



## Adaptive Management in Action: The South San Francisco Bay Salt Pond Restoration Project

[April 14, 2016](#) | [Maven](#) | [Conferences and Seminars](#), [Science Features](#)



The largest wetlands restoration project on the West Coast, the project provides a working example for an adaptive management framework applicable to other large habitat restoration projects

San Francisco Bay, much like the Delta, has lost an estimated 85 percent of its historic wetlands to development and other human uses. The dramatic decline in tidal marsh habitats has caused populations of marsh-dependent fish and wildlife to dwindle, as well as impairing water quality and increasing local flood risks.

The [South Bay Salt Pond Restoration Project](#), when complete, will restore over 15,000 acres of industrial salt ponds to a mix of wetland habitats in the south San Francisco Bay, while also providing for flood management as well as wildlife-oriented public access and recreation. It is the largest tidal wetland restoration project on the West Coast, and part of a larger effort to restore 40,000 acres of tidal wetlands to the San Francisco Bay.

The lessons learned will provide working examples for an adaptive management framework in other large habitat restoration projects such as those currently planned and in-progress in the Delta and Suisun Marsh.

The project will be implemented in phases over the next 50 years with

A promotional banner for the University of the Pacific. It features the text "MPA and MPP DEGREES at McGEORGE SCHOOL OF LAW" in white on a dark blue background. There is an image of the American flag and the University of the Pacific building. Below the main text, it says "UNIVERSITY OF THE PACIFIC McGeorge School of Law Public Policy | Public Administration". A red button with white text says "LEARN MORE AT WEBINARS - RSVP".

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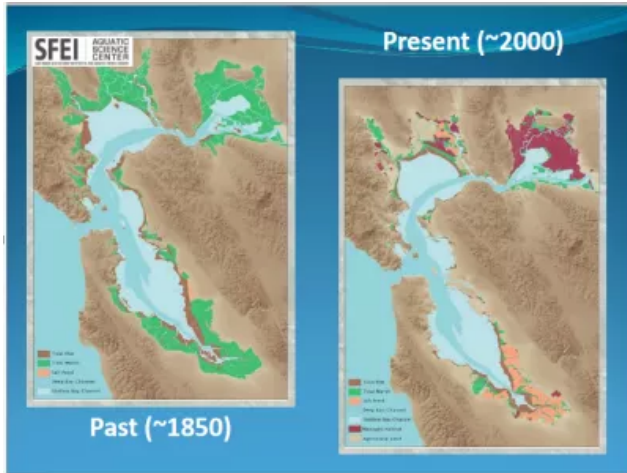
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The project will be implemented in phases over the next 50 years, with the plan allowing for scientific information gained from earlier phases and applied studies to be incorporated as management objectives and designs of future actions are revised and implemented. In this brown bag seminar jointly presented by the Delta Science Program, the Ecosystem Restoration Program, and the Surface Water Ambient Monitoring Program, Lead Scientist [Dr. Laura Valoppi](#) focused on the restoration process, summarizing the results of some key studies and how managers have revised management actions and restoration designs in response to scientific research.



Historically, there was much more tidal marsh

surrounding the bay than is existing today. Dr. Valoppi presented a slide showing how things have changed over the last 100-150 years, noting that the green is tidal marsh and the brown is mud flat habitat; she noted that the mud flat habitat was prominent in the South Bay and still exists. The pink in the graphic on the left signify where the marsh was diked off and evaporative salt ponds put in.

She presented a map of the project area, noting the location of the San Mateo and Dumbarton bridges, as well as the Silicon Valley. "We have three complexes that make up the project," she said. "One is Eden Landing which is owned by the California Department of Fish and Wildlife; the Ravenswood Complex which is owned and operated by the US Fish and Wildlife Service as part of the Don Edwards San Francisco Bay National Wildlife Refuge, and the Alviso Complex which is part of the

US Fish and Wildlife National Wildlife Refuge."

The project



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**1:30 pm**

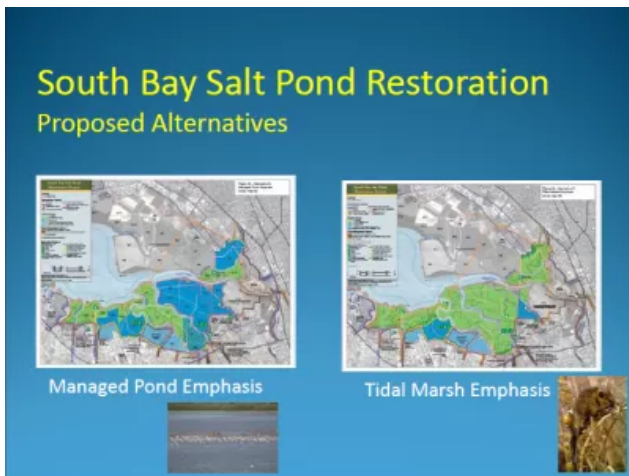


encompasses approximately 15,000 acres split across the three complexes, which together are essentially the same size as Manhattan; the area shown is gray is still under salt production and is not included in the total acreage. The land was acquired in 2003 for \$100 million through a public private partnership that included the state, the federal government, and a consortium of Silicone Valley- based foundations. The restoration project is a partnership between state and federal agencies and NGOs.

So why restore the salt ponds? *"A lot of the marsh habitat has been lost, and many of those marsh species are now threatened and endangered, primarily because of the loss of habitat,"* Dr. Valoppi said. *"The conversion of these habitats back to marsh is critical for the recovery of these species. In particular, for the Ridgeways, formerly called the California clapper rail, and the salt marsh harvest mouse, the recovery plans are very dependent on having the area converted back to tidal marsh."*

The salt ponds now are open water ponds and historically have been when they were used as salt production ponds; even today, several hundreds of thousands of water birds, ducks, and shore birds use these open water areas, she said. *"It's key habitat for migratory wintering birds that come through the area,"* she said. *"It's on the Pacific flyway, and it's also particularly important for shore birds that use mud flood habitats – it is very critical habitat, forging habitat for shore birds. For the most part, the ducks and the shore birds and the other water birds don't really use the vegetative marsh. So we have to try and retain as much of the managed ponds for open water habitat to continue to support these water birds that have come in the last 100 plus years, but we also want to convert as many as possible to marsh."*

There are two different



alternatives: One is to emphasize managed ponds and the other is to

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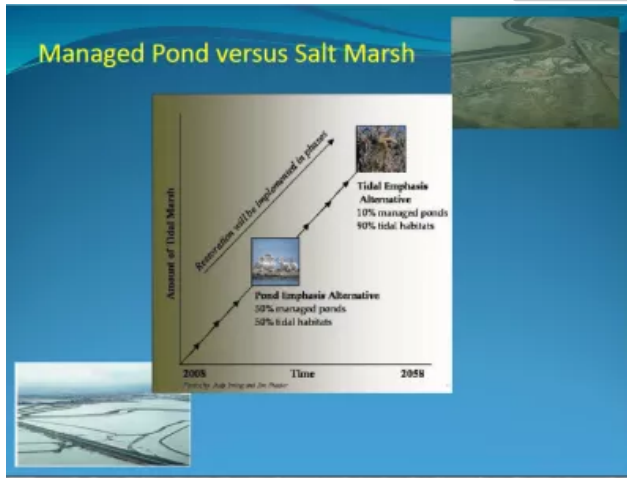
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emphasize tidal marsh. "One of the scenarios, we might have about half of the ponds as managed pond or open water pond in blue, and another half as tidal marsh which is in green, shown on the left," Dr. Valoppi said. "Or if we could figure out a way to put those hundreds of thousands of birds in a smaller number of ponds, then we can convert more of those ponds to tidal marsh habitat; that version is on the right."

