ESTUARY NEWS

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Healthier but still troubled...

The good and the bad news about San Francisco Bay as told by 92 speakers at the September 2011 State of the Estuary Conference

Photo by Robert Marshak

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Summary of Bay Health, from State of the Bay 2011 report			
	Status	**Trend**	**Details**
Water			
Safe for aquatic life	Fair	Improving	Bay water quality is better than 40 years ago, but the rate of improvement has slowed. Mercury, exotic species, toxic sediments, and trash are still problems, with improvement expected for exotics and trash. Many potentially harmful chemicals have yet to be assessed.
Fish safe to eat	Fair	No change	Limited consumption of most popular Bay fish species is advised due to contamination from legacy pollutants. No signs of improvement since 1994.
Safe for swimming	Good	No change	Most Bay beaches are safe for swimming in summer, but bacterial contamination is still a problem at most beaches in wet weather.
Freshwater inflow	Poor	No change	Amounts and variability of freshwater inflows have been reduced, resulting in chronic drought conditions for the Estuary. Flow conditions have been predominantly poor for the last 10 years, with the Freshwater Inflow Index at a record low level in 2010.
Habitat			
Estuarine open water	Fair to poor	Deteriorating	Quantity and quality of springtime habitat is declining. Since the 1980s, habitat conditions have generally been poor in all but wet years.
Baylands	Fair	Improving	Historic decline has ended; gradual restoration underway; there is a long way to go.
Watersheds	Fair	No change	Watersheds are largely stabilizing after damage from historical land use changes; monitoring in more watersheds is needed to improve assessment of status.
Living Resources			
Fish	Mixed, mostly fair	Deteriorating	Fish abundance and diversity are declining in all regions of the Bay except near the Golden Gate. The fish community is in poor condition in Suisun Bay.
Shrimp/Crab	Good	Improving	Most shrimp and crab populations are increasing, but ocean species dominate in the Bay. The abundance of Dungeness crab juveniles fluctuates widely, but Bay shrimp are generally stable.
Birds	Mixed, mostly fair	Trends mixed	Some populations are increasing, some are static, and some are declining, with some earlier increases recently reversed. Tidal marsh birds are below desired levels. Reproductive success is generally low or has decreased since 1993.
Ecological Processes			
Flood events	Poor	Deteriorating	Dams and water diversions have cut frequency and duration of floods by more than half, reducing freshwater inflow variability and transport of sediment and nutrients to the Bay.
Food web	Fair	Deteriorating	Declines in reproduction of fish-eating birds suggest that less food is available.
Stewardship			
Individual/Community action	Fair	Improving	Active stewardship could be greater, but regional efforts appear to be increasing. Bay Area citizens are using water more efficiently, and we are gradually expanding our use of recycled water.
Management action (example)	Good	Improving	In-Bay disposal of dredged material has been greatly reduced since the Comprehensive Conservation and Management for the Estuary was adopted in 1993.

EXAMINING BAY HEALTH

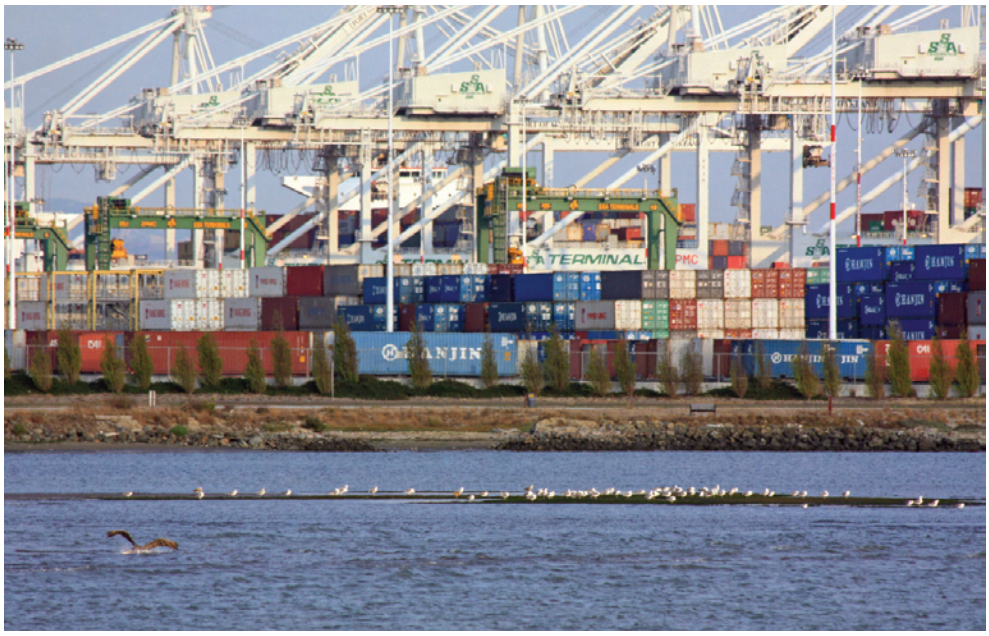
Some Positive Trends, Some Thorny Problems

Coming up from under the Bay to the heart of Oakland on BART, riders must wonder what Gertrude Stein was talking about when she complained there was no *there* there. At first you're blinded by the blaze of blue off the Bay, then intrigued by the port's snowy cranes and stacked containers. Then you tunnel under a downtown teaming with bay-related activity, ranging from the offices of the State Coastal Conservancy to the Regional Water Quality Control Board and San Francisco Estuary Partnership, among others. So there is a *there* there if you want to be where the action is concerning San Francisco Bay.

There were also 700 people there—in the elegant lobby of Oakland's Marriott—on two mornings this past September sharing news about everything from salmon to salt ponds as they filed into the annual State of the Estuary conference. Many of these thinkers and doers come back to the conference year after year to catch up with their colleagues, men and women absorbed in the health of the bay's fish, wetlands and wildlife, and tasked with the management of its pollution problems and restoration initiatives. This time was no different.

The first speaker, Oakland mayor Jean Quan, was quick to welcome those assembled to "one of the most sustainable and greenest cities in the USA." Indeed Oakland lies in the heart of a region where half a dozen other cities are likely to make the same claim. Such dedication to the quality of the Bay Area metropolis, and to the health of the Bay at its doorstep, was certainly something most conference attendees had in common. They also shared an unusual level of expertise when it comes to managing an urban estuary, a task that remains unprecedented in scope and complexity. As Alexis Strauss of the US Environmental Protection Agency's Water Division put it, "The Bay is much loved and much studied, but there are still huge gaps in understanding."

Strauss opened the conference, organized by the San Francisco Estuary Partnership, by setting a framework for the findings of the *2011 State of San Francisco Bay* report. Despite "extraordinary commitments and accomplishments" in habitat restoration and pollution control, she said, some aquatic species are at record lows. EPA and partners are studying numerous other stressors, she said, and acknowledged the current tough political context: "We can't expect more funding or more legislative action," she said.



Oakland harbor. Photo by Max Eissler.

Three of the report's authors shared some of its details. "We've given the Bay a licking but it's still ticking," said Andrew Gunther of the Center for Ecosystem Management and Restoration, who also served as project leader for the report. "How's the Bay doing? It's slowly returning to a healthy status," he said. After reviewing overall findings for the audience (see p. 2), he suggested "The Bay's future is going to be determined by the state of your minds—by your commitment, dedication, and vision."

Another contributor to the report, Josh Collins of the San Francisco Estuary Institute, described his struggle with measures of ecosystem integrity, sustainability, and ecological health, as applied to the Bay. "I know it when I see it, but these terms are a matter of culture, not just science," he said. Collins gave a snapshot of the report's data on the health of tidal environments, and speculated about coming changes. "With sea-level rise, marshes will move upstream and inland. The new challenge will be to make way for the Bay," he said. Marsh size and structure are also a concern—historic marshes were more diverse, and few large marshes remain. "What can we do to make it better? Make more marshes and make them bigger," he said.

One thing that makes everything better for fish, especially upstream, is more freshwater inflow, according to Tina Swanson of the Natural Resources Defense Council, another contributor to the *State of the Bay* report. As a result of declines in freshwater flows over the last 50 years, she said, the Bay is now experiencing a "chronic drought condition." Flows, in turn, affect the health of the fish community: "The report's fish index tells us the health of San Francisco Bay varies geographically," she said. The percentage of native fish species, as well as their overall abundance, is stable in the Central Bay, but declining in other parts of the estuary. "The best health is in the lower regions, where the Bay is influenced more by ocean conditions than by freshwater inflow conditions," Swanson concluded. "Conditions are poorer the farther upstream you go."

Black crowned night herons, which nest on Alcatraz Island. Photo by Max Eissler.

After these three presentations on the state of San Francisco Bay, the talk turned to climate change. Biologist Terry Root, wife of the late climate scientist Stephen Schneider, gave a tribute presentation in honor of her husband. Many conference attendees remember her husband's inspiring speech at the 2009 conference. Root, a Senior Fellow at Stanford's Woods Institute for the Environment, said data show the world getting warmer very rapidly. She sketched the present state of knowledge of climate change and its implications: earlier snowmelts, more and larger fires, melting polar ice and retreating coastal wetlands. Her main focus, though, was on biological impacts of global warming in the Bay Area. In the last 100 years, California's coast experienced an eight-inch sea-level rise, but in the next 100 years the rise may top five feet, she said.

Beyond advancing waters, ocean acidification caused by carbon dioxide mixing with seawater and forming carbonic acid is already "a ticking time bomb" for the Bay, Root said. One result has been less calcium available for shelled animals as evidenced by the discovery of juvenile clams with transparent shells. With higher tides or more extreme tidal surges, local sensitive species like the California black rail and the salt marsh harvest mouse will also become more vulnerable to predation. "They're sandwiched between people and the sea," she said.

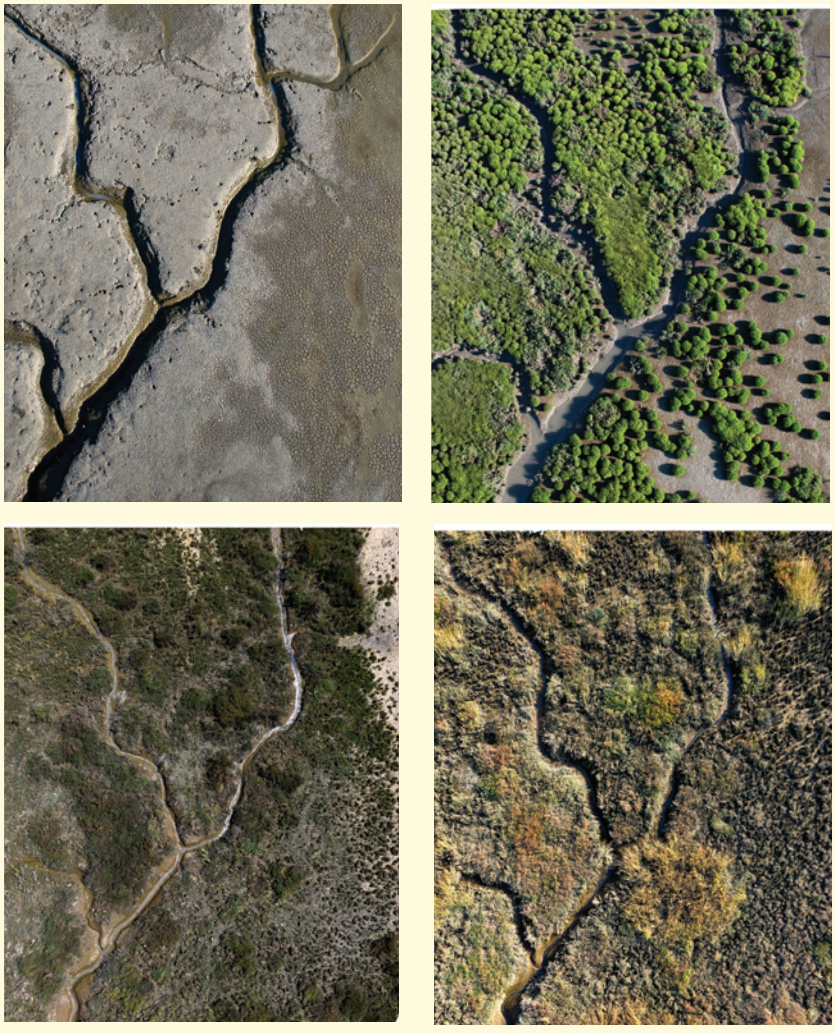
Root predicted that both wildlife ranges and phenology—the timing of natural events—will shift, disrupting natural communities. "When species can't adapt, it amounts to extinction," she warned. Many biologists believe we're on the brink of the planet's sixth massive extinction event, in which 50-75% of species now present may be lost over the next 200-300 years.

Stopgap measures like managed relocation of threatened species might mitigate the effects, but in the end it's all about energy use. "We have to do something about carbon dioxide going into the atmosphere," Root concluded. "We may have the urge to bury our heads in the sand, but we can't. We've got to stand up to the naysayers who say climate scientists are rigging their data. That's just a reassuring lie." JE & ARO

FLYING LOW REVEALS BAY'S TRUE COLORS: CRIS BENTON'S KITE PHOTOGRAPHY

The state of the Bay is perhaps most visibly seen through the eyes of an artist, but not just any artist. At the conference, UC Berkeley's Cris Benton, founder of the Hidden Ecologies Project, shared his unique view of the South Bay from above with images from his kite-lofted cameras. Inspired by what he called a "golden age of kite photography" around 1900, Benton spent a decade developing his own equipment—cameras dangle on a line 100-200 feet below the kite—and exploring the estuary's maze of ponds and sloughs, natural features and human artifacts. "San Francisco Bay is a vivid multicolored landscape," he said. "I became seduced by all the colors and textures, and walked every levee in the South Bay."

Benton showed images of the maroons and purples painted by masses of extremophile microorganisms in the salt ponds, the ruins of boat landings, the ghost town of Drawbridge, and the crumbling infrastructure of defunct salt works. Historic maps inspired him: "Tracing marsh channels on 19th-century charts, I realized I could photograph those exact same channels entombed, waiting for freedom," he said. He's also been able to capture the effects of restoration, as vegetation reclaims the barren bottoms of former ponds. "I go out there and the place changes, sometimes because of inadvertent changes but more often because of purposeful management. It's fun to see those changes underway. There's cause for optimism," he said. JE



Post restoration views of Pond A21 as it changes with the seasons and increasing tidal influence. South Bay Salt Ponds Restoration Project. Photos by Charles Benton.

PATHWAYS TO PROGRESS

Reducing Trash, Restoring Rivers, Delivering Recycled Water

Environmental managers all around the Bay have been experimenting with a variety of ways to tackle its aquatic health problems. In the second half of the conference's Tuesday morning session, a panel of managers from San Jose, San Francisco, Napa and Oakland described their agencies' responses to the challenges raised by the *State of the Bay* report: specifically, what's working and what's not.

In San Jose, the city's Environmental Services Department has been actively pursuing water recycling and water quality monitoring, according to speaker Melody Tovar. During summer months, more than 10% of the wastewater treated in San Jose, or 10 million gallons per day, is delivered back to approximately 600 customers for irrigation and industrial uses. Tovar also described efforts to integrate public art with bio-retention processes that trap and filter runoff before it reaches streets, storm drains and the Bay, most notably at the Roosevelt Community Center near downtown San Jose where the roof runoff flows through two art pieces at opposite sides of the building. The art pieces provide both treatment and an illustration of how communities are connected to their creeks by the urban landscape. San Jose is also struggling with every busy city's nightmare—plastic refuse. "Trash is the poster child" of the city's efforts to improve the Bay environment and the impetus for its Bring Your Own Bag Ordinance, she said. According to Tovar, San Jose has a long tradition of using good science to inform management decisions.

