around a long-broken leg. It would never heal properly, they said, so Tesla's destined to go to more meetings and classrooms to help save other owls, rather than back to the wild. In addition to new gloves, their grant proposal covered a new supply of mealworms to feed rescued bats.

The man in the bill cap wanted a projector. One of the commissioners suggested this sounded like a rather old fashioned piece of equipment in this day and age, but turned out he wanted to show DVDs. Turned out the man held \$15, all-day, classes for budding hunters young and old, teaching them not only how to track and shoot animals but also how to respect and treat wildlife. I guess that owl knew a thing or two about human nature. Or not. At least he knew how to vocalize. **ARO**

To receive notice of the next grant round, contact: Annette Thompson annette@infotechresearch.net. Grants are primarily supported by fine revenues and restitution monies which result from violations of the Fish and Game Code and Title 14 of the California Code of Regulations in Alameda County, and other civil and criminal violations of environmental laws.

Steiner is a hunter. In the beginning, he shot and stuffed ducks to serve as models, but he doesn't shoot many ducks these days, except with his camera.

"I hate to admit it," he says. "I'm more a fan of seafood." **AG**

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DESIGN

Up or Out? The Laid Back Levee

Ideas for monumental scale interventions have started cropping up on the desks and drawing boards of Bay Area planners faced with the prospect of sea level rise. “We’re hearing about tidal barriers at the Golden Gate, and bigger and bigger levees, but then what happens to our marshes and mudflats?” says engineer Bob Battalio of the consulting firm ESA PWA. The answer, according to a new model developed by Battalio and colleague Jeremy Lowe — with the help of coastal ecologist Peter Baye, the Ora Loma Sanitary District’s Jason Warner, and East Bay Dischargers’ Mike Connor — is to integrate flood control with habitat restoration in a way that could bring back a lost ecosystem and streamline wastewater treatment, at a significant cost saving over traditional approaches. A recent report by The Bay Institute calls this concept the “horizontal levee.”

The term was borrowed from the Netherlands, but that’s the only resemblance to Dutch flood control practice. “They use large levees with asphalt and turf grass,” Battalio explains. “We emphasize natural shoreline formations and ecological function.”

What’s being proposed is a gently sloping rise from the salt marsh along the Bay up into a wet marshy meadow in front of the levee (see diagram). Depending on lots of variables, the wet area on the landward transitional edge can be a “freshwater meadow,” “back marsh,” “brackish marsh,” or for purists, “estuarine terrestrial ecotone.”

The tidal marsh slows wave action and prevents levee overtopping in a flood or storm surge, while the upper marshy area gains elevation. Plant

species adapted to fresh or brackish water grow faster and put down more roots than salt marsh species. By bulking up faster, and tolerating thin sediment deposits, the transitional marsh can keep pace with sea level rise longer.

“The concept is pretty simple: it’s a big, extra-wide, wet levee, runny (seeping) and supporting wetland vegetation on the slope instead of artificially dry upland vegetation,” says Peter Baye.

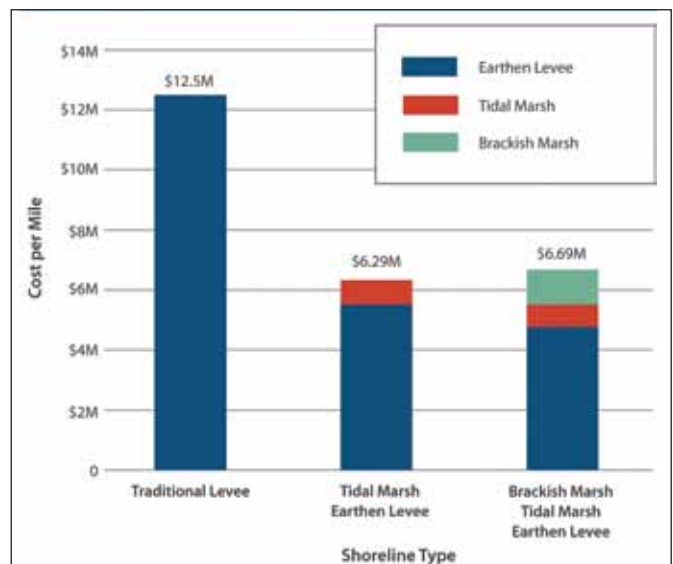
What’s missing for the Bay scenario is enough sediment and a source of fresh water to the transitional marsh, which was once fed by natural runoff. And that’s where the wastewater from Ora Loma, and material dredged out of flood control channels, comes in.