She presented a chart plotting tidal marsh acreage against time. "We figure it's going to take about 50 years to restore and enhance

15,000 acres, and the idea is that over time, we're going to slowly open up these ponds to tidal marsh and study the effects to see what happens," she said. "The environmental documents indicate that we can convert as much as 50% to tidal marsh without adversely impacting the water birds, but we would like to be able to convert up to 90% to tidal marsh; but that means we have to enhance that 10% of ponds very highly so that we can fit that large number of birds into a smaller footprint."



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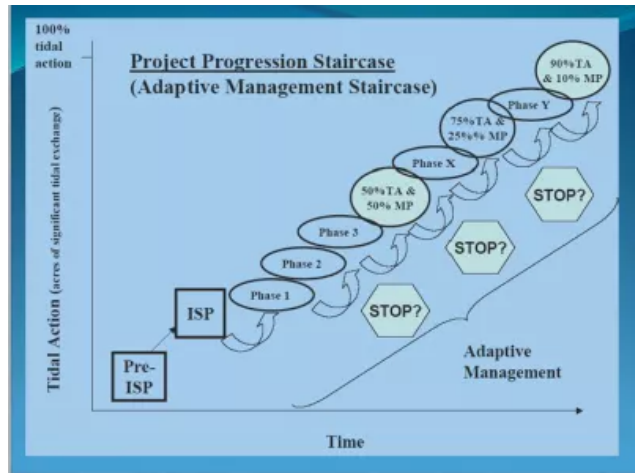
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actions, study those effects, move into phase three, etc. So this shows over time the amount of acres restored. We're just finishing up our last phase one restoration action, and we've completed our phase two environmental documents, and the final EIR-EIS should be coming out shortly."

"What we've done here is we've broken the restoration up into phases," she said. "We do a couple thousand acres in phase one, study the effects, and take that information and bring it into phase two, do some more

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story.

"This is the adaptive



management cycle," she continued. "You plan, you have an idea of what you want to do – a restoration action or an enhancement project; you implement that project, you monitor it, you might do some fine-tuning in the middle as needed, and then you evaluate the monitoring results, maybe bring in new data on that species or other factors, and then you start the whole cycle again. You plan, implement, monitor, evaluate. So in phase one, that's what we did; we've learned those lessons, we've moving into phase two. We're going to plan, implement, monitor,

evaluate again, and we'll do that in phase three on the cycle." Since the restoration project is 15,000 acres, it can be broken down into smaller projects instead of having to do all the acres as once, she noted.

"Adaptive management is only possible if you have science support to track the changes," Dr. Valoppi said. "Strong science and applied research will be critical for success of the restoration. The science support is provided by US Geological Survey employees, but it's also provided by academic, nonprofit, and consultant scientists, so we have a multidisciplinary team."

### Uncertainties

"Several key uncertainties were evaluated in the environmental documents," she said. "The first is, will there be enough sediment to fill the ponds? Some of the areas, particularly in the far South Bay, have subsided. There was some groundwater pumping historically that was unrelated to the salt pond productions that subsided the land surface, so we need to bring up some of the elevation in some of the ponds up to eight or 10 feet. Once the elevation of ponds has increased, the elevation is high enough that plant material that comes in can take hold and colonize."

"But with all that sediment coming into the newly breached areas, we don't want erosion of the mud flats to be a consequence of that," she continued. "So we have uncertainties about what impacts will the

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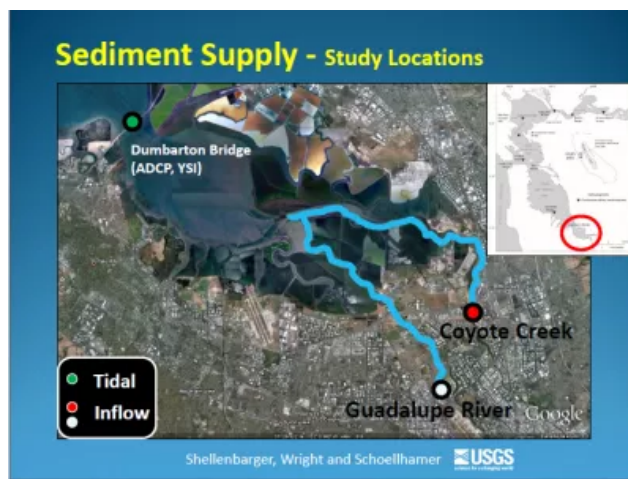
restoration have on the mud flat habitat. Recall that the mud flat habitat is a key resource for foraging shore birds, so we don't want to lose that. Then in general, how will the restoration affect birds? The key uncertainty is how to fit a large number of water birds on a smaller footprint, so that's a definite focus of a lot of our studies. We also want to see how the restoration benefits other species, like fish species and other aquatic species, and we've had some nuisance species."

The entire San Francisco Bay Delta has a mercury problem, but the salt pond project has a particular enhanced problem. "There's a large mercury mine upstream of one of our large complexes that has washed contaminated sediment into the project area at high levels."

"We want people to use this area for recreation, but we don't want to do it in a way that may adversely affect wildlife, so we've had some studies on that," she said. "Also how to manage water quality. The ponds were designed to hold water, and we're trying to push water through, but because of the shallowness of the ponds and the large area and the warm conditions in the summer in the South Bay, we often get water quality problems. Dissolved oxygen increases and fish are killed in the South Bay. And of course we're concerned with how climate change and sea level rise may affect the area we're restoring."

## Sediment

One important factor in the restoration is sediment. "Even in the areas that weren't subject to

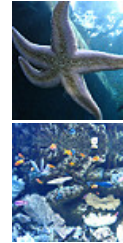


groundwater pumping, the fact that they've been cut off of a sediment supply for a century or more means that they've subsided, so almost all the ponds need some sediment subsidy," she said. "So we're interested in the sediment supply coming into the South Bay. Will we have enough sediment on a macro level? On a micro level, as we breach an individual pond, what's the sediment accumulation within that pond? And we're concerned with the scour of mud flat habitats as a result of that sediment coming into the ponds, and with that sediment is also some contaminated mercury, so there's that aspect of the sediment dynamics as well."