The second speaker weighed in on what it's like to be a bigger agency with projects not only around the Bay but also up and down the state. In his talk, the State Coastal Conservancy's Sam Schuchat credited the Bay Area's environmental community for the success of watershed restoration to date: "We're better organized, and better able to play well with each other, than anywhere else in the state." He praised local members of Congress for their help, singling out Senator Dianne Feinstein ("a huge force for good in the work we do"). In recent years, state and federal funding has declined, however. "Polling shows the Bay is incredibly well loved, and that people are willing to pay for restoration," he said. "The bad news is that they're not willing to pay for it right now."

In his talk, Schuchat identified several other challenges ahead, including balancing invasive *Spartina* control with endangered species protection ("It's not clear how we're going to thread that needle") and finding better uses for dredged sediment. "Dumping dredged sediment in the ocean is stupid," he said. Schuchat also expressed some pessimism about the task of raising public awareness of sea-level rise: "To be honest, I don't think it can be done. Convincing people something really bad is happening, but happening really slowly, is fundamentally impossible. We asked focus groups in Sunnyvale if they were worried about flooding; they acted as if the idea was bizarre."

The next speaker, Patrick Lowe from the Napa County Conservation, Development and Planning Department, seemed relieved to be in friendly surroundings. "Its good to be in the science environment with logical thought, as opposed to the contentious political milieu in which we do so much of our work," he said.

Napa's new watershed information center, he said, has become a focal point for sharing science and community education. Meanwhile working to control flooding and downcutting on the Napa River via a geomorphically-based "Living River" strategy has become a county priority. Restoration of river reaches between Rutherford and Oak Knoll is underway or planned, Lowe said. The restoration will set back active land uses and agricultural berms and improve 15 miles of degraded riverbanks. Lowe also paid tribute to Laurel Marcus' Fish Friendly Farming project (see "Good Grapes," *Estuary News*, August 2009), which has enrolled more than 100,000 acres in its certification process in four counties including Napa. He described new survey technology that is helping clarify the status of salmonids in the Napa River, and the removal of barriers to fish migration such as the one at Zinfandel Bridge. Lowe also mentioned the historical ecology atlas for the county completed by the S.F. Estuary Institute, and described how the atlas has helped inform decision-making needed to pinpoint the right places for oak woodland restoration. The Napa Valley will also likely benefit from stronger management of the county's underground aquifers and springs via a newly formed groundwater advisory committee that is working to ensure water resource sustainability, said Lowe.

Down in the city of San Francisco investments are also being made in healthier watersheds and water supplies. San Francisco draws its water from as far away as the Tuolumne River's Hetch Hetchy reservoir near Yosemite, and the city manages an extensive water delivery system and thousands of acres in both urban and rural watersheds. Speaker Michael Carlin, of the San Francisco Public Utilities Commission, says business has not been quite as usual for the utility in this last decade. He described a change in culture within the PUC, exemplified by the decision to replace copper sulphate with hydrogen peroxide for algae control in reservoirs and a ninefold increase in the agency's conservation budget. "We're in the middle of a $4.6 billion capital program to improve water delivery systems, and that involves a lot of habitat restoration," he said. As for the future, the SFPUC, as part of the Water Utility Climate Alliance, is supporting research on the Tuolumne River watershed and its snow pack. "We've embraced climate change. It's happening," said Carlin. JE

Public education poster. Courtesy City of San Jose.

Undaria. **Photo by Steve Lonhart, NOAA MBNMS.**

BATTLING INVASIVE PLANTS

Start Early, Finish Strong

Nobody likes weeding. Whether digging out star thistles from the backyard or sea lavender from the Bayshore, getting rid of weeds takes time and muscle, and sometimes chemicals and permits. But most people involved in bay conservation and restoration activities agree with Dan Gluesenkamp's view that for an estuary as urbanized as ours, controlling exotics is a kind of necessary hygiene: "We need to be able to live on a planet crowded with humans and still have biodiversity," he said at the beginning of the conferences' Tuesday afternoon session on invasive plants.

Gluesenkamp, who directs The Calflora Database, is a man with a keen eye for plants that look out of place among the natives. If development has been the number-one threat to native plant communities, biological invasions are number two, he said at the conference. What's worrisome is that the rate of exotic plant introductions is increasing, in part because of global commerce. With two international ports, the Bay is especially vulnerable to invasions.

Gluesenkamp went on to describe a new tool for coping with invasive flora: the Bay Area Early Detection Network (BAEDN). The network, funded by federal agencies, has been locating, mapping, prioritizing, and coordinating treatment of invasive infestations in the nine Bay Area counties for the past two years. As of last September, efforts by BAEDN and partners had led to a third of the identified infestations being under active treatment. "We've made a good start for a shoestring operation," he said. BAEDN relies on an integrated mapping platform built by Calflora, which brings together web maps, a professional-grade application for smartphones, and other tools to report and track new occurrences. The exotic Algerian sea lavender *(Limonium ramosissimum),* a relatively new invader, has been a priority target for the early detection network. BAEDN and Calflora are now working to make their tools available to other groups.

The next three presentations focused on specific invaders. Chela Zabin of the Smithsonian Ecological Research Center and UC Davis talked about a giant alga *(Undaria pinnatifida).* "Wakame is something you might see in your miso soup," she said. It's not just a tasty garnish. The alga grows on surfaces like boat hulls and docks. It outcompetes native algae and changes the structure of benthic communities. Zabin says *Undaria* has been found at several locations in San Francisco Bay, including Fisherman's Wharf, and invaded waters from Australia to Argentina and Spain. Each individual can release over 10 million spores—and it's been named one of the top 100 aquatic plant pests in the world. *Undaria* hasn't been documented north of the Bay yet, although it could potentially survive as far north as southeast Alaska.

According to Zabin, eradication efforts so far have engaged many volunteer "kelp kickers." But outreach to boaters and marinas has had mixed results. "Despite prior discussions, a hundred San Francisco Marina boaters dispersed to other marinas this year before their boats could be cleaned," said Zabin. She and her colleagues hope to make more progress working with an America's Cup advisory committee on invasive species. Unfortunately, there's currently no funding for ongoing control efforts.

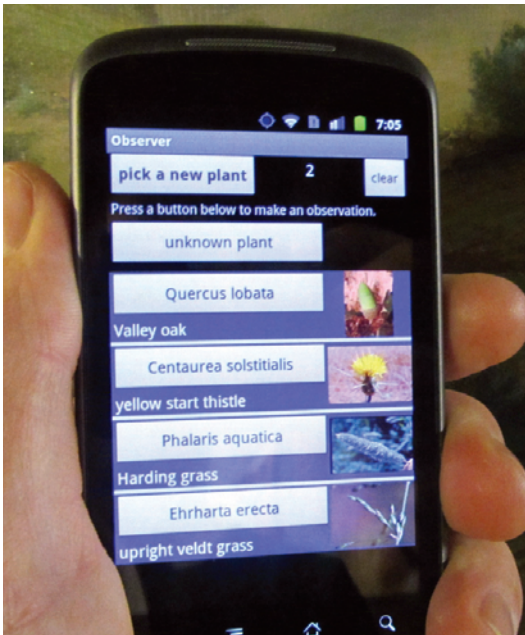
After Zabin, conference attendees heard about another invader making major inroads into estuarine tidal marshes: perennial pepperweed (*Lepidium latifolium*). This member of the mustard family forms dense single-species colonies and populations in tidal marshes continue to grow, according to speaker Donna Ball of H. T. Harvey & Associates. "It is commonly known to occur in freshwater marshes, but we are finding increased populations in brackish and saline marshes too," said Ball. "Perennial pepperweed tends to favor disturbed sites such as levees along marsh edges."

Lepidium likes higher marsh elevations, which are crucial tidal refugia for endangered species such as the salt marsh harvest mouse (*Reithrodontymys raviventris*) and California clapper rail (*Rallus longirostris obsoletus*). Originally documented in the South Bay, where its range has increased 200% over a 22-year period, pepperweed can also be found at Rush Ranch, Benicia, and other North Bay marshes. Restoration underway in the South Bay increases the potential for further spread due to the creation of new low marshes and levees. "Scientists are working on developing effective methods of control, but large-scale regional control is not currently being conducted," Ball said. She recommended more regional data sharing and coordinated mapping of infestations.

Another invader still plaguing bay marshes is Atlantic cordgrass (*Spartina alterniflora*), but significant headway has been made in the eradication of this species and its hybrids. According to speakers Erik Grijalva and Jen McBroom of the Coastal Conservancy's Invasive Spartina Project, infestations have been reduced from 809 acres in 2005 to 38 this year, at a cost of $20 million. Eradication efforts, which combine spraying and mechanical control, are among the most ambitious ecosystem purifying endeavors undertaken in the Bay region to date.

Atlantic cordgrass is particularly problematic because it hybridizes so readily with native *S. foliosa,* according to conference presenters. In the hybrid swarm, different forms have transgressive traits that allow them to exploit a greater variety of niches. California clapper rails have used hybrid *Spartina* for nesting, foraging, and cover, and their population expanded as the hybrids spread. After *Spartina* control measures, clapper rail numbers dropped significantly in many marshes, although the population in the Hayward area has stabilized since treatment. The ISP's current strategy is to continue treatment on most marshes Bay-wide but to avoid selected marshes with high densities of clapper rail until the population stabilizes and treatment can be resumed. Not everyone is happy about this gap in a carefully planned seven-year program. Grijalva called 2011 "effectively a lost year" for comprehensive treatment. Over the next few years, the Project and its partners will be actively planting *S. foliosa*, Grindelia, and other native plants at 30-40 sites to rapidly improve habitat for rails. JE & ARO

App used by BAEDN for easy tracking of invasive plant sightings. Photo by Dan Gluesenkamp.



NATIVE FISH & WILDLIFE

Mixed Messages

Longjaw mudsucker, a native fish. Photo courtesy Jim Hobbs.

It's getting crowded around San Francisco Bay. Native birds, beasts, butterflies, and fish continue to be challenged as they hunt for food and shelter, compete with invaders, and struggle to adapt to human development and environmental restoration activities on their doorstep. In a Tuesday afternoon conference session, biologists assessed how a variety of wildlife are faring around the Bay.

Marsh birds, herons and waterfowl, reported Nadav Nur of PRBO Conservation Science, all remain sensitive to environmental conditions. Since 1993, biologists have been monitoring seven avian indicators—bird species selected because they're sensitive to environmental changes, easy to detect and count, and of high conservation concern. Many of these indicator species have shown net improvement, though in some cases, such as the California clapper rail, recent declines have followed earlier gains, said Nur. The overall picture is mixed. Populations of marsh-dependent song sparrows increased in the Central and South bays but declined in San Pablo and Suisun bays, possibly due to predation and flooding. California black rails increased in San Pablo and Suisun Bays. "Restoration has been helpful," he noted. While heron and egret populations appeared stable or increasing in many areas, those in the Suisun Bay region suffered a 20% decline in young produced per nest, which may signal an impaired aquatic food web; in particular, wintering numbers of diving ducks in the Estuary, especially canvasbacks and scaup, are down, possibly because of changes in their prey base and loss of deep-water habitat. But population counts don't tell the whole story. "For locally breeding birds, it's more important to monitor reproductive success," he said.

After Nur's state-of-the-birds overview, US Geological Survey biologist Michael Casazza delved into more detail on the status of the California clapper rail. Balancing removal of invasive Atlantic cordgrass (*Spartina alterniflora*) with rail conservation is "a tough management conundrum," he said. "Can we develop a strategy that avoids having to choose between maintaining ecosystem function and protecting this endangered bird?" The rail survived a population crash in the 1990s, then rebounded to a peak of 1,500 to 2,500 birds around 2005. The most recent surveys suggest a current population of about a thousand birds. "My goal is to provide sound scientific data for management decisions," said Casazza, who has used call-count surveys to do population estimates, and radiotelemetry to monitor the movements of 108 rails. Preliminary results suggest strong site fidelity, with only a couple of birds traveling long distances (from Colma to the North Bay). Survival in winter, when the rails are vulnerable to extreme tides, is low—half the rate of other seasons—and would have been lower without invasive *Spartina* as cover, he said. His data show an overall decline beginning 2008, with *Spartina* treatment doubling the rate of decline. "Revegetate, quick!" he urged. At Arrowhead Marsh, an East Bay treatment site, Casazza has experimented with artificial "floating islands" as high tide refugia for rails; he said they work, and some pairs also used them as nest platforms.

Other scientists have been tracking changes in the Bay's fish community, including its response to restoration in the South Bay. UC Davis' James Hobbs presented the results of a two-year survey of fish populations in restored ponds in the Ravenswood and Alviso areas and adjacent waters (see "Return of the Natives," *Estuary News*, August 2011)."Things look pretty good," he reported. Of 32 species detected, 97% were Bay natives. Longjaw mudsuckers (*Gillichthys mirabilis*), a sentinel species for contamination, have moved into the restoration ponds and are in good condition. In general, Hobbs said, fish communities are similar in restored ponds and natural sloughs.

Lange's metalmark. Photo courtesy USFWS.

Higher up the food chain, harbor seals (*Phoca vitulina richardii*) are also indicators of the health of the Bay (see "Flipperhold in the Bay," *Estuary News*, October 2011). Corinne Gibble of the Moss Landing Marine Laboratory analyzed the diet of the Bay's seals, a process that involves collecting their scat from haul outs ("We actually had a lot of volunteers," she said) and searching it for otoliths (fish earbones), squid beaks, and other identifiable remains of prey. She found regional variations: more anchovies consumed in the North Bay, more gobies in the South. Invasive gobies made up a larger proportion of the seals' prey base than in a 1991-92 sample. They may be "junk food," less nutritious than native fish. The dietary shift may help explain why the local harbor seal population is not increasing.

As the species health session neared its end, a creature far more delicate and colorful than the brown seals, black rails and grey fish made an appearance at the podium: a butterfly found only in the Antioch Dunes National Wildlife Refuge. US Fish and Wildlife Service biologist Susan Euing, the dunes' steward, said it was the first (and so far only) refuge in the system established for insects and plants. The insect is the Lange's metalmark butterfly (*Apodemia mormo langei*). Its larvae feed only on the locally endemic Antioch Dunes buckwheat (*Eriogonum nudum var. psychicola*). The refuge protects a remnant Aeolian dune formation surrounded by industry and the river. "In essence it's an island habitat," said Euing. "The butterflies can't go anywhere because the buckwheat doesn't occur in any other place." The metalmark's numbers have fluctuated from a peak count of 2,342 in 1999 to an all-time low of 28 this year. "There's an imminent possibility of extinction," she continued. The dune habitat has suffered from exotic plant invasions and frequent wildfires. Ironically, recent research indicates herbicides used to control invasive plants may be harming the butterfly; exposures reduced adult emergence by 20 to 40% in the closely related Behr's metalmark. To save Lange's metalmark, larvae are being bred at Moorpark College in Simi Valley and released in the refuge. North Coast Native Nursery and the California Native Plant Society are growing buckwheat seedlings to be planted by volunteers. The refuge has also experimented with cattle grazing as an alternative to herbicides. JE

RESTORING WETLAND LANDSCAPES

Lessons Learned & Next Steps

Examine almost any shore of the Bay—north, south, east or west—or even underwater, and signs of region's major restoration push abound. Observers can see water pouring through dikes, green shoots carpeting mudflats, hoses spouting slurried sediment, tide gauges poking out of pickleweed, and upon closer scrutiny, banded birds and radio-tagged fish. Everyone wants to know how fast the new wetlands are growing and which species they are serving, and how local communities can care for the ecosystem at the heart of their urban estuary. Nine speakers addressed this topic on Wednesday afternoon at the conference.