“The really new thing here is the idea of using treated wastewater to facilitate a brackish transition marsh farther upslope,” says Battalio. Treated wastewater may contain nutrients, which act like fertilizer. “Slope marshes with high nutrients are like wet prairies — very productive, depositing stable below-ground biomass in soil that sequesters carbon and nutrients,” says Baye.

The proof of the concept may come at the Hayward shoreline. As Lowe explains it, a city council member persuaded the Hayward Area Shoreline Planning Area to commission a study of the shoreline’s future from ESA PWA. That led to the design of a demonstration project and The Bay Institute report. Lowe says Ora Loma Sanitary is interested because of the water quality benefits and potential reduction in operations costs. According

to The Bay Institute’s Marc Holmes, the S.F. Bay Regional Water Quality Control Board also seems favorably inclined. He’d like to expand the scope to include other parts of the South Bay. But what may make the demo work in Hayward is a combination of forward-looking leadership and an effective local governance structure. Holmes hopes other cities will buy in, building a legislative campaign.

As for cost, Holmes says he was surprised by the difference between the horizontal levee and a more traditional 13-foot-high mound of dirt: “We did not anticipate the scale of the savings.” The study suggests that a traditional levee without a marsh would cost more than



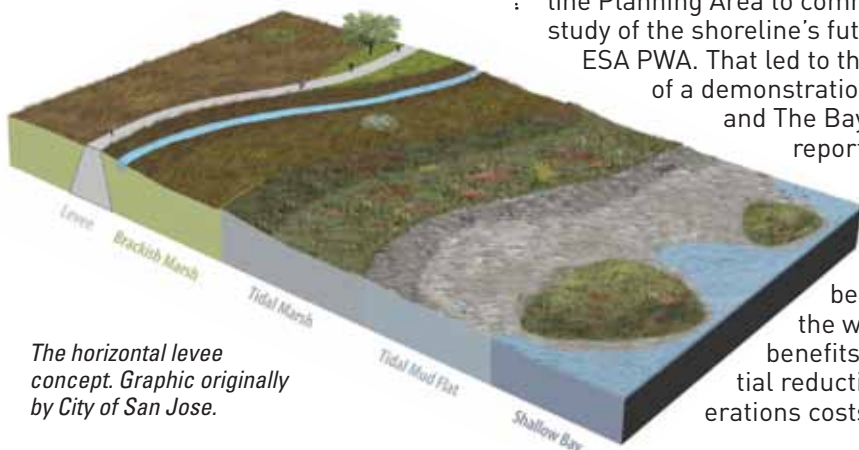
Levee cost per mile (in millions) over 50 years. With 200-300 miles of flood control levees around the Bay, many in need of strengthening, costs could have a major influence on the region's choices in the face of sea level rise. Source: The Bay Institute, 2013

\$12 million per mile over 50 years. With a 200-foot-wide salt marsh on the Bay, and/or a brackish marsh on the upland side of the levee, the price almost halves (see graph).

To Lowe and Battalio, using natural topography and native vegetation to knock down waves is not a radical departure. Others have floated the idea in the recent past. “Using the natural environment as much as possible is the kernel of our practice,” says Battalio. “We need to recognize the value of mudflats and marshes, and consider where we draw the line. Otherwise we might wind up spending more money and being less effective.” **JE**

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The horizontal levee concept. Graphic originally by City of San Jose.

F L O O D S

Wet Feet for Silicon Valley

The headquarters of some of Silicon Valley's best-known companies hug the edge of San Francisco Bay, but only upper-floor offices have water views. That's because the buildings sit on subsidized earth that lies several feet below sea level.

Google, Yahoo, and Cisco Systems are just a few of the Silicon Valley companies that lie only a levee or two away from the Bay, and some of their offices risk being inundated when sea level rises by the expected two or so feet in the next half century. Facebook's headquarters is separated from Bay water by only a skinny bike path on a low levee — even companies with buildings several miles from shore, such as Cisco, are in zones that will get flooded by high tides within fifty years if levees aren't raised. If protection isn't increased, by 2067 there's a one percent chance each year that bay water will overtop levees and flow into some of the office parks south of Highway 237, which lies about 4 miles away from the open waters of the Bay. If the crude dirt levees actually gave way, programmers and social media managers could have wet feet far sooner.

"Many of the levees around the South Bay were not built to provide flood protection. They were built for salt production ponds," says Caleb Conn of the U.S. Army Corps of Engineers.

Now, engineers and biologists are working together to protect urban areas with both soft, marshes and hard levees. Part one of the protection is the South Bay Salt Ponds Restoration project, now celebrating a decade of work completed. That project is designed to restore wetland habitat, but it's also providing a buffer against storms and sea level rise for urban areas.