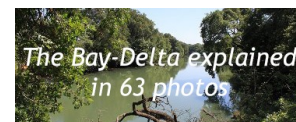
Studies were done to look at sediment flux coming through the

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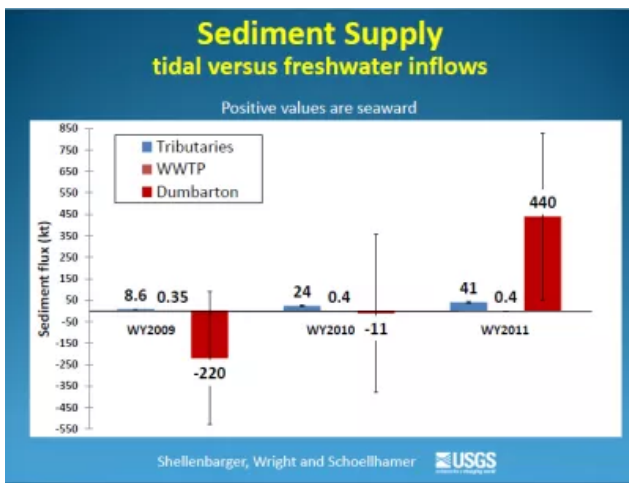
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Dumbarton Narrows underneath the bridge, as well as sediment coming in from the two main tributaries in the South Bay, the Guadalupe River and Coyote Creek.

Dr. Valoppi presented a graph of the results for the first three years, noting that sediment flux in kilotons is on the y axis. On the chart, positive numbers mean that the net sediment flux is seaward or away from the project area; negative numbers mean that there's a net sediment flux toward the project area in the South Bay. Red is what's coming through tidally at the Dumbarton Narrows and blue is what's coming in from the tributaries.

*"In 2009, we had 220 kilotons of sediment coming in the South Bay, and very little was contributed by the tributaries, and even less by the*

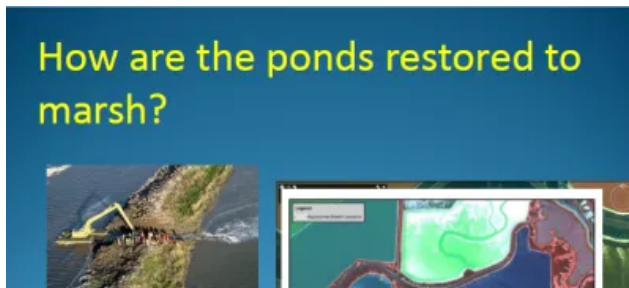


*wastewater treatment plants," she said. "The following year, in 2010, it was kind of a net zero. Not much came in through the Dumbarton Narrows,*

*more came in through the tributaries, but overall, very little net sediment accumulated in the South Bay."*

*"In 2011, we had just the reverse. We had 440 kilotons moving out of South Bay, so twice as much as went in in 2009, went out in 2011, and the scientists are still investigating this, but they think it was because water year 2011 was a very wet year, there are some dynamics with salinity that may have caused this to occur. We think it's an anomaly; we've been studying this for the last couple years, and they're still analyzing the data, so I don't have those results yet, but it does look like the preliminary data suggests that the wet water year of 2011 was an anomaly. With an el Niño, it'll be interesting to see what happens there as well."*

Dr. Valoppi then discussed the restoration process for the salt ponds.



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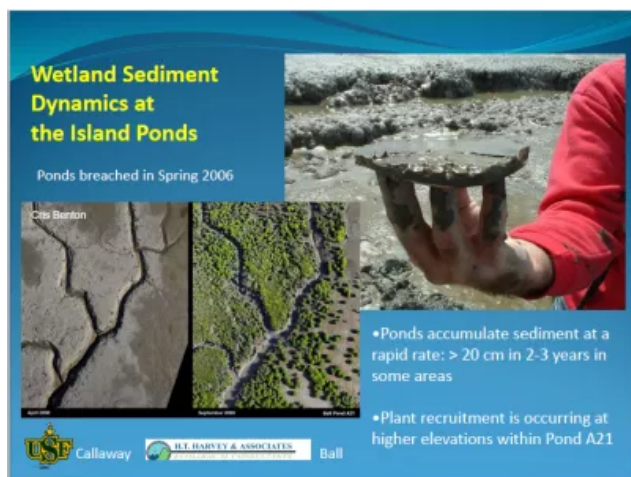
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"They created the salt production pond by taking a big



scoop, digging up part of the marsh, and piling it up to create a berm or a levy around a portion of a marsh, so all of the ponds have this borrow ditch on the inside with a berm on the outside," she said. "But the marsh channel habitat is still existing in the little corkscrew channels that create the marsh. This is very good for our restoration, hydrologically, the marsh is intact except for the area around the borrow ditch and the berm."

"So the engineers and hydrogeologists do analyses, and they determine where best to breach; usually it's near where the existing channels are," she said. "Then some amphibious equipment comes out or sometimes equipment comes out on the levee depending on the situation, and it breaks the berm and creates an open channel to the tide. The tidewater rushes in, and with that tidewater, it brings with it all this wonderful sediment, and then that sediment builds up the marsh, and eventually that tide brings in seeds and plant material, and that seed and plant material can then colonize and take hold and develop the marsh, so it's all very passive restoration."



Sediment studies were done on two projects where ponds have been breached, the Island Ponds were breached in 2006

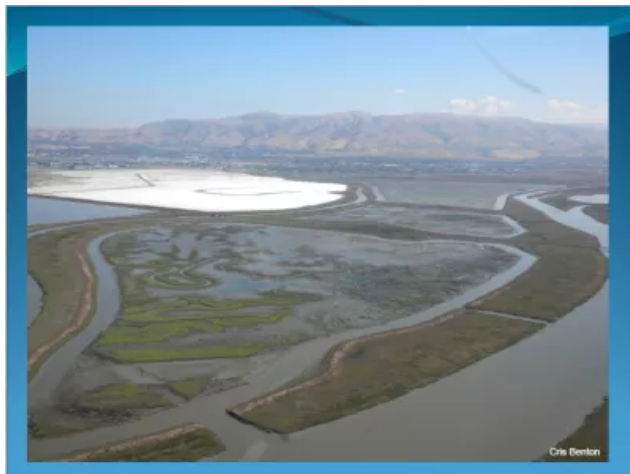
and the Duck's Head pond, which was breached in 2010.