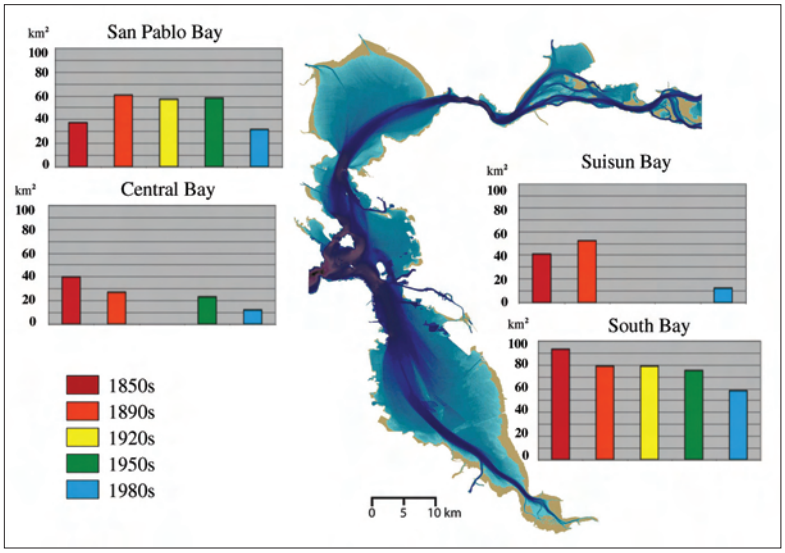
The State Coastal Conservancy's John Bourgeois kicked off the session with a progress report on the massive, multi-year South Bay Salt Ponds Restoration Project (see "Salt Ponds to Shorebird Heaven," *Estuary News*, August 2011). "We have a blueprint," he said, "but that doesn't mean we're on an easy road. It's not just a matter of putting water back in natural slough channels." Beyond breaching dikes, the project has had to install 53 new water control structures. Phase I of the project has modified or improved 3,750 acres to date. The work shows signs of changing the local ecology, as planned. Bourgeois has seen significant shifts in bird populations, including snowy plovers and avocets nesting on the recently reconfigured Pond SF2 in the Ravenswood area. He remains concerned about the tradeoffs between these new users and those species who frequented the ponds prior to restoration. "We're in the midst of a balancing act, and trying to provide alternative habitats," he said. Phase II of the project targets "big chunks of tidal marsh," he said. "We hope to get these marshes established, as well as broad upland transition zones, so they'll be more resilient down the road." Bourgeois also pointed out one major constraint to their activities in the urbanized, low-lying South Bay. "There are big areas we can't restore without true flood protection in place," he said.

The South Bay often gets the limelight. But the second speaker, Karen Taylor of the California Department of Fish and Game, described how 9,000 acres of wetland restoration have also advanced in the Napa-Sonoma marshes. In a joint effort between the state and the US Army Corps of Engineers, three former salt ponds were restored in 2006, three more were enhanced in 2007, and five more are now in progress. Monitoring efforts for these restoration projects are a collaborative effort between various state, federal, and other entities. "There's been quite a bit of sediment accretion in four years. We're very proud to see all three ponds developing the physical conditions required to establish a plant community on the marsh plain," said Taylor. As in the South Bay, fish and wildlife are responding to the new habitat. "Fish use of the Central and South units was immediate," she said. "The percentage of native species increased from 57 to 65." The fish in turn attracted harbor seals, river otters, and birds. California least terns and western snowy plovers now nest on restored habitat islands, and other avian species hunt for food in the mudflats: "Low-tide foraging by small shorebirds has exponentially gone up. We have a moving carpet of peeps running back and forth," said Taylor.

Another moving part in the restoration game is sediment supply. With supply going down naturally, and demand going up due to all this restoration activity, sediment experts like US Geological Survey oceanographer Bruce Jaffe are in the hot seat. Planners want to know how different locales in the Bay may respond to sediment supply shifts. Jaffe thinks the South Bay could lose mudflats due to a combination of sea-level rise and restoration. The sediment demand created by restoration will stress the system and potentially starve mudflats south of the Dumbarton Bridge, an area that has historically been a "sediment magnet," he said. Hydrodynamic and sediment-transport geomorphic modeling may help inform management decisions as the system changes. "For the long term, we have to go to modeling because we just can't collect the data we need or rely on the recent past as typical," he said. Jaffe suggested that planners may want to accelerate the pace of restoration while there's still enough sediment in the system.

A different set of challenges are facing the East Bay Regional Park District at Breuner Marsh in North Richmond, where restoration must be balanced with community access. "It's a very high-profile location, with a lot of public expectations," said the District's Brad Olson in his presentation. Olson explained that the shoreline at Breuner lies in "the front yard" of a low-income minority community called Parchester Village. "The community all along has been very supportive," he said. The Park District hopes to create 25 acres of new salt marsh and 20 acres of seasonal wetland at Breuner, along with enhanced habitat for rails, raptors, and the San Pablo vole, a California species of special concern. Olson explained that facilities, including a 1.5-mile Bay Trail link, are being designed with sea-level rise in mind. "At the end of the century the marshes will have migrated inland, and some features like the trail to the spit will be underwater. We plan to let those fail," he said. The Breuner project has a lot going

Tidal flat area decrease >50%



Source: Bruce Jaffe, USGS, State of the Estuary Conference 2011.

Data from Fregoso, T.A., Foxgrover, A.C., and Jaffe, B.E., 2008, Sediment deposition, erosion, and bathymetric change in Central San Francisco Bay: 1855-1979: USGS Open-File Report 2008-1312, 41 p. [URL: http://pubs.usgs.gov/of/2008/1312] • Jaffe, B.E., Smith, R.E., and Foxgrover, A.C., 2007, Anthropogenic influence on sedimentation and intertidal mudflat change in San Pablo Bay, California: 1856 to 1893. Estuarine, Coastal and Shelf Science 73 (1-2), 175-187, DOI:10.1016/j.ecss.2007.02.017 • Jaffe, B.E. and Foxgrover, A.C., 2006, A history of intertidal flat area in South San Francisco Bay, California: 1858 to 2005, USGS Open-File Report 2006-1262, 32 pp. [URL: http://pubs.usgs.gov/of/2006/1262] • Cappiella, K, Malzone, C, Smith, R. E., and Jaffe, B.E., 1999, Sedimentation and bathymetry changes in Suisun Bay, 1867-1990: USGS Open-File Report 99-563 [URL: http://geopubs.wr.usgs.gov/open-file/of99-563/].

Salinity reduction breach in the South Unit of the Napa Plant Site Restoration Project opened to tidal action for the first time in over 100 years on August 25, 2010. The plant site was previously used for solar salt production. Due to residual salt issues, breaching events were carefully phased to minimize the potential for adverse water quality conditions to the Napa River. Photo courtesy Karen Taylor, CDFG.

for it: congressional support, agency interest, and a community commitment to stewardship. "Hopefully we'll be able to put together a project that meets funding and permit requirements, satisfies the community, and benefits endangered wildlife," Olson said.

Also on the urban fringe, Heron's Head Park in San Francisco is a similar venture into community-based restoration. In his talk, Anthony Khalil of Literacy for Environmental Justice said "You can't restore land at the urban interface without restoring the people around the land." The people around Herons' Head live in Bayview-Hunter's Point, a neighborhood that encompasses San Francisco's only Superfund site and clocks the city's highest sulfur dioxide and particulates emission levels. The park itself is a former brownfield. Despite these challenges, local community members transformed Heron's Head into a park through habitat restoration and stewardship. The reason the name of Khalil's organization refers to ecological literacy is because "learning the names of things like plants and birds is the beginning of stewardship," and a way of engaging city kids who don't like bugs, he explained. Clapper rails do like bugs, at least the aquatic kind living in the mud at Heron's Head marsh, however. This summer, the restored habitat attracted a pair of endangered rails who raised two chicks (see "Rails in the City," *Estuary News*, October 2011). Khalil called the event "a profound benchmark of restoration."

In the next presentation, the State Coastal Conservancy's Marilyn Latta reminded the audience of the release earlier this year of the final version of the San Francisco Bay *Subtidal Habitat Goals Report*. "The bottom of the Bay hasn't received as much attention as the wetlands and uplands until now," she said, heralding completion of the 180-page technical report as a milestone in Bay restoration planning. Although the new goals are non-regulatory, she hopes they will set the stage for policy changes. Latta shared stories about the difficulty of studying the subtidal realm—the muddy bottoms, rocky reefs, and seagrass beds largely invisible and hard to access in cold water and high currents—and the remaining uncertainties. "It's hard to set targets for protection if we don't know the distribution, function, and amount of habitats. The goals report is a great list of research questions for graduate students," she said.

Much more of the Bay may soon be subtidal if projected sea-level rise over the next century comes to pass. Speaker Howard Shellhammer of H. T. Harvey & Associates asked the audience to imagine looking down on San Francisco Bay fifty or a hundred years in the future: "My guess is it will look like Holland, with large dikes holding back the sea from a continuous span of urban development." Even if the region does build a lot of new dikes to protect Bay cities, these bare mounds won't offer much decent habitat to sensitive species. "High marsh is a place where rodents and rails can go when high tides cover the marsh. A salt marsh at winter solstice—it's crazy, it's bacchanalian," said Shellhammer, referring to times when the marsh teems with creatures popping out from the vegetation. Most of what remains of this high marsh ecotone around the Bay is very narrow and remains vulnerable to invasive plants like *Lepidium* which degrade habitat. Natural marshes offer species high spots both inside and outside the low marsh zone, and naturally retreat inland with sea-level rise. Shellhammer would like to see restoration efforts that create "a few very large marshes that can develop both internal and peripheral high marsh," and that connect fragmented smaller habitats around the Bay.

Internal or external, every high marsh requires a foundation of sediment. Speaker Brenda Goeden of the SF Bay Conservation and Development Commission picked up the thread of the sediment budget issue spun out earlier in the session. "We're facing a double whammy: reduced sediment supply and rising sea level," she warned. Supplies remain stuck behind dams high up in the watershed, and scientists say those introduced by historic hydraulic gold mining are now flushing out of the system after more than a hundred years of clouding the Bay. In addition, researchers are seeing effects of humans removing sediment from the system both inside and outside the Bay and along the outer coast. Sediment dredged from bay shipping channels and marinas may provide some supply for restoration, as it did at sites like Hamilton and Montezuma wetlands, but Goeden isn't convinced supply will be adequate for future projects. Restoration designs need to be adapted, she said, to reconsider target habitats and the proximity of restoration projects to sediment-bearing tributaries. Other sediment management practices such as flood control channel and watershed management may need to be revised to redirect sediment into areas of crucial need. The climate may be becoming less hospitable for restoration but the need for it is more urgent than ever to stabilize shorelines and adapt to sea-level rise, said Goeden.

The final speaker Wednesday afternoon described a tool that may help cities, counties, and planners like Goeden make some of the hard choices ahead about investing in restoration. Gregory Guannel of the Natural Capital Project introduced InVEST, a computerized tool for quantifying the value of the ecosystem services provided by wetlands. InVEST, Guannel said, can evaluate changes resulting from specific management actions aimed at coastal protection. The model's outputs allow planners to rank shoreline segments by risk of erosion and inundation during large storms. It can also be applied to quantify the protective benefits provided by living structures (such as oyster reefs, marshes, mangroves, coral reefs) against nearshore flooding and erosion. "In Mobile Bay off Alabama, oyster reefs provide coastal protection by reducing the size of waves," he explained. "Likewise, having more marsh may reduce the amount of storm surge. It's a way to help stakeholders talk about the future of their region." JE

CLIMATE DRIVEN ECOLOGICAL CHANGES

Scaling to the Local Level

Climate change is coming to a bay near you—bringing with it earlier snowmelts, more flooding and fires, and retreating coastal wetlands. Experts predict San Francisco Bay will rise by 16-55 inches within the next 50-100 years, and may collude with high tides and storms to spread water over what is now "dry" land. Of course much of what is dry now was not in the past. Many acres of our airports, freeways, harbors and urban waterfronts sit on bay fill, making our region particularly vulnerable to sea-level rise. So it's no wonder scientists are scrambling to downscale global climate models to take into account local conditions, and to provide those charged with protecting wildlife and water resources, not to mention urban infrastructure, with tools to help them plan for a climate-changed future.

Ellie Cohen opened the climate change session of the conference on Tuesday afternoon by describing regional efforts to coordinate Bay climate science and develop indicators of ecosystem impacts. Cohen hails from PRBO Conservation Science, which helped organize the two-year-old BAECC initiative (Bay Area Ecosystems Climate Change Consortium). "We all know climate change is accelerating and we have not a moment to lose," she said. "We need to connect people across boundaries," she said.

A key foundation for this planning process will be downscaling global climate models to the finer scale needed for local planning. Second up on the podium, US Geological Survey hydrologist Alan Flint spoke to the challenges of projecting the region's future climate. "We have to simulate regional hydrology in local watersheds using very coarse models," he said. USGS is working with scenarios generated by the International Panel on Climate Change's Fourth Assessment (IPCC). While all scenarios show rising temperatures, parameters like runoff and recharge vary. Even in a relatively compact area like the North Bay, Flint cautioned that not all land managers will see the same thing. Flint used the North Bay watersheds as a case study to run various simulations of hydrologic change, in which dry and wet seasons change in duration and timing. He also described the concept of the "climatic water deficit"—when annual evaporative demand exceeds available water. "Even if there's more rain, it will be lost to runoff and recharge," Flint said. Deficits may result in landscape-scale changes: "In Sonoma County, areas suitable for redwood forest could shift to the coast," said Flint, by way of example. Whichever scenario, drier or wetter, warming could amplify the climate water deficit in North Bay watersheds by 5-20% by the end of the 21st century. Indeed the climate water deficit will be going up statewide, said Flint.

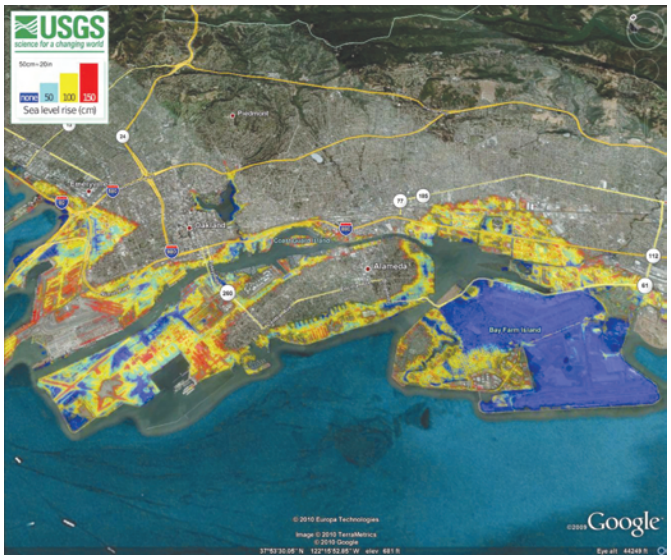
Hydrologic changes due to global warming will also pile up on top of natural changes in ocean cycles and coastal currents. San Francisco Bay, perched in the interaction zone between a vast continent and even vaster ocean, is already influenced by powerful coastal processes. As John Largier of the Bodega Marine Laboratory explained, San Francisco Bay is part of the California Current Ecosystem, one of the planet's four large mid-latitude boundary current systems. This system has been suppressing sea-level rise until recently (see next paragraph). The Bay is also influenced by seasonal upwelling of cold water from offshore depths. "Over the last 28 years, there's been a trend toward increased upwelling. Only time will tell if it's a long-term trend or a shorter-term fluctuation," he said. Largier and other scientists also want to know if the intensity of upwelling is changing, how far and strongly it intrudes into the Bay, and even what the make-up is of its load of nutrients and fish food. Recent decadal oscillations in oceanic conditions complicate the picture. "We're now in a warm period in the Pacific Decadal Oscillation but may be going into a cold period. The last such change was in the 1950s, before the modern era of studies," said Largier. The oscillation appears to have brought about a regime shift in the Bay's community of fish, invertebrates, and phytoplankton. Factoring human-induced climate change into these other major shifts in the region's environmental conditions may prove a complicated research endeavor.