"It's the idea of using our natural infrastructure to enhance our built infrastructure," says Amy Hutzel of the Coastal Conservancy, which is in charge of the project.

Part two of the protection is a parallel project now undergoing a feasibility analysis known as the South Bay Shoreline Study. The Corps of Engineers is working with the Coastal Conservancy and the Santa Clara Valley Water District, which is responsible for flood control and stream stewardship, to put together a plan for the first of several sections of improved levees by the end of this year. Construction is expected to cost between \$80 and \$130 million, with the Corps picking up 65 percent of the bill and state and local agencies the rest.

"We want to see additional wetland restoration move forward and we can't do that without flood protection," says Hutzel.

Before restoration, the levees encircling each salt pond provided several lines of protection for the urban areas inland of the ponds. But the restoration project is poking lots of holes in the Bay side of the levees to let the tides in and re-establish natural marsh function. With that border breached, the land-side levees that separate the city from the marsh need to be strengthened.

The re-engineered levees will protect not just corporate headquarters, but hundreds of homes in the Alviso district of San Jose, as well as the all-important San Jose/Santa Clara Water Pollution Control Plant, which treats sewage for 1.4 million people.

Early versions of the study call for superwide levees 400 feet across that on the Bay side slope so gently that they will create many acres of new transitional habitat between the marsh and upland areas (see opposite). Acquiring soil to create these huge, broad levees — about 2 to 3 million cubic yards, enough to cover 400 to 500 football fields thigh-deep — is a major challenge. The Conservancy is now banking clean, free dirt from urban construction projects to use for future new marsh plain and levees. Construction will likely start in 2017, following Congressional authorization of the plan recommended by the Corps. **SKM**

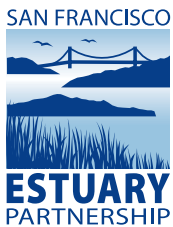
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Business and urban areas located within South Bay zone projected to be at risk from flooding or sea level rise.

Map produced by GreenInfo Network for the South Bay Shoreline Study. Data from Knowles; Seigel and Bachund, FEMA, and other sources.



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CLAMS - Continued from page 3

over a range of water transport times, which reflect how long water stays in one place. "We isolated what's key to each hypothesis and got rid of everything else that could complicate it," Lucas explains.

The models predicted that, contrary to the traditional view, neither shallower nor slower was necessarily greener when Asian clams were present. The team field-tested their models by comparing algae, light, and clam grazing at sites that spanned the Delta. "We zoomed around in small boats taking water samples to measure chlorophyll and water clarity," Lucas says. Clam grazing was estimated based on sediment samples. "Metal jaw-like contraptions called benthic grabs bring up a known amount of sediment, along with any clams," she explains.

Data from more than 200 sites across the Delta suggests that shallow, slow waters were not always greener when clams were present. "We don't know how to predict or control where clams will be, so this is a big uncertainty when restoring or creating habitat in the Delta," Lucas says. "You just don't know what you're going to get."

One way around this dilemma may be to restore floodplains in the Delta. These habitats are shallow and slow, making them ideal for phytoplankton, but also dry out periodically, making them inhospitable to clams. "Restoring floodplains in the Delta is not a new idea," Lucas points out. But, as her new work shows, it could be a good one. **RM**

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RAIN BARRELS - Continued from page 7

software modeling tools to try to determine the effectiveness of rainwater catchment on a watershed. "We are trying the take the peak off the hydrograph, which really helps creeks respond to run-off," Stoller says.

Rain barrels are just one strategy to slow stormwater. Other methods advocated by LID practitioners are building rain gardens, amending soils so that

they are more retentive, and creating water-slowing structures like berms and swales to aid with short-term water storage. Stoller recommends calculating a home's impervious surfaces, like the area of a roof and driveway and dedicating between four and ten percent of that number to bio-retention activities.

Another major partner in the Oakland Rain Barrel Program is the DIG Cooperative, an eco-design and build firm active in getting the rain barrels installed. DIG works with homeowners to come up with a stormwater storage system to fit their individual needs. DIG members are also providing support for rain barrel installations at the institutional-scale. They recently installed barrels and rain gardens at the Chabot Space and Science Center and Skyline High School.

With the rain barrel subsidies ending at the close of the federal grant funding, the active partners are hoping that there is enough traction to sustain a citywide interest in backyard stormwater management. "All of this is easily replicated," Sawyer says, "This whole thing is like a big pilot project. Who knows where it will go from here." **DM**

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