"At the Island Ponds, we did some studies looking at sediment accumulation in these ponds and we found very rapid accumulation of about 20 centimeters in the first two to three years – that's about eight inches of sediment," she said. "That's very, very high. Usually for an existing marsh, it's a couple millimeters a year of sediment accumulation, but because the areas are subsided, there's very rapid initial sediment accumulation."

The Island Ponds were breached in 2008, and two years after the breach, sediment had come in and settled along the channels, and a year later,



there was plant colonization. *"The elevation of the marsh had reached an elevation where it could start to colonize and recruit. ... Once the breaches occur, natural tidal processes act to widen many of the breaches. ... You can see the corkscrew channel pattern as well as the green showing the*



*development of the marsh."*



Dr. Valoppi presented a picture of the project last year, nine years after it was breached. *"The US Fish and Wildlife Service conducted some*

*studies, and they found evidence that clapper rails were breeding in this marsh, as well as salt marsh harvest mouse. So the two keystone species that use this marsh are now utilizing this habitat less than 10 years after we started the restoration, so we were very excited to see this. This is what we want to happen."*

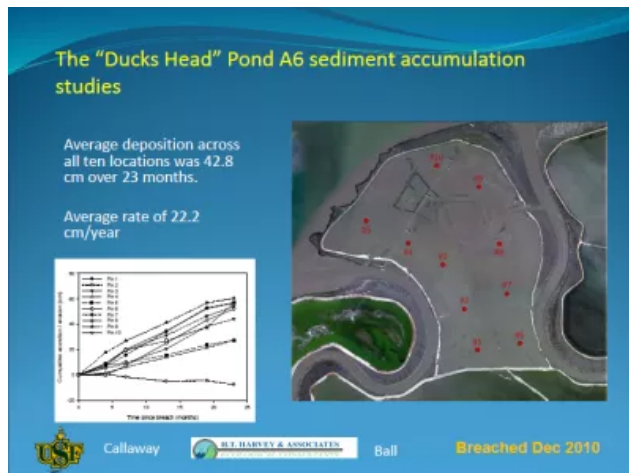
The other pond studied was Duck's Head pond, which was breached in 2010 in four locations. It is about 350 acres; ten locations within the pond, noted by the red dots, were used to track sediment accumulation. The graph shows time since the breach on the x axis, with sediment accumulation at the ten locations on the y axis.

*"The different locations had varying amounts of sediment accumulation; only one had some erosion which was the one right near a breach*

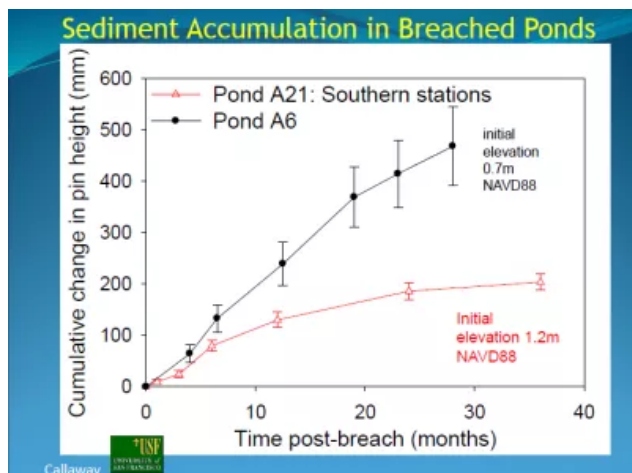
*location.*

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But we had average depositions at very high levels – almost 43



centimeters in less than two years. That averaged about 22 centimeters per year."



She then presented a graph comparing the results from the two sets of ponds, noting that on this chart, time since the breach is on the x

axis and amount of sediment accumulation on the y axis. "A6 is Duck's Head; it had a lower initial elevation and so it had a higher gradient that could allow much more rapid rates of sediment accumulation," she said. "The first set of ponds, the Island Ponds, also had very rapid accumulation at the beginning, and then it starts reaching a plateau, and that's very typical for the sort of breach application."

The A6 pond was breached in the end of 2010; Dr. Valoppi reminded 2011 was the year there was 440 kilotons of sediment moving out of South Bay. "So on a large level, there was a lot of sediment moving out of South Bay in 2011, but on the pond scale, there is still a lot of sediment in the system, and there's very rapid sediment accumulation during that time. That was encouraging to us. Even though we were concerned that we were seeing this massive amount of sediment moving out of South Bay, there's still lots of sediment in the system to drive the sediment accumulation that we need to build the marshes."

"This is what it



looks like at various periods afterwards; it's developing nicely, but all the sediment pouring into the ponds and



filling up makes us concerned about what's happening to the mud flat habitat or shoals," she said, noting that the project area has 4,000 acres of mud flat. Dr. Valoppi said using traditional satellite imagery is problematic for a lot of reasons she wouldn't go into, but last year, they did a pilot study using the satellite World View 2 which charts water better than some of the traditional satellites; some ground truth was also included.

**How will restoration affect mudflat habitat?**

- ~ 2000 acres of mudflat habitat
- Traditional satellite imagery problematic
- Pilot Study using World View 2 or 3 with Coastal Blue Band
- Ground-truth

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"This is an example showing that this picture is from the world view two satellite imagery, and this green line is some very high-

resolution symmetry data, and you can see it lined up very well," she said. "That was very encouraging to us that we might be able to use this World View 2 in a more cost-effective way over a large area. So far, we don't think we're eroding the mud flat habitats, but it's early in the restoration yet, and that's something we want to keep an eye on. We're hoping this technique will help us do that."

## Birds

Dr. Valoppi then turned to discuss the work being done to restore and

**How can we enhance habitat for birds?**

> 40 species of birds

restore and enhance habitat for birds. There are over 40 species of birds –



shore birds, ducks, diving ducks, pelicans, and some breeding birds; most of the birds, however, are wintering here or coming through in the fall or spring migration.



The first bird habitat project was pond SF2 Menlo Park and Palo Alto. *“Engineers created a set of 30 ponds by scooping out the mud of the*

*pond when it was dry, and then piling it up to create these islands,” she said. “We have 15 linear islands and 15 round islands; we didn’t know which shape of island the birds would prefer, so we did both.”*

There are two different cells with islands; there are water control structures for inflows and outflows, as well as several water control structures to control the depth and the timing of the water.