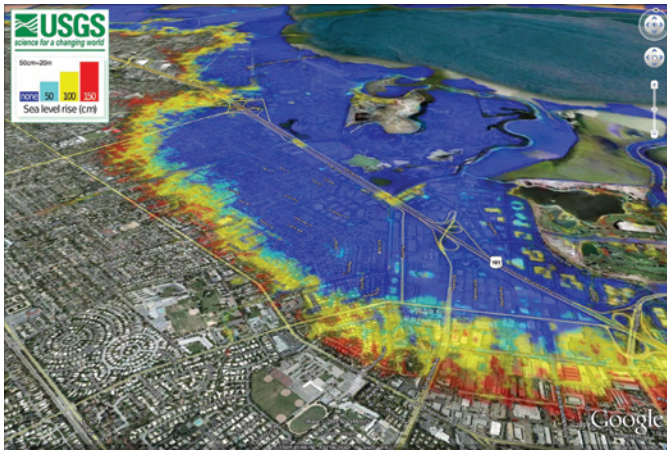
But scientists do seem pretty clear on the basics of how rising sea levels, caused by thermal expansion of the ocean and melting land ice, will alter the physical structure of the Bay and outer coast. As speaker Patrick Barnard of USGS explained, more frequent flooding of the Bay margins and geomorphic changes to the Bay floor are likely, superimposed on a current pattern of sediment loss. Meanwhile, shoreline erosion rates on the outer coast have increased by 50% since the 1980s. "West Coast sea-level rise has been suppressed for the last thirty years by dominant wind patterns along the US West Coast," said Barnard. "But these patterns appear to be relaxing, so we're likely to return to the global rate or higher."

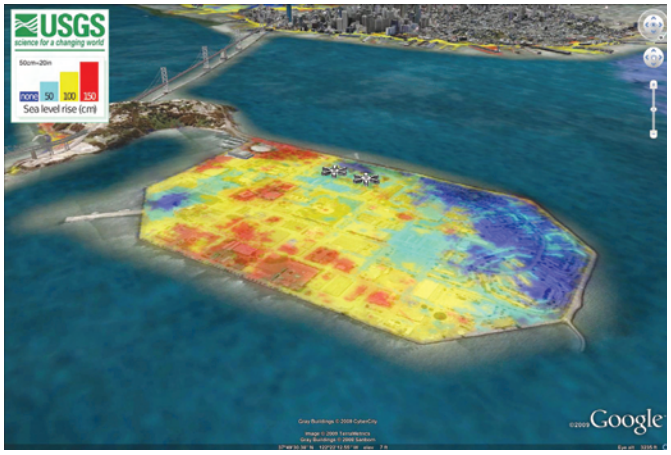
Barnard's colleague Noah Knowles has prepared the first complete analysis of the Bay's vulnerability to coastal flooding under different climate change scenarios, with ominous results. As Barnard explained it, "Sea-level rise will inundate new areas and increase the risk of levee failures in others. By 2050 the one-year peak flood event could equal today's hundred-year peak event. The Oakland airport, South Bay tech sector, and Treasure Island are all extremely vulnerable." In addition, the Bay's tidal wetlands require a steady supply of sediment to keep up with sea-level rise or risk being permanently inundated. Observations by Dave Schoellhamer suggest the supply of sediment from the Delta has been sharply reduced in recent decades, and therefore the ability of these sensitive ecosystems to keep pace with sea-level rise will be a struggle.

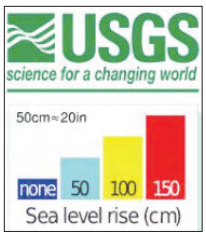
As the sea creeps inland, bringing even more of the ocean into the Bay than current tides do, those managing the ocean resources of the region's coast are also making preparations for climate change. Speaker Kelley Higgason of the Gulf of the Farallones National Marine Sanctuary described a multi-agency project to provide managers and planners around the Bay and along the outer coast with science-based decision-support tools that will better equip them to deal with sea-level rise. The project has already organized two regional workshops to help outer coast decision-makers to clarify their needs. "Most are currently using the State of California's interim guidance sea-level rise scenarios, but not San Francisco, it varies by agency and mandate," said Higgason. More workshops are planned for 2012 in the Bay region. "What the tool can't do is endorse a particular retreat strategy or specific adaptive actions," she cautioned. "Our goal is to provide information for managers to use to make decisions, not to say 'These are your best options.'"

Whatever the prescription, retreat or adapt, wetlands can do both naturally. Scientists have been busy trying to pin down just how rapidly the Bay's wetlands might be able to build up









Areas projected to be vulnerable to inundation by 100-year high water levels under different amounts of sea level rise. *Top:* Alameda and Bay Farm Island; *Middle:* South Bay, Palo Alto; *Bottom:* Treasure Island. Source: Noah Knowles, USGS, 2011.

sediment to stay ahead of rising water levels, and if there is enough sediment in the Bay system to do so. To this end, speaker Kathleen Swanson of the USGS described her efforts to fine-tune the Wetland Accretion Rate Model of Ecological Resilience (WARMER) so it can better assess the sustainability of salt marsh habitat. WARMER is an adaptation of a marsh accretion model developed by John Callaway of the University of San Francisco. Swanson's version incorporates data from four sites in the Bay: China Camp, the Petaluma River marshes, Laumeister Marsh and Coon Island. Sea-level rise is one sensitive parameter in the new model, and the influx of sediment into a marsh another. "In one scenario we ran, all the high marsh habitat at Coon Island was lost in the first 20 years," said Swanson, a loss that, if extended to other wetlands around the Bay, wouldn't bode well for endangered rails and mice in need of high-water refugia.

Speaker Samuel Veloz also discussed salt marsh as habitat for vulnerable species, and the need to identify those habitats that might best weather climate change. Veloz, who works for PRBO Conservation Science, described using models to inform restoration planning with a focus on the needs of the California black rail, California clapper rail, common yellowthroat, marsh wren, and song sparrow. "We created statistical models to predict the occurrence of species and the carrying capacity of habitat," he explained. "If we take away levees a lot more habitat area may become available, but not all that area is equal." Veloz hopes the models can be used to rank potential restoration sites: "We can get a sense of which projects will be more resilient to climate change. Others might need to be redesigned."

Wetlands can help mediate climate change impacts in more ways than just providing adaptable habitats for wildlife and buffering cities from storm surges. Speaker Stephen Crooks of ESA Inc. pointed out that rebuilding Delta island soils to restore freshwater wetlands can sequester carbon (see Banking on Tules, *Estuary News*, October 2011). Reporting data gathered by the USGS, he said reversing subsidence in Delta wetlands could halt 25 tons of carbon dioxide emissions per hectare each year and remove an additional 37 tons of carbon dioxide per year from the atmosphere, even allowing for increased methane emissions as the marsh builds up. Governments and investors are showing interest. On a global level, Crooks and other advocates have persuaded the IPCC to investigate the potential for coastal wetlands to be included in national greenhouse gas accounting.

At the close of the climate change session, speaker Wendy Goodfriend of the SF Bay Conservation and Development Commission profiled her agency's efforts to provide local adaptation planning guidance. In a project called Adapting to Rising Tides, BCDC is evaluating the vulnerability of a portion of Alameda County (from Emeryville to Union City) to sea-level rise and storm events. Goodfriend says her agency chose to focus on this portion of Alameda County initially because it has "diverse shoreline types, both built and natural, and regionally important transportation infrastructure." New sea-level rise and storm event maps are being developed for the project that will include existing shoreline protection, daily and extreme tide levels, storm wave scenarios, hydraulic connectivity, and depth of inundation. In addition to these new, refined inundation and flood maps, the shoreline has been categorized based on its ability to protect inland areas from flooding and inundation (e.g., engineered flood protection structures, non-engineered berms, natural beaches, etc.) and analyzed to determine the potential for overtopping. In sum, the analyses will provide a comprehensive picture of the shoreline vulnerability and risk for six future climate scenarios, says Goodfriend. "We can start showing people who own and manage shoreline that they can make a difference to the region's future climate resilience," she concluded.

Regional agencies may be embracing the need to plan for sea-level rise, but some federal agencies are not. Though the Federal Emergency Management Agency is updating its 100-year flood determination for the outer coast, it is not factoring in sea-level rise. But other public agencies are paying attention, and so are private interests. According to Andrew Flint, "We're beginning to hear about some long-term investors trying to avoid investing in things along the coast." JE & ARO

IMPROVING WATER QUALITY

Beyond the Basics

The Bay may be clean enough to swim in most of the time, and its fish safe to eat some of the time, but it's far from pristine habitat for aquatic life all of the time. Today's level of "cleanliness" comes from major strides in wastewater treatment and pollution prevention work around the Bay between the 1980s and today. But some contaminants—especially those that got into the Bay before the Clean Water Act and those that no treatment plant can yet remove—may take a long time to go away. At the Tuesday afternoon session on water quality, conference attendees got an overview of recent progress, new findings, and remaining challenges.

First speaker Jay Davis, the scientist in charge of the Regional Monitoring Program for the San Francisco Estuary Institute, reviewed the water quality findings of the 2011 *State of the Bay* report for the audience. He discussed how levels of many heavy metals and the banned pesticide diazinon have been going down in the Bay in recent decades while levels of other contaminants have been going up. Mercury, trash, invasive species, oil, and pyrethroids (the pesticides that replaced diazinon) continue to be a problem. The report suggested that rapid progress could likely be made on preventing more trash and new exotic invaders from entering the Bay, while rapid progress on clean-up of mercury and other "legacy" contaminants in the sediments was unlikely. "We've learned that the Bay recovers very slowly from persistent particle associated contamination," he said. The report also highlighted concerns about emerging new contaminants like fluorinated stain repellents. "If we become complacent water quality could decline," said Davis. In the worst case, we could see excessive algae, new bioinvasions, and increased selenium and mercury, all exacerbated by deteriorating infrastructure and even earthquakes. In the best case, "We follow through with existing plans and regulations, and with detection and prevention of emerging problems, and with addressing tractable aspects of legacy contamination," said Davis. Only then may we see a significant general improvement in Bay water quality.

The safety of water contact recreation was the topic of the second presentation by Mike Kellogg of the San Francisco Public Utilities Commission. Kellogg said getting in the water off most Bay Area beaches is safe 90% of the time, especially April through October. The wet weather during the winter leads to elevated bacteria levels. In the drier months, one of the biggest sources of beach contamination problems is what they refer to in the water quality trade as the dingleberry phenomenon. In other words, it's all the kids on the beach with dirty diapers that can trigger bacterial pollution events. The good news is that beach water quality conditions are regularly monitored and published on county web sites, and summarized on Heal the Bay report cards. EPA is currently revising its recreational water quality criteria, which haven't been updated since 1986. New criteria are due out in October 2012. In the meantime, Kellogg is excited about new molecular methods that can detect a hit list of major pathogens, as compared to the older method of culturing bacteria for 18-24 hours. "Whenever we post a beach as unsafe, it's a day after the fact," said Kellogg. "Molecular methods may be faster, but notification by noon would be a heroic feat for most counties." A good rule of thumb is avoid water contact during rainfall and for 72 hours afterwards, he said.

Fish can't avoid much of anything in the water, and those species that live a long time or are very fatty tend to build up more contaminants in their tissues. Speaker Margy Gassel of the State's Office of Environmental Health Hazard Assessment discussed the evolution of the state's safe eating guidelines for bay fish. The state issued its first fish advisory for the estuary in 1971 against eating striped bass due to unhealthy levels of mercury. Advisories evolved to target those most sensitive, women of childbearing age and children, and to include other fish species and contaminants such as PCBs. The state began sampling eight Bay fish species favored by local anglers in 1994, and has since collected nearly a decade's worth of triannual data (over 600 samples). It has also finetuned its methods and guidelines—teasing out the difference between skin on and skin off consumption, for example, as well as calling out those species combining the worst of two contaminants: mercury and PCBs. In general, guidelines warn against too frequent eating of striped bass, white croaker, white sturgeon, shark, and surf perches. Two new interesting developments were, firstly, that the size of a striped bass is not really a good predictor of mercury content: "We can't draw a line anymore at different lengths," said Gassel. Secondly, tests show California's ubiquitous flame retardants aren't building up in Bay fish. "PBDEs were well below levels of concern," she said. "So you can still eat bay fish, just check advisories."

The embryos of smaller forage fish such as herring that spawn on the surfaces of bay pilings and of macroalgae are especially susceptible to the toxic effects of oil spills, said the next speaker, Nat Scholz of the National Oceanic and Atmospheric Administration (NOAA). "Herring eggs can be in harm's way," said Scholz who together with his NOAA team and their colleagues at UC Davis' Bodega Marine Lab studied the effects of the 2007 *Costco Busan* spill of 57,000 gallons of bunker fuel into San Francisco Bay. Scholz described how oil affected the developing hearts of herring embryos that were placed in subtidal cages near oiled and unoiled shorelines in the Bay. The team also documented very high rates of mortality among naturally-spawned herring embryos in the lower intertidal areas of oiled habitats, presumably due to a toxic interaction between the spilled oil and natural sunlight. The team's findings will be published this winter in two scientific journal articles.

Photo by Jude Stalker.

Oil and water don't mix, and plastic isn't very soluble either. Trash floating along shores and cluttering up creeks can be just as unpleasant as the Bay's rotten-egg smell was to

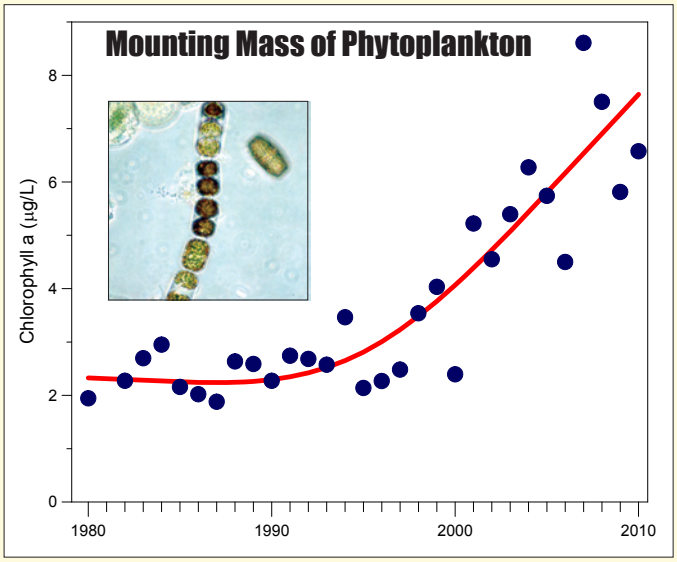
NUTRIENTS: A VINTAGE PROBLEM WITH A NEW TWIST

Nutrients like nitrogen and phosphorus are vital to natural systems. But nutrient-laden sewage or fertilizer entering ponds, lakes, and waterways can boost the growth of algae and plants, which suck oxygen from the water and create a hostile environment from many aquatic species. On a global scale, nutrient overloads have caused hypoxic dead zones in North American, European, and Asian coastal waters. The San Francisco Bay Estuary is a much more complex system than a farm pond, but it's not immune to eutrophication—which could have dramatic consequences for food webs, biodiversity, and human health.

At the conference, four speakers described nutrient loads and effects on the Estuary's ecosystems. First up, Tara Schraga of the US Geological Survey talked about research led by James Cloern on changes in the Bay's phytoplankton community (see "More Bay Blooms," *Estuary News,* October 2011). Schraga compared San Francisco Bay with Chesapeake Bay. Our Bay, she said, has been more resilient to nutrient impacts, in part because its greater turbidity limited algal growth and its large population of filter-feeding bivalves kept phytoplankton in check. Our Bay hasn't had Chesapeake's history of harmful algal blooms and fish kills, she said, but that may be changing. Since the 1990s, San Francisco Bay has seen dramatic increases in chlorophyll *a*, an indicator of phytoplankton biomass, and decreases in dissolved oxygen (see chart). "Something happened after 1998," she said. The change may be linked to increased numbers of demersal flatfish, crabs, and shrimp feeding on bivalves. Scientists aren't sure if changes are long term.

Phytoplankton is not just an undifferentiated mass of small green things. As Raphael Kudela of UC Santa Cruz pointed out in his talk, some algal blooms can be deadly to marine life and dangerous to humans. "Harmful algal bloom organisms love our waste and nutrients even better than harmless organisms do," he said. Although harmful blooms have been historically rare here, a number of problematic algal species are present. *Microcystis*, typically a freshwater problem, has been recently detected in coastal waters. Other species of emerging concern include the red-tide-producing *Akashiwo sanguinea*, which may be associated with bird die-offs. Insufficient sampling clouds the picture of what's out there. The relationship between nutrients and phytoplanktonic organisms can be very specific, Kudela said: "Given urea, *Pseudo-nitzschia* can double its toxin production." Other nitrogen sources don't have the same effect.

Ammonia, a compound of nitrogen and hydrogen, is a nutrient of concern in the Delta, where levels have historically been high. The Sacramento Wastewater Treatment Plant is the major source, discharging 15 tons per day. One issue, according to Central Valley Regional Water Quality Control Board ecologist and speaker Chris Foe, is its potential toxicity to the Delta smelt (*Hypomesus transpacificus*) and to copepods including *Pseudodiaptomus forbesi*, a key food source for Delta fish. Samples indicated that ammonia concentrations rose eleven-fold below the treatment plant but decreased rapidly downstream as microorganisms converted it into nitrite/nitrate. The sampled concentrations were below the toxic threshold for the smelt, but were toxic to *P. forbesi* for 30 miles downstream of the plant and high enough to inhibit the growth of diatoms. A new Water Board permit for the Sacramento plant requires reduction of discharged ammonia to non-toxic levels.



Annual mean phytoplankton biomass (chlorophyll *a* concentration) in surface waters of South San Francisco Bay (USGS stations 21-33) for the months June through October. Data available online at: http://sfbay.wr.usgs.gov/access/wqdata/. Figure by Jim Cloern, USGS. Inset: *Melosira* sp. diatoms, among the phytoplankton responsible for algae blooms. Photo by Carol Burns Lopez.

For nutrients such as nitrogen and phosphorus, figuring out safe levels in our estuaries is a challenge. "Nutrients support life, so the problem is figuring out how much is too much," said Martha Sutula of the Southern California Coastal Water Research Project. "Direct toxicity is seldom the endpoint of interest, because adverse effects from algal overgrowth and low dissolved oxygen occur at much lower nutrient levels." For San Francisco Bay, there's no existing framework to assess whether beneficial uses are being compromised by nutrient overenrichment and eutrophication. To establish this framework, water quality regulators are considering an approach that involves measuring the response to nutrients (e.g. overgrowth of algae, dissolved oxygen), coupled with a model to link those measures back to nutrients and other management controls. This approach is known as the California Nutrient Numeric Endpoint (NNE) Framework. With the federal EPA pushing the states for nutrient objectives and local water managers on board to develop a nutrient management strategy for the Bay, Sutula thinks that the timing is right to develop an NNE assessment framework for the Estuary. JE

shoreline residents in the 1960s. The smell only drifts into downtown windows on occasion now, thanks to decades of clean water action on the part of nonprofits and public agencies. Speaker Tom Mumley, who works for the SF Regional Water Quality Control Board, described progress on the regulatory side of water quality management, in particular working on "TMDL" projects. Developing TMDLs typically involves regulators working with multiple sources—dischargers and municipalities—to reach an agreed-upon specific maximum regionwide load of a contaminant. In the Bay coastal region, TMDLs have been completed for mercury and PCBs, and are underway for legacy pesticides, dioxin, and selenium. "TMDLs don't solve problems, they're a call to action," said Mumley. He also described the "tremendous progress" made by publicly owned treatment plants, resulting in a 48% decrease in copper loads in wastewater since 1995, for example. "The biggest challenge we're dealing with now is aging infrastructure, such as sewer overflows caused by tree roots," he said. Stanching pollution from urban runoff

Water Quality session continued

Ballast Water Treatment Comparison

Organism Group	EPA Targets	Shipboard Treatment	Onshore Treatment
Zooplankton	500x reduction	10x to 100,000x reduction	100,000x to 10millionx reduction
Phytoplankton	30x reduction	5x to 2,000x reduction	100,000x to 10millionx reduction
Protozoans	None	30x to 8,000x reduction	100,000x to 10millionx reduction
Bacteria	None	2,000x reduction to 800x increase	1millionx to 100millionx reduction
Viruses	None	No data available	100,000x to 100millionx reduction

Reductions in viable organisms achieved by shipboard systems vs. onshore systems using conventional water treatment methods. EPA targets are reductions from the current mean concentrations in untreated ballast discharges that would be required by the EPA's proposed discharge standards. Source: Andrew Cohen, CRAB.

is also a challenge. Mumley described recent efforts to consolidate all municipal stormwater discharge permits for 76 communities into one single regional permit (see page 15).

Another challenge may be a new push to prevent non-native species, which are considered to be biological pollutants, from taking over San Francisco Bay. Since 1850, at least 300 exotic species have colonized the Bay and Delta according to speaker Andrew Cohen, from the Center for Research on Aquatic Bioinvasions (CRAB), with the most recent wave arriving in ships' ballast tanks. Court decisions require the US Environmental Protection Agency to issue national ballast water discharge standards to address this problem. Cohen discussed the "contentious" debate that erupted this year on the EPA's Ballast Water Advisory Panel, on which he served, regarding the use of shipboard versus onshore treatment systems to remove organisms from ballast water before discharge. The Panel reported that onshore treatment is feasible, as well as more reliable and adaptable than shipboard treatment. Onshore treatment is also apparently less expensive to build and easier to monitor and enforce. As Cohen put it, "Thousands of treatment plants roaming around the world on ships would be very challenging to monitor." The data also suggest that onshore treatment would be much more effective at removing or killing the organisms in ballast water (see table). "There is a stark difference between the two approaches, and as one Panel member commented, 'choosing between them is a no-brainer,'" said Cohen. Nonetheless, the EPA recently released proposed standards based on shipboard treatment that are the weakest of all the options on the table (public comment period ends February 21, see page 24).

Invasive organisms are not the only threat to bay water quality carried by ships. The deteriorating "mothball" reserve fleet of 52 vessels up in Suisun Bay has been a sore spot for water quality regulators for other reasons. "Our main concern was the discharge of soluble and non-soluble metals in paint flaking off ships that were being cleaned in the water and stored in the Bay for decades," said speaker Bruce Wolfe, from the Regional Water Board. Wolfe described what he called the "saga" of his agency's efforts to apply pressure on the US Maritime Administration to address ongoing pollution from the ghost fleet. Board staff evaluated a number of tools, he said, from cease and desist orders and technical report orders to penalties and press attention. "There was a lot of push back from the Maritime Administration," he said. The Board and environmental groups eventually sued. Two things changed in 2010 as a result of the lawsuit: first, a judge ruled that each vessel was a "point source" of pollution, changing the Board's level of cleanup clout; and second, Obama's new appointee to the Maritime Administration offered a "breath of fresh air," said Wolfe. The Administration has since agreed to pull all ships into dry dock before cleaning their hulls, and to remove all exfoliated paint before transferring ships to a permanent graveyard in Texas. Two hundred tons of old paint have already been removed from the 25 ships in the worst shape. Enforceable goals have been set to get all the exfoliated paint off the entire fleet by September 2012, and then dismantle and recycle all of the vessels in stages between now and 2017. A few ships will remain in Suisun Bay, however, waiting to be called up to serve the country at sea.

Next speaker Naomi Feger, also of the Regional Water Board, tackled the issue of managing emerging contaminants such as pyrethroid pesticides, flame retardants, and perfluorinated chemicals used as stain repellants and in fire-fighting foams. "We're trying to focus our limited resources based on environmental risk levels," she said. Flame retardants (PBDEs and others), so widely used in California for fire safety, have been of "elevated concern" to the Board, she said. They're entering the Bay from many sources, including upholstered furnishings and computers, as they attach to dust particles that get into the air, and then into stormwater and wastewater. Some of the highest levels measured in the world occur in humans and wildlife in the Bay region. As a result, the board added PBDEs to the suite of contaminants now regularly checked in bay waters, sediments and biota by the Regional Monitoring Program. So far, monitoring results haven't shown any alarming trends in PBDEs in mussels, sediments, bird eggs, or sport fish. The only hot spot, she says, is a marsh near the region's only foam production plant. Californians banned several flame retardants in 2003. "A chemical ban is a good thing, but leaves unanswered questions about what's still out there that will continue to migrate from our homes and offices into the environment," said Feger. Based on trends to date, the Board doesn't think the Bay should be listed as "impaired" by flame retardants, but Feger remains concerned about high levels in seals and localized hot spots.

Seals, as long-lived mammals higher up the food chain, accumulate more contaminants than fish, birds, and other wildlife. Scientists have detected long-banned PCBs and DDT in harbor seal tissues for decades, and more recently PBDEs. Speaker Denise Greig of The Marine Mammal Center discussed her recent analyses of contaminants in the blubber of newborn pups found stranded or dead in the Bay region. Pups would have absorbed contaminants from their mother's milk, and their levels reflect maternal loads, said Greig. "Nursing pups are feeding at a higher trophic level than they will be when they're mature enough to catch fish on their own," she said (as reported in "Flipper Hold on the Bay," *Estuary News,* October 2011). Greig found more PCBs in San Francisco Bay pups and more DDT in Monterey Bay pups. She is now exploring whether specific contaminants, as opposed to many other stresses, actually impact health and survival.

All of these presentations raise the underlying question of whether we can somehow stop contaminants from getting into the Bay, and its wildlife, in the first place. In the final presentation of the day, Debbie Raphael of the Department of Toxic Substances Control discussed California's Green Chemistry Initiative.

TRASH OVERHAUL

Trash is the pollutant that everyone can relate to. Whether it's clogging urban creeks, floating at the Bayshore, or accumulating in the middle of the Pacific, the coast's trash problem is all too tangible. In a Wednesday afternoon session, representatives of local agencies and nonprofits talked trash: sources and strategies. The SF Bay Regional Water Quality Control Board's trash reduction requirements in the Municipal Regional Stormwater Permit added urgency to the discussion. The permit gives municipalities deadlines: reduce local trash in waterways by 40% by 2014, and to zero by 2022.

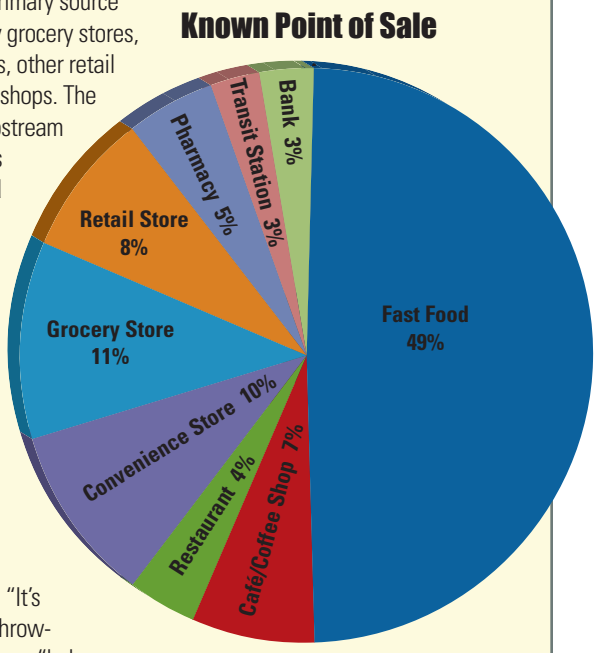
Measuring progress toward meeting those requirements will eventually require new more accurate methods for monitoring trash flux in creeks, said Dale Bowyer of the Water Board. Rapid Trash Assessments of trash hotspots provide a snapshot of what's at shorelines and along streams. Trash in the water is harder to quantify. Researchers in Los Angeles County used hand nets and manta trawls to sample trash in streams and measure the plastic debris component, but these and other direct methods have their challenges. "Filamentous algae can clog the equipment," Bowyer said. "And we have to be careful not to net fish."

Speaker Melody Tovar of San Jose's Environmental Services Department recounted one city's experience with trash reduction. "It's been slow progress, balancing cost and effectiveness," she said. The strategy is three-pronged: prevention, interception, and cleanup. Preventive measures include a Bring Your Own Bag ordinance (see p. 5 graphic) and a Green to Go program aimed at take-out foam food packaging. Technology has helped with interception: two hydrodynamic trash separators have been installed, with more in the works. With the help of volunteers and partner organizations, the city removed more than 190 tons of trash from streams last year alone in San Jose. "We're gluttons for partnership," said Tovar. Environmental and social objectives align in a pilot project which will provide homeless individuals cleaning up trash in Coyote Creek with incentives, transitional housing, and other assistance. The goal is to transition 50 individuals living in creek encampments into permanent housing over two years.

On the regional level, speaker Janet Cox of the San Francisco Estuary Partnership described the Partnership's efforts to help Bay Area cities and counties meet regional trash reduction requirements. The Bay Area-wide Trash Capture Demonstration Project, operating on $5 million in federal stimulus funds, purchases trash capture devices for 66 participating municipalities and facilitates information sharing. Equipment costs range from $250 for small media filters that retrofit catch basins to $200,000 for a large hydrodynamic separator that removes trash from infrastructure draining many acres. "The smaller ones are cheaper to buy but more expensive to maintain," Cox said—although maintenance requirements provide jobs. All devices purchased with grant funds should be in place by November 2012. An additional $3 million in state funds may be available for disadvantaged communities if that amount can be matched from local sources.

Although creek trash has many components, the plastic bag and the polystyrene takeout container are ubiquitous. Save the Bay's Allison Chan reported progress in controlling these products, with more cities jumping on the "ban wagon." Save the Bay, she explained, works directly with local municipalities to curb their use, providing the resources cities need to pass local ordinances. The movement has gained momentum despite pushback from the plastics industry and the economic climate. In the past two years, Marin, San Mateo, and Santa Clara counties and the cities of Hayward and Fremont have come on board, as have some business groups. Save the Bay also identifies local creeks as trash hot spots and runs an adopt-a-hot-spot contest. "Recycling doesn't solve the litter problem," Chan warned.

Miriam Gordon of Clean Water Action had the last word in the trash talk session. "Trash in waterways is an emblem of massive disregard for natural resources and the epidemic of thoughtless, unsustainable consumption," she said. "Surveys can tell us the composition of trash but not where it's coming from." Clean Water Action and partners inventoried litter in selected urban neighborhoods over a two-year period. They collected and categorized 11,395 individual pieces of trash—not counting cigarette butts, which were "too numerous to count." Of the trash logged, take-out food and beverage packaging accounted for 67%. Fast food outlets were the primary source (49%), followed by grocery stores, convenience stores, other retail stores, and coffee shops. The ultimate goal in upstream source reduction is to reduce food and beverage packaging through local ordinances that promote reusable containers and voluntary reduction of disposables by business. "We need to make best management practices normal," Gordon concluded. "It's time to end that 'Throwaway Lifestyle.'" Even "baby steps" by a few proactive major players such as Starbucks, KFC, and Jamba Juice should be recognized as progress, she said. JE



The largest sources of litter were fast food and grocery stores. Graph accounts for litter with known POS (19% of the litter). Source: Clean Water Action.