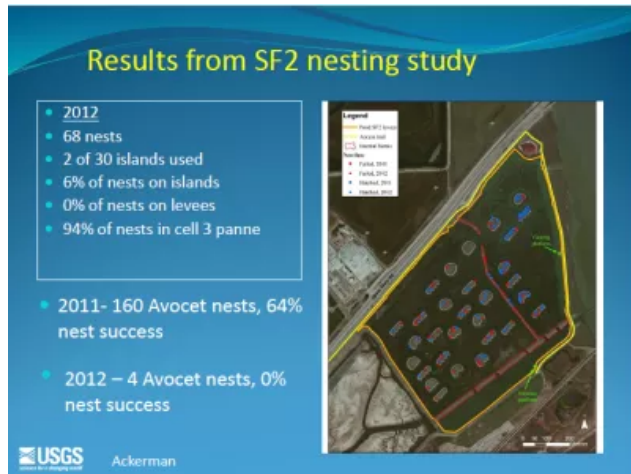
The ponds were opened in the fall of 2010; by the next year, there were

193 bird nests; almost all of the islands were being used by nesting birds, she said. *“Most of the nests that were occurring*



*on this pond were on the islands with a few on other locations and we*

on this pond were on the islands, with a few on other locations and we thought, this is wonderful. Unfortunately, if you've ever been in the bay, the bay mud when it dries out, it cracks. So on top of these islands where it was drying out, several cracks had formed, and unfortunately we lost some of the chicks, they perished in these cracks. They fell in and couldn't get out, and the parents couldn't get them out. Not what we had intended. But that's adaptive management. Things don't always work out the way you want."



The refuge brought a amphibious piece of equipment called a Marsh Master, which went on to each of the islands and broke up the surface

to eliminate the cracks. The next year, there were only 68 nests, and very few of the islands were used for nesting.

"We don't know if the birds avoided this area for nesting because of the prior year cracks; there were also some nuisance species like California gull that were using these areas that might have dissuaded the shore birds from nesting in that area, we weren't quite sure. But the net result was in 2011, we had 160 avocet nests and a fairly high nest success, even given some of the chicks perished in the cracks. But by 2012, very limited nesting on our islands. This was a disappointment."

By looking at the results from the FS2 pond as well as looking at nesting on other islands in the project area,



researchers developed a 'recipe' for nesting birds. "We know how far to put the islands from the bay, how far to put them from features like

levees, and we found that linear islands are preferred over round," she said. "We have an idea of the size of islands that the birds prefer, we know how high to build the island and the top of the surface. Most important, they told us fewer islands per pond are better. Instead of putting 30 islands in there, it's better, it's more cost-effective to put three to five islands per pond. It's not that more islands prevent nesting, it's just that it doesn't give you any advantage, so why spend the money?"

Pond A16 was also planned as a bird enhancement area; 16 islands were created in this pond. The construction was in process prior to having the full results from the SF2 study, so they went ahead and put the same islands in there. "The purpose of this was to try and see if nesting islands away from the bay as opposed to closer to the bay would have any difference, but basically, they found that very few of these nesting islands were used, despite all of the very first year showing high success. So the managers decided, they're not using the islands, let's try and attract them."

"Basically, social attraction is a single bar for birds," Dr. Valoppi said, noting that it works for certain birds such as terns which are colonial nesters, but it doesn't work for solitary birds. "You put these decoys out that look like the bird you're trying to attract; we also had these call systems that would also attract them, and this way we could attract the



**Social Attraction**

What is it?

- Singles Bar for Birds

Why are we doing it?

- To attract nesting birds to specific areas



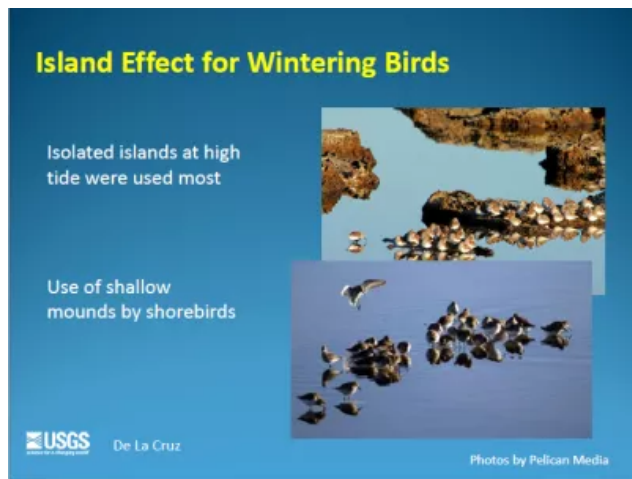
nesting birds to a specific area. And so we did that for these FS2 islands and the A16 islands that we had put all this money into

constructing."

"So three of the islands were prepared; there was about 50 decoys, and a solar operated call system was set up in the FS2 island; in A16 we set up two of the islands with Caspian tern. We also tried this in a limited extent for forster terns and clovers, but the focus was really for Caspian tern," she said.

"The results for Caspian tern were very successful. We had 147 nests in the three islands at FS2 producing 120 tern chicks, very good nesting success. Similarly, the two islands that had the social attraction in A16 had lots of nesting and produced lots of birds. We had a breeding success of about 70 chicks per breeding pair which is pretty good. This

success of about .79 chicks per breeding pair, which is pretty good. This was the first year of a three year study, so we have two more years."

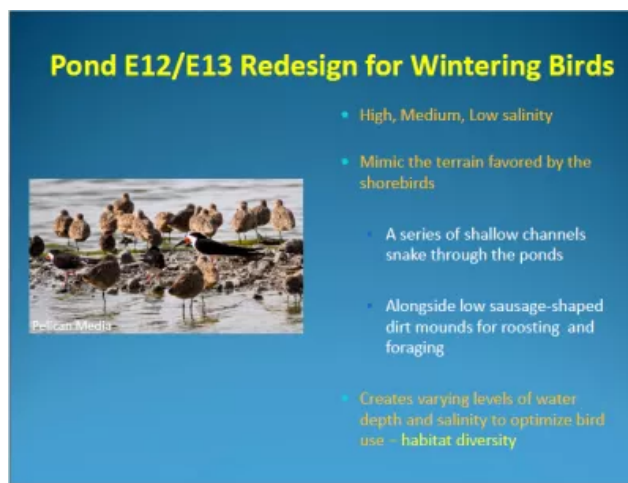


They also studied how wintering birds were using the islands. "Basically, they found that the wintering birds like isolated islands at

high tide, and they were mostly using it for roosting, not foraging," Dr.

Valoppi said. "But anecdotally, they were seeing that when these islands were created by the heavy equipment coming in and scooping up the dirt to pile it up to create the nesting islands, some of these would be some remnant material left that hadn't quite gotten smoothed out or moved over, and it would create these very shallow mounds – maybe a couple centimeters of water. And the researchers were observing that the shore birds especially really like these shallow, little mounds."