Raphael outlined the principles of green chemistry, which range from designing chemicals to be safer and more degradable to preventing waste and promoting energy efficiency in their production. "This is another tool in the pollution prevention toolbox. We're trying to accelerate the quest for safer products," she said. The tool derives from AB1879, the Safe Consumer Product Law. The law enables the state to ask product managers questions like: 'Is it necessary to put formadehyde in carpet adhesives? Or flame retardants in furniture?' Sometimes the answer is 'no, or not always,' according to Raphael. "This regulation is a phenomenal opportunity for innovation. It's the first time a public agency is requiring meaningful, honest alternatives assessments," she said. ARO

CREATING RESILIENT URBAN WATERSHEDS

Creeks, Beavers and Beaches

Arambaru beach restoration, Marin County. Photo by Peter Baye.

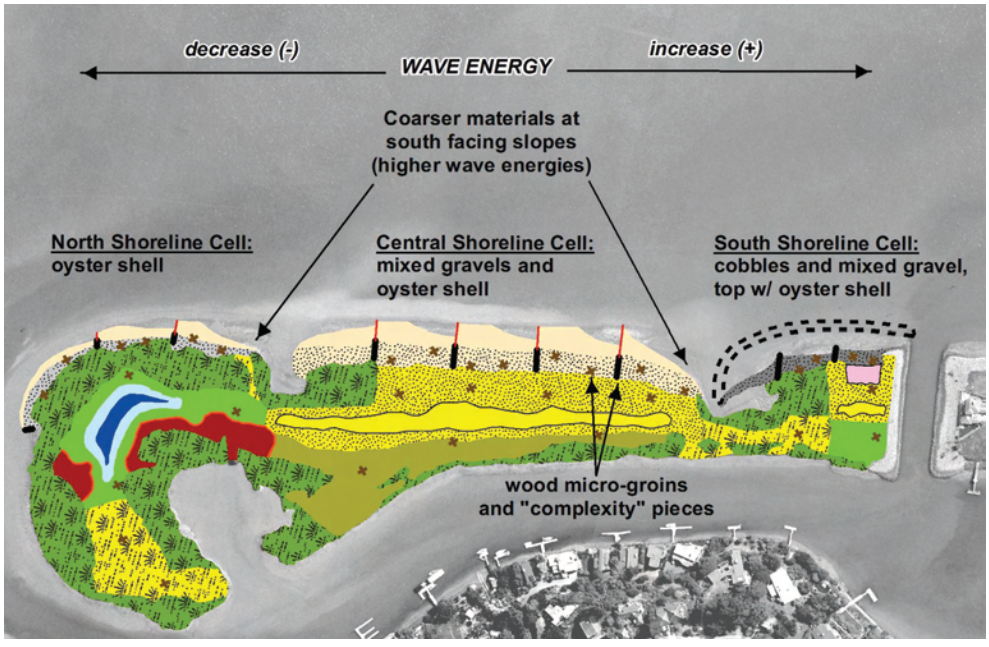
The watersheds draining into San Francisco Bay pass through all kinds of hardscapes: suburban cul de sacs, dense city centers, industrial shoreline. But as the water flows down the line, popping in and out of culverts and drains, percolating over parklands and streambanks, it creates opportunities for improving the ecological sustainability of our metropolitan zone. Planners throughout the Bay region have been coming up with innovative ways to manage urban creeks and runoff. One of their goals is to rebuild and reconnect our watersheds so they can better support the birds, trees, fish, and natural landscapes still surviving in the midst of the nine-county Bay Area. Another goal is to use creeks, riparian zones, and bay shorelines to soften the hardscape and make it more adaptable to future changes in rainfall, runoff, and sea level. Four speakers in the Tuesday afternoon conference session on sustainable communities explored lessons in resilience to be found in our watersheds, past and present. With this context in mind, the audience then heard a panel discussion about specific initiatives to boost resilience, from green parking lots to sustainable forestry.

However altered by humans, watersheds have a certain measure of resilience built into their history as pathways of drainage. First speaker Robin Grossinger, of the San Francisco Estuary Institute, began with a definition of resilience: "It's the capacity of a system to absorb disturbance and maintain its functions and values." Grossinger has done pioneering work in historical ecology. Complexity contributes to resilience, he said. Historic stream reaches had interconnected habitat mosaics along gradients, allowing species to have different adaptive responses to environmental change. Much of that diversity has given way to development: "We've lost the refuges like beaver ponds, side channels, and perennial stream reaches with riparian forest, the places that would survive under tough conditions." Stream flows have also been altered. "We've taken an episodic system and made it flashier, more sensitive to climate changes and extremes," Grossinger said.

Grossinger expressed concern about sea-level rise, and how marshes and creek mouths will adapt, but saw reasons to be hopeful. "We can help landscapes become more resilient so they can maintain themselves over time. There's a lot of room to improve adaptive capacity with strategic investment within the next 20 years, before the effects of climate change get really extreme. We need to figure out how to put the pieces back together where we can," he said. Grossinger praised recent efforts to "re-oak" the Napa Valley.

Second speaker Brock Dolman of the Occidental Arts and Ecology Center followed with his own take on watershed resilience. "Our watersheds are our lifeboats—we need to retrofit them. To quote Betsy Damon: 'Just as water is the foundation of life, it must also be the foundation of design in the built environment,'" he said. That will mean designing urban spaces to slow, spread, and sink runoff, and pursuing

Arambaru Island Shoreline Plan



Courtesy Dan Gillenwater, Wetlands & Water Resources, Inc.

options like rooftop water harvesting. Dolman also suggested we could learn some lessons from nature's ecosystem builder, the beaver. There has been no comprehensive report on beaver status in California since 1942, according to Dolman. Yet research shows they play a key role in recharging groundwater, and that beaver ponds provide rearing and over-wintering habitat for juvenile coho salmon and help seasonal streams flow year-round. "Where you find beaver dams you find beautiful habitat in terms of water quality and quantity," said Dolman.

The third talk by coastal ecologist Peter Baye and design engineer Roger Leventhal, who works for Marin County Flood Control, shifted the focus to the role of San Francisco bay beaches. Beaches are not only an important habitat type but also a natural alternative to engineered rip-rap to protect our eroding shorelines from increased wind-wave erosion from a rising bay. "Natural beaches meet Robin's criteria for resilience, but the riprapped shorelines that have replaced them can't respond to change. They lose function as sea level rises," said Baye. When rocks and concrete get piled up on shores to armor them against waves and floods, or "rip rapped," it eliminates habitat for native wildlife and plants and prevents shorelines from being able to rise with sea level. Historically, Baye explained, the Central Bay's shorelines supported landforms (or numerous bay beaches) composed of coarse sediment: oyster shell "hash," sand, and gravel that migrated up and down with the local wind-wave energy environment to stabilize the shoreline. Today, the Bay's remnant natural beaches provide reference systems for restoration.

Baye suggested investing in more projects to restore natural beaches, not just marshes, would help build more resilience into the estuary. Leventhal described the design steps and construction of one of the first beach restoration projects built in the region at Aramburu Island in Marin's Richardson Bay. The island had experienced severe shoreline wave erosion of up to 70 feet in some locations. The project, completed in November 2011, imported a variety of sediments to create a mixed beach (cobble, gravel, shell, sand) distributed among three shoreline "cells" of 475, 1000, and 375 ft each (see diagram). The project is intended "to buffer and slow erosion while enhancing shorebird habitat during long-term sea-level rise, beach retreat, and eventual submergence of the island," said Leventhal. If it functions as planned, Aramburu's beach would require only limited maintenance in the form of small-scale coarse sediment nourishment. It would also provide an important test case of the ability of beach systems to combat wind-wave erosion around San Francisco Bay. JE

BOOSTING ESTUARY RESILIENCE: SIX LOCAL INITIATIVES

If buildings can enjoy the hype of platinum *"LEED"* status, why can't landscapes have a *"LID"* rating promoting low-impact development projects that are more bay- and habitat-friendly? Cities, counties, and the region have all been experimenting with a variety of approaches to developing green projects. The following covers a few observations made and examples given by panelists during the Tuesday afternoon conference discussion.

Panelist Anne Cook described her coalition's Bay-Friendly Landscaping Program as a way of valuing and protecting a watershed's ecosystem service by, among other sustainable practices, eliminating excessive irrigation, fertilizer, and chemical pest controls. Rethinking conventional landscaping practices is one approach. Replacing a lawn by sheet-mulching in place, she said, can significantly cut water and pesticide use, reduce maintenance costs, and send less waste to the landfill. Cook presented case studies of exemplary Bay-Friendly rated landscape projects at Newark's Ohlone College and Hayward's Sara Connor Court. Cook's organization provides trainings and tools for landscape professionals, home gardeners, and public agencies, and administers a third-party rating system.

Panelist Brock Dolman (see p.16) explored perspectives on LID. "Low-impact development is perceived as a very urban thing, but what about LID for sustainable forestry, ranching, or vineyards?" he said. "To control floods, we need to catch rain where it falls—use the uplands like a sponge. With climate change all bets are off, so the planning is best done in advance. We need to create complementary interconnected systems." He praised the Sonoma Valley Groundwater Management Program for undertaking such planning, and "laying the foundation for LID in the future at a watershed scale."

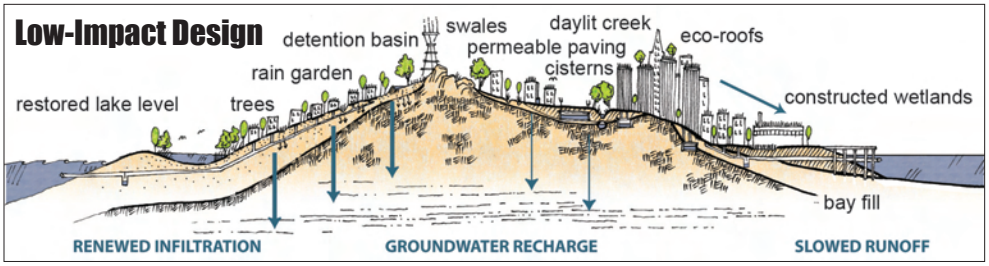
Panelist Matthew Fabry of San Mateo's Countywide Water Pollution Prevention Program described four LID projects already in place, including a rain garden and vegetated parking lot curb extension in Brisbane, with two more in the design phase. The projects will be funded for the next 25 years by a $10 vehicle registration fee. "With green infrastructure, you're doing something to solve the world's problems with a local project," he said.

Panelist Wendy Goodfriend, a senior planner with BCDC (see also p. 11), emphasized the need for watershed-wide solutions to the increased flooding anticipated with global warming, when sea-level rise will interact with more extreme storm events. "Everything does drain eventually to the Bay," she reminded the audience. Sea-level rise could reduce this drainage capacity, but residents can help regardless of where they live in the region. "Building green infrastructure is something homeowners can do on their own property in their own community," she said.

Panelist Rosey Jencks of the San Francisco Public Utilities Commission's Urban Watershed Management Program said San Francisco is using green infrastructure to address both stormwater management and groundwater recharge. "Keeping stormwater out of the sewer decreases the power and chemicals needed for sewage treatment," she added. Public outreach is critical. "People are irrigating with potable water. We need to educate them about LID and rainwater capture," she said.

Panelist Carol Mahoney of Alameda County's Zone 7 Water Agency emphasized that "More than anything, the integration of all functions in a watershed is key. One challenge is that there's no comprehensive hydrologic modeling showing how extensive LID can help. We need to figure out how to incentivize LID and offer more options to the redevelopment community."

Panelist Peter Schultze-Allen discussed Emeryville's experience with LID, including green street projects. "Bay-friendly is the best way to go," he said. "It's best to design and maintain LID projects in ways that won't create more problems," especially with dealing with property not owned by the city. "Passionate bureaucrats" are essential, said Schultze-Allen. JE



Courtesy SFPUC.

WATERSHED STEWARDSHIP

Frontiers of Monitoring, Coordination & Outreach

"Sustainability" is a popular concept, but what exactly does it mean when it comes to watersheds and water quality? Watersheds are so big and diverse that every initiative, whether public or private, has to cover a lot of bases and include a lot of interested parties. On Wednesday afternoon, conference attendees heard about how different watershed groups are tackling these challenges.

First up at the podium was Fraser Shilling of UC Davis examining how we measure stewardship progress. Shilling reviewed local, statewide, and national experience with indicators of watershed health, noting that many assessment systems are built around the "3 E's—Ecology, Economics, and Equity." He said there is no uniform national (or international) assessment system, only regional report-card type systems which use inconsistent terminologies and definitions. Here on the home front, the California Water Plan Update 2013 will include the California Water Sustainability Indicators Framework, which incorporates the 3 E's. California's framework builds on principles used in several regional collaborative projects and could help structure a Bay Area wide watershed health index. For comparison's sake, Shilling suggested that indicators should measure conditions based on distance to a targeted outcome and use appropriate statistics. By standardizing how indicators are evaluated and reported relative to desired and un-desired reference conditions, regions can compare stewardship results in a meaningful way. By including "leading indicators" (those that anticipate change) we can also get ahead of the curve and develop more sustainable land, water, and infrastructure practices, he said.

Developing more consistent indicators of watershed health could also help those trying to comply with new federal stormwater discharge requirements. Impacts of the new monitoring requirements, which go into effect next year, were covered by the second speaker, Terri Fashing of the Marin County Stormwater Pollution Prevention Program. These draft Phase II municipal stormwater regulations will require small cities and counties throughout the state to do stepped-up receiving water quality monitoring of, among other things, dissolved oxygen, pH, pathogens, nutrients, and sediment chemistry, and assessment of habitats and benthic organisms. Fashing said the new requirements pose significant challenges for small municipalities due to the cost. For cost-effectiveness, some municipalities may prefer to work with the state's existing Surface Water Ambient Monitoring Program (SWAMP) to collect information to comply with the federal Phase II permit. SWAMP will only be a suitable option if costs can be controlled and local managers can be at the table, said Fashing. As an alternative, she recommended giving cities the flexibility to design their own monitoring programs in support of local watershed and riparian restoration, fish habitat enhancement, and multi-benefit flood control. And she sees a role in monitoring for non-profits like Students and Teachers Restoring a Watershed (STRAW), a hands-on Point Reyes Bird Observatory education program with which her program has collaborated.

Permit compliance also means conducting public outreach, and the next speaker explored ideas for how municipalities and districts around the Bay Area can best comply with the extensive outreach requirements of both stormwater and wastewater permits. Cheryl Wessling, from the Environmental Services Communications Division of the City of San José, presented a compelling look at the value of implementing an iconic brand in pollution prevention campaigns across the Bay Area. Iconic brands, Wessling said, have been used in regional campaigns in Puget Sound, San Diego, Lake Tahoe, and elsewhere. "Iconic brands help people easily recognize, process, and remember information," she said. Wessling recounted the success of the Smokey the Bear and "Don't Mess with Texas" campaigns, which both enjoy recognition rates of 95% in their target audiences. Fundamental to the success of an iconic brand is putting it in play for the long term. The "Don't Mess with Texas" campaign was launched in 1985 and has since been shown to reduce litter by 76% statewide. With the San Francisco Estuary Partnership as fiscal agent, Wessling has helped organize a growing coalition of agencies in a regional effort inspired by the "Puget Sound Starts Here" campaign. "We want to similarly develop an iconic brand for pollution prevention and embed it in the Bay Area's collective psyche and culture," said Wessling.

Taking a regional approach has been the priority of other water management initiatives as well. Speaker Harry Seraydarian heads the North Bay Watershed Association, which coordinates multi-agency stewardship efforts in Marin, Sonoma, and Napa counties. Seraydarian gave an overview of the state's Integrated Regional Water Management (IRWM) program, its funding under Proposition 84, and its efforts to coordinate water quality, supply, recycling, treatment, flood control and restoration programs across 11 funding regions in the state. IRWM's Bay Area Integrated Regional Water Management Plan (BAIRWMP) will emphasize climate change mitigation and adaptation in a 2011-2013 Plan Update. "The Bay Area has been pretty good at the regional approach, but we have more work to do on integration," said Seraydarian. The BAIRWMP will soon get $30 million from the state to spearhead regional level implementation. One future goal is to include disadvantaged communities and Native American nations in the planning process, he said.

Levees influence water management in many ways and the next speaker, Mitch Avalon of the Contra Costa County Public Works Department, gave an update on the US Army Corps of Engineers' policy on levee vegetation. The policy is creating compliance challenges for local agencies (see "Corps Report Puts Policy in Question," *Estuary News*, October 2011 and "Riparian Risk Redux," *Estuary News*, October 2010.) The Corps tolerated vegetation on levees for years, said Avalon, but more recently threatened to pull funding for storm damage unless it was removed. "But the Regional Water Board won't give us a permit for the removal," said Avalon, adding that the Corps' directive ignores regional variations. "The state's levees are all very different. Even in our state we can't have a uniform policy, let alone a uniform national policy," said Avalon. Railroad creek crossings are also a challenge for Avalon's agency. "They're usually old and undersized, and can create flooding and increase sedimentation," he said. "The railroads that ring the Bay are also a hydraulic constriction. So with sea-level rise we'll need a regulatory approach to railroad culvert and bridge improvements."

The last speaker, Doria Robinson, reminded the audience that small inner-city nonprofits do much of the heavy lifting in watershed improvement programs (See "Watershed Warriors," *Estuary News*, October 2011.) Robinson, born and raised in Richmond, runs Urban Tilth, an organization with a dual focus on urban food security and environmental health. She explained how food production through permaculture benefits the local watershed and how creek restoration translates into training and employment for Richmond youth. JE

Main Street, Napa -1940

ANCHOR WATERSHEDS

Enhancing Rivers for Fish and Floods

Almost everyone working in local watershed restoration would like to see steelhead on the upswing, even as the primary goal for many projects remains flood control. Many people are trying to remove barriers blocking historical fish migration routes. Others have been championing improved flows in critical migration seasons, and trying to spruce up riparian habitats. In this session, watershed experts described a variety river restoration and steelhead conservation initiatives along some of the Bay's largest tributary streams, including the North Bay's Napa River and the South Bay's Alameda Creek, among others. Each of these efforts promises to give steelhead a helping hand upstream to recovery.

Steelhead, the anadromous form of rainbow trout, is a keystone species, said the first speaker Gordon Becker. Becker directs the steelhead program of the Center for Ecosystem Management and Restoration, and said the term 'keystone' refers to species that play a critical role in maintaining the structure of an ecological community. For local steelhead, there's good news and bad news, he said: "Even though we're seeing steelhead in three-quarters of the streams we historically saw them in, the number of streams that can support their anadromous life history is only around 40%." Eight Bay Area watersheds account for 75% of their rearing habitat. Becker noted that there were a number of sites where barriers to steelhead migration have been removed, or where fish passage has a good prospect of being improved soon, such as the South Bay's Upper Penitencia Creek and Marin's Corte Madera Creek. But he's not sure yet how we'll know if these programs, once implemented, are doing any good. Long-term funding for creek and species monitoring is sorely lacking, he said. Although low population dynamics in many Bay Area systems is troubling, Becker is optimistic about steelhead's future. "Fish and restorationists are notoriously resilient species," he said.

Speakers for the next two presentations highlighted major changes along the Napa River. Ann Riley of the SF Bay Regional Water Quality Control Board recounted how watershed management there has evolved from a single-purpose flood control to a more holistic approach. The city of Napa has been flooded repeatedly since 1896. In 1995 state and federal agencies, including the US Army Corps of Engineers, launched a flood control project that came to incorporate other objectives. "The community decided to have a living river and a living downtown," Riley said. "Two-thirds of the valley voted to tax themselves to pay for it." The project involved relocating a water treatment plant, 33 residential and commercial buildings, and 53 mobile homes, and converting 650 acres of farmland to floodplain. "The whole Napa Valley embraced the zen of river management, the concept of taming the river by letting it run free," she continued. (See also p. 5.)

A big thrust in the Napa River restoration effort has been to enhance long-degraded aquatic habitats. The Rutherford DUST project, for one, restored side channel habitat to give fish a fighting chance. Speaker Jonathan Koehler said his Napa County Resource Conservation District has been monitoring the fish community's response since 2003, with emphasis on steelhead and Chinook salmon. Before then, very little fisheries data was available for the river. New surveys show a relatively intact native fish assemblage (minus Sacramento perch, tidewater goby, thicktail chub, and coho salmon) and few exotic species in the Napa River. Koehler's program uses spawner surveys, snorkel counts, and traps to track the life stages of salmon and steelhead. "How many smolts are leaving the river is a direct reflection of watershed health," he said. "We've found consistent steelhead smolt production in the river, and the smolts tend to be large, which favors their survival in the ocean." Chinook trends are less consistent. "They're successfully spawning and producing smolts in most years, but there's tremendous fluctuation," said Koehler. As such, salmon may not be a suitable indicator of restoration success or failure. With the difficulty of estimating the size of such a small population, it's still unclear whether these runs are self-sustaining, he said. In the meantime, he doesn't know how long he will be able to keep up his monitoring of how fish are responding to the newly restored river: funding for long-term monitoring is always a challenge, and Koehler may have to continue to make do with local volunteers.

Alameda Creek is another "anchor" stream where biologists and planners are trying to help steelhead in a big way. Tim Ramirez of the San Francisco Public Utilities Commission (SFPUC) called Alameda Creek's watershed, the largest within the Central Coast Distinct Population Segment Region for steelhead, "an almost 700-square-mile jigsaw puzzle of land management and water district agencies." Those agencies have collaborated in the Alameda Creek Fisheries Restoration Workgroup since 1999, with the SFPUC taking a leading role beginning in 2005 and launching the Calaveras Dam replacement project. With permits from state and federal fisheries agencies, the project, which will allow steelhead passage through Little Yosemite in Sunol Regional Park, is four years from completion. Ramirez says his agency's work on Alameda Creek has relied on historical ecology research and hydrological and biological modeling. JE

The area known as Little Yosemite on Alameda Creek, part of the City and County of San Francisco's extensive watershed holdings where the SFPUC is making efforts to improve fish migration. Photo courtesy Scott Chenue, SFPUC.

SUSTAINABLE USE OF FRESH WATER

Doing More with Less in the Delta

"Difficult, ugly politics," is how one speaker up on the stage at Wednesday's plenary session characterized decades-long efforts to find enough fresh water in the Bay-Delta system to go around. The 2011 plenary proved reminiscent of Delta plenaries past, as speakers discussed plans and initiatives and permits and science for this and that, all in the name of delta conservation, restoration, and stewardship. Sitting through past conferences, many old hands must have heard as many versions of delta planning as there have been euphemisms for the peripheral canal. But this 2011 plenary did seem as if many of the players in the Delta chess game are no longer posturing, or at least not much, as everyone struggles to confront the truth: no matter how much restoration anyone does, anywhere, the system is over-allocated and everyone needs to step up so we can all, at last, perhaps, move on. And get there with the last few dozen Delta smelt on the planet still flipping.

Introducing the panel, Gary Wolff said saving the Delta would require effective governance. The way Wolff, former vice chair of the State Water Resources Control Board, sees it: "Science can only take us so far. Some government entity must be empowered to decide or we'll be trapped in a lose-lose situation. Fear of authority prevents us from granting the authority that could effect a solution." That entity, according to Wolff, might be the Delta Stewardship Council, the Resources Agency, the State Water Board, or the legislature and governor working in concert. It's not likely to be the courts, he said.

After Wolff, Delta Stewardship Council chair Phil Isenberg stepped to the podium. His agency is responsible for preparing and implementing an enforceable Delta Plan. Isenberg quoted the Water Code's definition of the coequal goals of the plan: "providing a more reliable water supply and protecting, restoring, and enhancing the Delta ecosystem." The new legislation (SBX7 1), he said, "forces both water districts and the environmental community to face up to the coequal goals. The dilemma we face on water is the same as the dilemma we face on budgets in Washington. It will be a challenge for all the water warriors of California who assume their own constituents are more important that anyone else. People like me used to make their living blaming Southern California for everything."

Isenberg noted that everyone seemed to agree that the status quo in the Delta was unsustainable. "Many of these same water warriors fear change," he said. "But change happens anyway; we can choose between a soft landing or a crash," he said. The statewide picture is bleak: California's water supply is under stress: supplies are finite, demand is growing, the reliability of the State Water Project is decreasing, and groundwater is being overused. "We annually use more water than nature provides," he summed up. "We are running up against the practical limitations of supply, and have little leeway to meet all water demands -- unless we change the way we behave."

Changes specific to the Delta will include the legislative mandate to reduce reliance on Delta water supplies, the Bay Delta Conservation Plan, and a far more important role for science in water and ecosystem decisions. From Isenberg's perspective: "'Using the best available science' sounds simple until you understand that every project proponent in California claims they are already using the best available science and adaptive management—so we should leave them alone."

The State Water Resources Board won't be leaving anybody alone, at least according to second panelist Frances Spivy-Weber. "The water board is back, not as the only group that will make the Delta better, but as the agency that will keep things moving forward," she said.

Spivy-Weber described the board as one of "the oldtimers in the room." She began her presentation with a capsule history of prior Bay-Delta plans, the Bay-Delta Accord, CalFed, and legislative goal-setting: "But we didn't really solve the Delta's problems. The authority of the Board is really quite strong, but authority isn't enough. Planning goals and standards are not self-implementing. We adopt them but in order to achieve them we have to have permits," she said.

Spivy-Weber explained how actions required under permits relate to both water rights and water quality issues. "Enforcement is extremely important," she said. Enforcement also requires measuring sticks to assess compliance, and some new tools are in the offing. A water board team is now developing flow and salinity standards for the lower San Joaquin; standards for the Delta and the Sacramento River will follow by 2014. Eventually, she said, instream flow objectives will be developed for streams throughout the state. Water rights options are on a parallel track, as well as the development of electronic reporting systems: "Everything will come together for water quality permits and water rights decisions."

The next panelist gave another perspective on efforts to finalize and implement a Bay-Delta Conservation Plan. Jerry Meral of the California Natural Resources Agency described the plan as "a $250 million effort to get a permit to pump under the state and federal Endangered Species Acts. It's essentially a Habitat Conservation Plan, but there's never been one quite like this because it's heavily aquatic." The plan

The Delta is a hub of recreational boating, among diverse interests with a stake in regional decisionmaking concerning management. Photo by Francis Parchaso.

operates under a legal requirement to meet the coequal goals of water supply reliability and biological restoration. "The water contractors who are funding BDCP want some certainty this is a good investment in supply reliability—something they can explain to their ratepayers. But to environmentalists, water supply reliability has to be seen through the lens of species recovery. Recovery of listed species is in the broader best interests of the contractors. They've been impacted by restrictions that will not be lifted unless we can recover those species," he said.

Meral described BDCP's reliance on science as a foundation for sound management, and explained how that reliance entails other tensions: "Scientists are famously reluctant to predict the impact of habitat change, which frustrates legislators and other decision-makers who want some level of certainty. Uncertainty is just something we have to live with." Meral added that Bay-Delta planners are still trying to address criticism of their science framework ("a lot of it justified") from the National Academy of Science. In the meantime, restoration work is already in progress in the North Delta and Yolo Bypass. "This project, if it works, will be one of the largest ecological restoration programs in the history of the US," he said.

It may also be the longest and most tortuous public process ever undertaken to negotiate a balanced use of limited natural resources. "I'm swept back and forth by waves of pessimism and optimism," said final panelist Peter Gleick of the Pacific Institute. "This is the most complicated problem I see out there in the water world. California's water problem sucks—a technical term. I'm sure it can be quantified."

Gleick noted the ambitious targets that have been set for restoration, seasonal and flood flows, and water quality, and the new policy of coequal goals: "Practically everyone agrees with one or the other of the coequal goals. Some tools are more appropriate for both goals than for one or the other," he said. Gleick pointed to environmental health issues that are unresolved or unacknowledged: "Our institute's study of sea-level rise impacts identified environmental justice concerns at serious risk within the Bay Area, largely low-income communities of color. That's not adequately addressed."

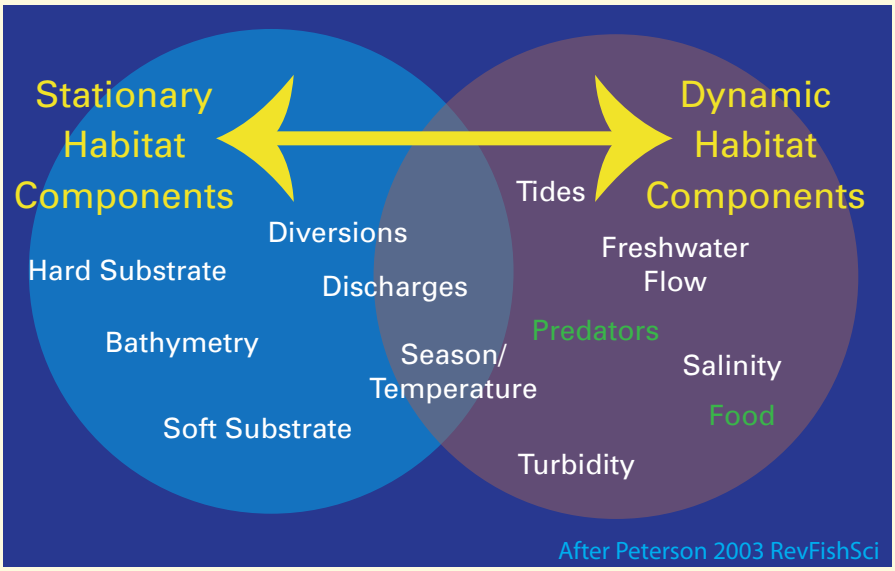
Flows, Gleick said, are only one piece of the puzzle, but a critical one. Despite a clear effort in the legislation to reduce reliance on Delta water, he expressed concerns about Interior Secretary Kenneth Salazar's recent remarks about taking more water from the Delta. "I believe it's possible to reduce withdrawals from the Delta through conservation and efficiency," he added. "There's been enormous progress. Per capita use has gone way down." As for new conveyances, by whatever name: "I'm intensely ambivalent about the idea of a Peripheral Canal. But as a scientist I have no opinion until someone tells me where it will be built, who will pay for it, what the operational rules will be, who will enforce them, and what's the size." If the potential to reduce water demand isn't considered, Gleick fears that "we're going to design the wrong thing."