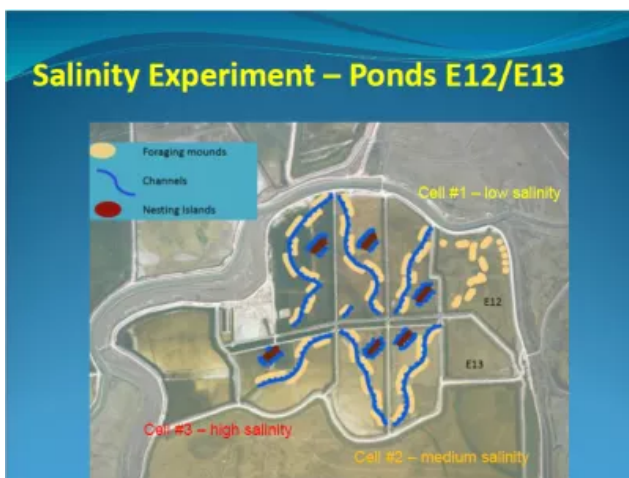
The next set of ponds they were working to enhance were E12 and E13. "Because this was the last pond that we were designing,



we had the information from SF2 and A16 to know how to design the islands," she said. "Originally, this pond was only going to have a salinity experiment of high, medium, low salinity, trying to mimic some of the higher salinities that were there when it was salt production, because some of the species really like that. But we also had an opportunity to redesign it to mimic this shallow habitat that the shore birds favored. So we created a series of shallow channels by scooping it out, scooping out shallowly the dirt, the mud, and then piling up alongside that channel to create these shallow mounds. So now we have an area that not only

create these shallow mounds. So now, we have an area that not only varies in salinity, but also varies with topography. So that means when you add water, you're going to have different water depths as well. So you have this habitat diversity, but hopefully bird diversity, increase in bird diversity and use."

She presented a design of the project, noting that there is a matched pair of low salinity cells, medium salinity cells, and high salinity cells in both ponds. The water comes in and is moved through a series of water control structures to control the amount of salinity, and then nesting islands were added, just one per cell. They are linear because they've learned that the birds favored linear over round. The shallow channels were added, shown in blue, and that material piled up to create the shallower habitats.

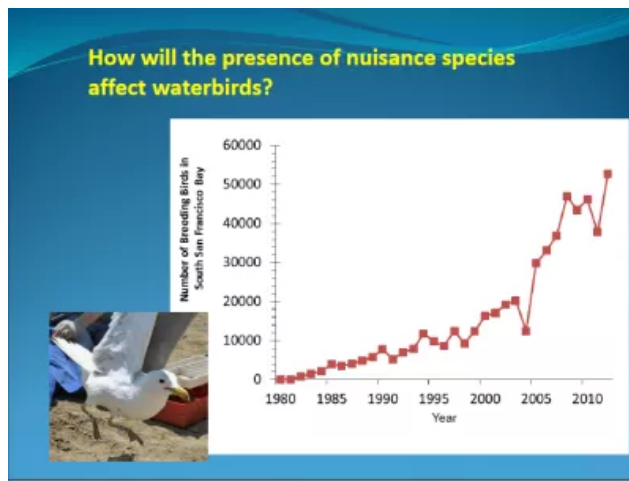


"This experiment really has started, we're in the process of studying this, but as soon as the water was added, the birds have started using these

cells and they started using the foraging mounds," she said. "We're still collecting data and assessing it."

## Nuisance birds

"This is a California gull," Dr. Valoppi said.

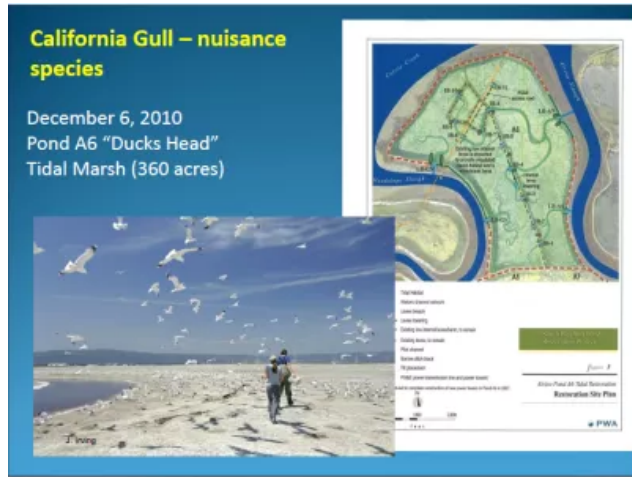


"Historically it had never really nested in San Francisco Bay, but with some changes in Mono Lake where it had historically nested, we started seeing more and more of the California gull coming in to nest in the San



Francisco Bay and you can see this exponential increase the California gull. Unfortunately, this gull has a bad habit of depredating shore bird nests. So it will take the chick or the eggs of those birds. ... We have data showing that these California gulls depredate not only avocets, but a number of other of the nesting birds that we're trying to enhance, including the snowy plover which is endangered."

"So this part of the story brings me back to Duck's Head," she said. "It was



kept dry a good part of the year as it was used for duck hunting. Half of the nesting gulls were at this one pond, so it was a very high

concentration of gulls. We were curious to see with all these gulls scattered over this area nesting, what would happen when we breached the pond? We were hoping they would move away and go back to Mono Lake or go back to somewhere else, and not impact our project area."

Several of the gulls were banded, and their locations in 2010 observed; most were at Duck's Head (A6), although some were in other

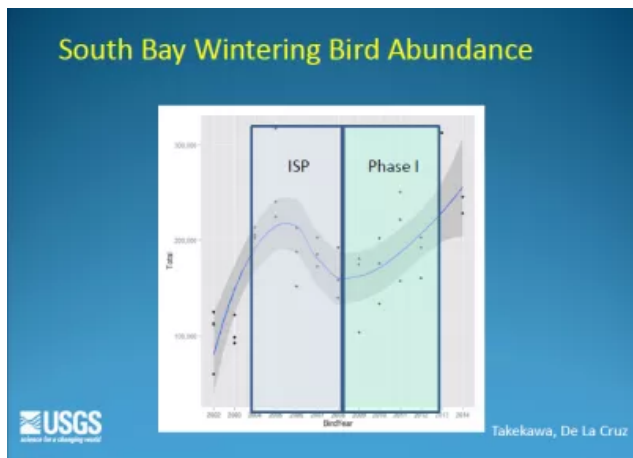
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- In 2010, 569 gull chicks were banded, and resightings done in 2011
- The majority of gulls moved to the pond levees on the other side of Alviso Slough
- Overall CA gull populations decreased 17% from 2010 to 2011, then increased 28% from 2011 – 2012 (52,704 birds).
- 2013, 2014 ~ 53,000 birds

locations. "After we breached, half of them moved over to the next set of ponds, and the other half dispersed and increased at existing colonies around the bay," she said. "Initially, there was a decrease in the California gull population by about 17% after we breached it. But within one or two years, we started to get the gull population settle down and start to increase. And right now, the last estimate is about 53,000 birds."

Back at Duck's Head, the California gulls moved over to the next set of

ponds and onto the levees separating those ponds; there was a Forster's tern colony just to the south. "In 2010, prior to the breaching of the A6 pond and flooding of the gull nest, there was only a 4% fledging success of these terns," she said. "With the opening up of this pond and the movement of those birds over and the dispersement of the gulls, the fledging success of those terns increased 40% or an order of magnitude. So even though they were still fairly close by, having the gulls further away and having fewer of them appear to benefit the tern fledging success, so that was encouraging. Even though we didn't decrease the number of gulls, the impact on the shore birds were lessened."



She then presented a graph showing the average number of wintering birds in their project area from 2003 to 2014. "You

can see it increased," she said, noting the initial starting phase was when water control structures were added, and there was some disturbance of the areas where birds had historically wintered. "At the start of our phase one actions, we started enhancing areas for birds and we started managing the ponds more for bird use rather than salt production, and you can see there was a general increase. Overall, there's been about a doubling of wintering birds from the initial purchase in 2003 to 2014, so that was encouraging."

However, not all birds are benefitting. The snowy plover is an endangered bird that historically has nested in beach habitat, but because of impacts on that beach habitat from development and human uses, it adapted to the dry, salt-crusted ponds. "It nests in this very shallow strait on this salt," Dr. Valoppi said. "It's a little cotton size ball and it's very vulnerable to predation by things like California gull as well as a number of other predators."





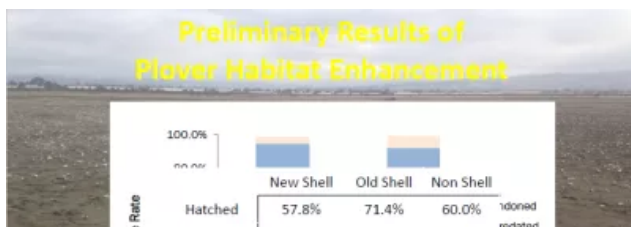
So they did  
a habitat



enhancement project and a pilot study putting out oyster shells to create camouflage for the chicks and the nest. "We got a bunch of shells, and last year distributed those shells over about a 50 acre area," Dr. Valoppi said. "We had plots with shells and plots without the shells. Once the shells were dumped off this flat bed, a leaf blower then scattered the shells to about five to eight shells per meter squared, the same density over all the 50 acres. We have areas with shells and areas without shells; this was the first year of the study last year. Initially, there were some old shells that had been put there before."

She then presented a slide of the results. "Looking at the hatch rate of plovers, you can see the old shell areas in particular had higher hatch rates than the non-shell areas, or the new shell areas," she said. "But more important, the depredation increase from the non-shell areas. There was an increase in abandoned nests and we think that it might be

due to a high density of plovers, which are more of an isolated



isolated  
nester; it  
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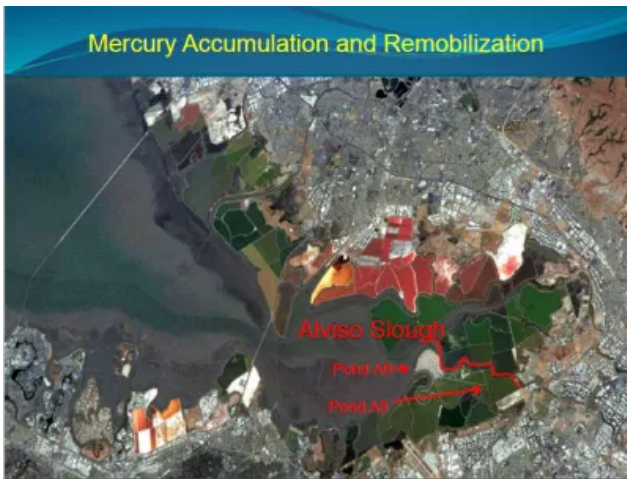
|            | (D4)  | (M8)  |       |
|------------|-------|-------|-------|
| Depredated | 31.3% | 21.4% | 40.0% |
| Abandoned  | 9.4%  | 7.1%  | 0.0%  |
| Unknown    | 1.6%  | 0.0%  | 0.0%  |
| N          | 64    | 14    | 20    |

San Francisco Bay Area Wildlife Center  
Tokatlian

competition that resulted in some of the nests being abandoned compared to the non-shell areas. But overall, this was a huge success. There was double the amount of hatching in the shell areas as had been previous, and far less depredated nests. So it does look like these shells do provide a camouflage for these clovers, and we're interested in expanding this to other areas and larger areas in this pond for this bird."

## Mercury impacts

The [New Almaden Mine](#) began operations in 1846 in the hills above south San Francisco and was one of North America's most productive mines, producing over 1 million flasks during its span of operations. The mine drains to the Guadalupe River, which is upstream of part of the project area.



"We were concerned that mercury would be mobilized as we opened up the ponds and that it would scour out the adjacent

sloughs; the sediments in those sloughs have mercury buried in them

and that would remobilize that mercury and distribute it in our project area or elsewhere, so where would it move to? And what is the effect of increasing tidal action on these ponds? Is it going to increase mercury methylation and bioaccumulation or not?," she said. "It's very complex biogeochemical processes that dictate how much mercury will accumulate in a bird or a fish, and it's not easy to predict."

So they set up a mercury experiment in Alviso Slough, which is connected to the Guadalupe River. The New Almaden Mine historically had washed down contaminated sediments down the river and into the project area, and with the rains, more sediment continues to come down through the upper watershed into the project area.

"The idea here was to control the amount of water and the timing of the water that we put into this pond operated as a muted tidal flow, and then

**Mercury**

- Inflow/outflow gates
- Armored Notch – 40 feet, 8 gates

Opened 1 out of 8 gates (5/40) June 1, 2011

**Ponds A8, A5, A7: Muted Tidal (1400 acres)**

check to see what effect that has on mercury," she said. She explained the infrastructure of the project, noting that there are eight bays and eight gates.

"Initially we only opened one gate, and the idea was we would open one, two, four, successive gates to see what the impact was on mercury in the 1,400 acre area," she said. "We opened it in June of 2011, but we did a before and after control impact study. We looked at mercury in the ponds, in the water, and in the Alviso slough in the fish, and also in the scouring out from the sediment before and after the opening of this pond, as well as comparing pond A8 to reference locations, reference ponds and reference sloughs."