Noting the harsh National Academy of Sciences critique of the Bay-Delta Conservation Plan, Gleick said he's "not convinced that science has been respected in all the processes going forward." He stressed the need for better data: "We have to have comprehensive data collecting, monitoring, and reporting. We won't do the right thing if we don't have good data on all water users." Gleick made additional recommendations for ways to make progress, including stronger water use efficiency targets for urban and agricultural users, better enforcement of existing laws, and more effective political leadership. "I've been dismayed by Governor Brown's absolute silence on water issues and his failure fill to key water positions," said Gleick. JE

WHERE *DOES* THE RIVER MEET THE SEA? BOUNDARIES AND CONNECTIONS

Everyone who's every been to a State of the Estuary conference knows that the Bay is an estuary, where rivers and ocean meet. But where exactly does this "meeting" occur? According to presenter Wim Kimmerer of San Francisco State University's Romberg Tiburon Center for Environmental Studies, it's sometimes hard for those with a stake in this or that piece of the estuary to think of it as a connected whole, not to mention a moving target. Different agencies and programs carve up the Bay and Delta in disparate ways for administrative purposes, he explained, sometimes using bridges as boundaries. "Organisms don't care about these boundaries," he said. "They live in habitats." And each organism's habitat has unique stationary and dynamic components: "Pelagic organisms respond to different things than benthic organisms or terrestrial plants. The area Delta smelt live in, for example, moves around, although their habitat conditions may not change." Of course, freshwater flow as it affects salinity is one key dynamic component defining habitat zones: "Each species has a different salinity range, some broad, some narrow. Anchovies are abundant wherever it's salty," he said. Invasive overbite clams, however, die back during low-salinity pulses. Species like salmon depend on both ocean and river dynamics. The message, according to Kimmerer, is that "acres of habitat restored do not equal species recovered. Population persistence and increase depends on more than the stationary attributes of the habitat." JE

What Constitutes Habitat?



Source: Wim Kimmerer.

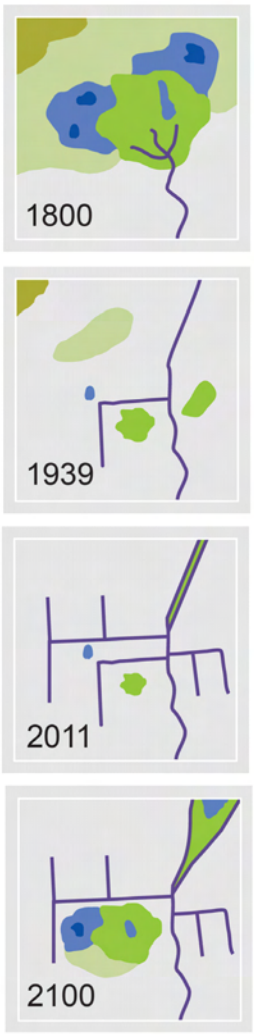
RESTORING THE DELTA ECOSYSTEM

People, Economics and Vision

Complexity seems to be the name of every game in the Delta. Simple, one step actions to improve conditions for either people or fish are hard to come by. So after the politics of the plenary in the morning, nine speakers devoted the afternoon to the nuances of a number of topics, zeroing in on the challenges presented by subsidence and adaptive management, unearthing historic sloughs and highlighting old company towns, and proposing ways to rearrange the economics and ecology of large tracts of the Delta.

Speaker Alison Whipple of the SF Estuary Institute described what the Delta looked like in the early 1800s. "It's not about recreating the past," she said. "It's about understanding how habitat types might fit together to improve ecological function in the future." Whipple reviewed the historical ecology of the Delta and highlighted aspects of the native landscape now lost: complex tidal channel patterns that varied depending on relative influence of fluvial and tidal processes; lakes and ponds located at the edge of tidal influence in the north and south Delta, which were able to hold runoff; and riparian forests intersecting the freshwater tidal wetlands along broad natural levees of rivers. "On the historic marsh plain, the channels that wove through the marsh were really the capillaries of the system that provided exchange between the marsh and aquatic environment," she said. Whipple presented mesmerizing before and after images of landscapes, as well as a sampling of the historic maps and old-timer observations that help her group piece together past landscapes. This information should help Delta planners chose between different restoration opportunities. "Any post-restoration Delta won't be at all like the past, or at all like the present, but it will hopefully have the functions we need. Understanding the past can help address related, but oft-viewed conflicting, human and biotic needs. The future isn't a compromise, it's a new landscape," she said.

Landscape Transformation



Reconnecting habitats lost through time. Graphic courtesy San Francisco Estuary Institute.

Compromise will certainly figure in the work of a new state conservancy dedicated to the Delta, however. The purpose of the Delta Conservancy, launched in 2009, is to be the state lead for habitat restoration and economic development in the Delta. Speaker Campbell Ingram's first year on the job has been spent reaching out to local communities and stakeholders, welcoming input, and developing a strategic plan to guide the Conservancy. "Absent major funding, we recognize one of the values we bring to the Delta is identifying what resources are available to people, and offering to serve as a fiscal partner," he said. Ingram admits most people still haven't even heard of the Conservancy, but they have heard about big plans to rearrange the Delta and restore tidal influence. "They know restoration will happen, and they're glad to see the economic development dollar and jobs that will come along with it, and we're glad to have their input on how it's done," he said.

Speaker Mike Machado went over the main elements of the Delta Protection Commission's Economic Sustainability Plan. The Delta, he reminded the audience, has three economic drivers: agriculture, recreation and tourism, and infrastructure services (water, power and transportation). 'What we see with the co-equal goals are a lot of co-conflicts," said Machado, referring to the new mandates (see pp. 20-21). "The conundrum is how do we fix the Delta without destroying the Delta?" Machado reviewed the Delta's contribution to California's economy in dollars, crops and jobs; showed maps of population growth and farmland coverage; and discussed four key targets for sustainability planning. These include levees, water quality and supply, agriculture and tourism, and legacy communities such as Hood, Isleton, and Freeport where sustainability challenges all come together. "We can't just take farmland out of production to help rear fish. We have to find opportunities to work with the people of the Delta, not displace the people of the Delta," he said.

A number of Delta residents have found ways to double dip on the co-equal goals through wildlife-friendly farming. Speaker Brent Tadman of Conservation Farms and Ranches talked about how the increasing efficiency of agricultural practices has offset the need to plow more acres. "The Nature Conservancy's Staten Island is proof that high production can co-exist with wildlife," he said, referring to the 9,200 acre island that produces both crops and habitat for greater sandhill cranes. The basic tools for keeping farms friendly to birds and fish include crop choice, crop rotation and cultural practices. Tadman described how "slow flooding provides bugline grazing for cranes," and how GPS technology on tractors can actually help drivers "place fertilizers and pesticides with sub-inch accuracy" to minimize chemicals in discharges. "It's not something you wake up one morning and decide to do, wildlife-friendly farming, it's a moral and business decision," he said.

Staten Island borders the Cosumnes River, one of the only undammed rivers in California. If the Cosumnes represents one end of the restoration spectrum, the San Joaquin represents the other. The lower San Joaquin River has had very poor conditions for salmon since the 1940s, when California began diverting and storing its waters for other uses. In his presentation, the US Fish and Wildlife Service's John Netto went over the long history of environmental battles over the San Joaquin, from the first lawsuits filed by the Natural Resources Defense Council 18 years ago to the settlement reached in 2006 and the resulting San Joaquin River Restoration Act of 2009. In the settlement, both water users and restoration planners had to give something up to negotiate a compromise, said Netto. Reintroduced Chinook salmon will get habitat and passage improvements, restored flows from

Northern Liberty Island after a 186-acre restoration project focused on creating tidal aquatic habitat suitable for special status fish species. Ecological and geomorphic input to the design, implemented by Wildlands, came from conference speakers Michelle Orr and Steve Crooks of ESA-Philip Williams & Associates. Photo by Chris Galloway, C.G. Construction.

the Friant Dam to the confluence of the Merced River, and downstream protections; water users get efforts to recirculate, recapture, reuse and exchange restoration flows and a new Recovered Water Account offering wet year water at reduced prices. "We've had decades of dry river, lawsuits and legislation, so there's a lot we don't know. It's a very complex project. We have to maintain a process that allows for discourse and adaptation," said Netto.

Speaker Steve Deverel of HydroFocus, Inc. got into the nitty gritty of one of the Delta's most challenging redevelopment and restoration problems: subsidence. Deverel's firm collected soils and elevation data on Bacon and Sherman Islands in order to develop a model that simulates subsidence and carbon loss from organic soils. They found that subsidence rates at Sherman and Bacon between 1978 and 2006 averaged 1.23 centimeters $^{-1}$ and 2.2 cm $^{-1}$ per year respectively. "Except for water management, there's not much you can do to stop subsidence," said Deverel. The model predicts that in the next forty years, delta elevation will decrease from another few centimeters to more than a meter, and that the accommodation space below sea level will increase by about 347 million cubic meters. With so much land sinking so low below sea level, and with peat soils continuing to disappear due to oxidation, seepage hydraulics are changing on Delta Islands. According to Deverel, in the central Delta we've begun to approach "critical gradients" that can cause sandy materials to move into drainage ditches. These changes, combined with increased seepage onto Delta islands, will make farming more difficult and levees more vulnerable. "When organic soils disappear, it's hard to excavate drainage ditches in quicksand," said Deverel.

Firmer footing in the climate change carbon market is what speaker Belinda Morris from the Environmental Defense Fund is after. Morris has been trying to quantify the carbon capturing abilities of freshwater wetlands, and their ability to reverse subsidence, and working to create a market for "growing" wetlands. In order to calculate carbon credits per acre, her research group factored in different considerations – wetland performance (in terms of biomass accretion), wetland productivity (metric tons of carbon dioxide captured per acre), construction costs per acre, and timeline required for wetlands to grow and produce results. She found that depending on available financing mechanisms and the construction approach used, costs might range from $1-$27 per ton of carbon reduced. Based on these costs, she estimated that annual net revenue for carbon ranged from $36-$301 per acre, whereas for corn or tomatoes the average revenue ranged between $38 and $187. "There are multiple benefits from this idea of carbon capture wetland farming," she said. "We're reducing greenhouse gas emissions, reversing land subsidence, improving water supply security, and increasing habitat for wildlife. We just have to ensure it makes financial sense to land managers," (see also Banking on Tules, *Estuary News*, October 2011).

The next presentation was given by Jim Starr of the California Department of Fish & Game as the planned speaker Carl Wilcox was unable to attend. Starr emphasized the paradigm shift resource managers are experiencing today concerning what makes good fish habitat. New research assessing conditions on Liberty Island —an "unintentional restoration" of a 5,000 acre island caused by a levee breach—is now revealing more details about the physical and biological processes that support inter-tidal and sub-tidal habitats, and how species benefit from them. Starr gave an example: "If you're producing fish food on the island, a big question becomes is the food getting off the island and out to the channels where the Delta smelt need it?" Starr reviewed various in-progress projects, and made reference to the plethora of regional plans and resource management initiatives they need to serve. "We have good habitat at Liberty Island, so we shouldn't mess around with it. We should study it and see how it works so we can use that knowledge to restore other parts of the Delta," he said.

The next speaker, Michelle Orr, waded into the murky waters of how to link broad habitat restoration goals with more specific objectives for saving endangered species, bolstering ecological processes and improving water quality. Orr, who works for ESA-Philip Williams & Associates, used the 1,166-acre Dutch Slough Tidal Marsh Restoration project as an example of how to frame and test ecological objectives and then use them to practice that equally murky activity – adaptive management. "If we find something is not working on a particular site, we have to go back and fix it. Adaptive management should follow a logic chain linking project objectives with actions put in the ground, and a plan to learn from those actions," she said. Orr organized her approach into parameters that require testing at the large scale (marsh-plain elevation and size) and those that can be tested at a smaller scale (aquatic food production, mercury methylation, invasive vegetation minimization, subsidence reversals and extent of channel formation through tidal scour). In her presentation, she explained how these parameters would be tested at the Dutch Slough project. "There's been talk about the promise of adaptive management for over a decade now, but we still need to figure out how to do it in an on-the-ground tangible way," she said.

Finishing up for the day, speaker Stuart Siegel of Wetlands and Water Resources, Inc. provided a vision for a "landscape scale" tidal restoration in Suisun Marsh. Suisun does offer a big restoration canvas, encompassing 8,500 acres of tidal marsh, 53,000 acres of diked marsh, 22,000 acres of shallow tidal bays and 4,000 acres of sloughs. Suisun also sits at that pivotal place in the system where estuarine mixing of salt and fresh water prevails. During his presentation, Siegel clicked through slides showing how plans for Suisun Marsh could accomplish three large-scale visions –conserving and restoring natural estuarine communities, conserving and restoring ecosystem processes and functions, and maximizing the potential for resiliency. He reviewed land uses and ownership in the marsh today, "salinity gradients that make Suisun special," elevation distribution, sediment supply issues, tidal energy expenditures, and sea-level rise implications. Building on these factors, he outlined a strategic vision for restoration. "The scale of our actions in Suisun is critical to functional outcomes," he said. "We've got to go large to succeed." ARO

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Editorial Office
PO Box 791
Oakland, CA 94604
bayariel@sbcglobal.net

Estuary News Web Site
http://www.sfestuary.org/pages/newsletter.php

To subscribe or ask questions
(510) 622-2304

Staff

Managing Editor	Ariel Rubissow Okamoto
Associate Editor	Joe Eaton*
Design	Bobbi Sloan

**Special thanks to Joe for uncommon valor in writing up zillions of conference notes into intelligible stories!*

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EVENTS

JANUARY 20-22 AND FEBRUARY 6-8
CALIFORNIA KING TIDES INITIATIVE

TOPIC: Preview Sea-level rise with Winter "King Tides"
LOCATION: Bay Area shorelines
SPONSOR: California King Tides Initiative Steering Committee
californiakingtides.org/when

FEBRUARY 1-3
WILDLIFE SOCIETY ANNUAL CONFERENCE

TOPIC: "Conservation in the Age of Litigation"
LOCATION: Radisson Hotel, Sacramento
SPONSOR: Wildlife Society Western Section
membership@wildlife.org; (301) 897-9770

FEBRUARY 10-12 FRIDAY-SUNDAY
FLYWAY FESTIVAL

TOPIC: 16th Annual San Francisco Bay Flyway Festival
LOCATION: Mare Island with field trips elsewhere
SPONSOR: Weston Solutions Inc., CH2M Hill, and others
www.sfbayflywayfestival.com

READ & SEE

2011 California King Tides Initiative Report, edited by Heidi Nutters and Laurel Kellner, Bay Conservation and Development Commission, October 2011. www.bcdc.ca.gov/planning/climate_change/KingTides.pdf

Evaluating Tidal Marsh Sustainability in the Face of Sea-Level Rise: A Hybrid Modeling Approach Applied to San Francisco Bay by Diana Stralberg et al, in PLOS One. www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0027388

Shifting Baselines: The Past and the Future of Oceanic Fisheries, edited by Jeremy B. C. Jackson, Karen Alexander, and Enric Sala. Island Press, July 2011. islandpress.org/bookstore/detailsyy33.html

The Fall and Rise of the Wetlands of California's Great Central Valley by Philip Garone. University of California Press, April 2011. www.ucpress.edu/book.php?isbn=9780520266636#desc

The State of the Birds San Francisco Estuary 2011 by Melissa. Pitkin and Julian Wood. PRBO Conservation Science and the San Francisco Bay Joint Venture, October 2011. data.prbo.org/sfstateofthebirds

The World's Water, Volume 7 by Peter Gleick et al. Pacific Institute, October 2011. www.pacinst.org/publications/online_update/worlds_water_7.html

Where We Live: The Changing Face of Climate Activism, directed by Mark Decena. Video documentary about the campaign against Proposition 23. Funders Network on Transforming the Global Economy, September 2011. wherewelivefilm.org/the-film

PUBLIC COMMENT PERIOD UNTIL FEBRUARY 21
EPA'S PROPOSED BALLAST WATER DISCHARGE STANDARDS

Speak Up: Request a West Coast public meeting.

Write or call Ryan Albert, EPA, (202) 564–0763 vgp@epa.gov

(Copy emails Mark Holmes,The Bay Institute, holmes@bay.org)

To review Proposed Regs go to: http://cfpub.epa.gov/npdes/vessels/vgpermit.cfm