**What is the Hg doing?**

- In the ponds? Hg birds and pond fish
  - Avocet
  - Forsyth's tern
- In water? Hg water samples collocated with fish
  - Striped bass
  - Reddrum
- In Alviso Slough? Hg in slough fish
  - Striped bass
- In Alviso Slough? Hg remobilization from sediment scour

"With the gate

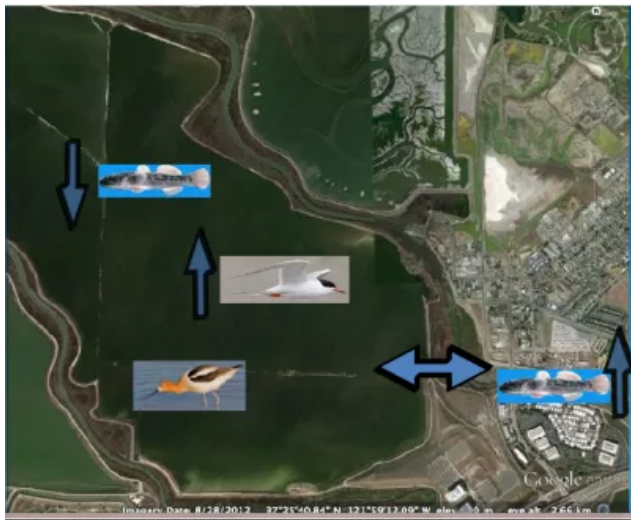


closed, in 2010, we found very high levels of mercury in pond fish and in nesting terns," she said. "We also looked at mercury in avocet



eggs, and they were not any higher than in adjacent ponds, but the tern eggs were much higher in pond A8 than adjacent ponds, and the fish were much higher in pond A8 than in adjacent ponds. We also looked at fish in the slough; they were not any higher when the gate was closed, and they were not any higher than adjacent sloughs."

"Once we opened that pond, we saw that the mercury in the slough fish greatly increased within the first month, and the mercury in the pond fish greatly decreased within the first month or so," she said. "The tern egg mercury level stayed high because they already finished nesting by June, and the avocet eggs didn't change. But at the end of that first season, by the fall, the mercury levels in the slough fish went down to levels comparable to what was seen in reference ponds."



"Originally, we were very alarmed that we had such a large increase in mercury in the tern eggs, and it still is large, but it's come down

considerably," she said. "We've continued to monitor it every year after, and it's looking very encouraging. Right now, we have five gates that are open. We've been able to successfully open the gates here, and so far after the initial spike in mercury in tern eggs, it's decreased, and similarly in the fish, so that's encouraging."

## Trails and recreation

There are also concerns with how trails and recreation through the project area will affect wildlife.

*"We want people to use these*

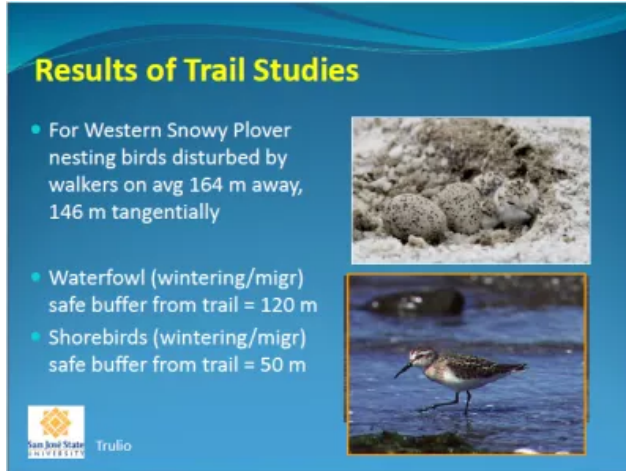
*trails and we want the people of San Francisco Bay to enjoy the area, but we don't want to do it at the expense of the wildlife that's there,"* Dr. Valoppi said. *"We're concerned with effect on breeding behavior, the nest success, foraging and roosting of winter and migratory birds, and basically what we determined from a number of different studies is a safe distance from a trail to a habitat feature like a nesting island, or an area where birds are foraging."*

The study result found that for snowy plovers, the trail must be at least at least 164 meters or about 500 feet away from the nesting habitat as they are sensitive to any disturbance, she said. Winter waterfowl were also very sensitive, needing a trail buffer distance of 120 meters, but shorebirds needed only 50 meters from the trail to where they are foraging. *"When we're designing areas to put trails in, we managers know how far away we need to keep it from features we're trying to enhance for birds."*

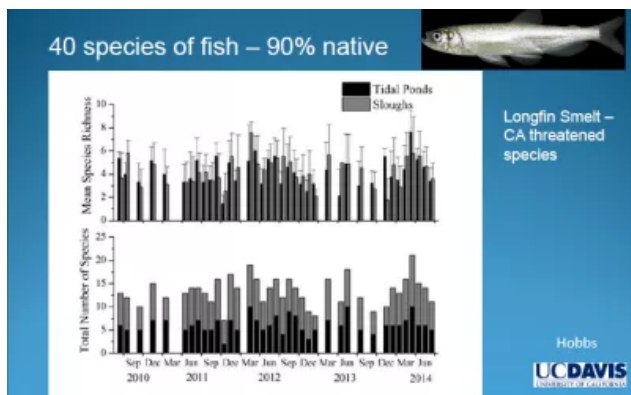
## Benefits of restoration for water quality and for fish

Dr. Valoppi said they expected the restoration to benefit fish, but they wanted to track and document that that was the case. Researchers found over 40 different species of fish, mostly native; they found a summer assemblage and a winter assemblage of fish. *"The winter assemblage of fish included long-fin smelt, a California threatened species, that seems to be doing very well in the winter down there despite that it's decreasing numbers in the rest of San Francisco Bay Delta,"* she said. *"Basically when the water gets warmer in the summer, the salinity increases and you see a shift in species that are more tolerant of those higher temperatures and a higher salinity. In the winter it goes back again to a more winter assemblage, very abundant."*

They also wanted to see if the



**How will restoration affect water quality and fish?**



fish were using the newly restored ponds compared to the sloughs. She presented a graph

showing species richness and number of species, explaining that the black are the newly restored tidal ponds, and the sloughs are in gray. "This is basically showing you that there's equal use of the tidal ponds as they are to adjacent sloughs, suggesting that once we open up these ponds, the fishery's resources go in very quickly and use the area."

### Climate change

There are concerns about climate change and sea level rise and the effect on the biology and habitats of the entire San Francisco Bay and Delta, as well as specifically on the restoration project, and how managers can adaptively manage to ameliorate the effects.

"The managers have done several strategies," Dr. Valoppi said. "First, they were trying to restore wetlands earlier rather than later with the idea that a wetland that's already established has a better chance of withstanding sea level rise impacts. They've also been bringing upland fill to increase the elevation, which kick starts the process to create a wetland, and we're also exploring using dredge material to enhance some of these ponds and increase the elevation. We're also working to create high tide refuge like upland transition zones and marsh mounds within the wetland restoration project."

Dr. Valoppi then concluded her presentation with a nod to the project's entire science team's hard work and dedication. The floor was then opened up for questions.

**Question: Do you know how much of your material is organic versus inorganic? And where is this inorganic material coming from?**

Dr. Valoppi: "You're referring to the sediment accumulation studies we were doing in the ponds. Yes, almost all of that is inorganic. That's pretty typical in the first initial restoration; almost all of it is going to be inorganic sediment coming in and accumulating. Once the vegetation takes hold, like now in Island Ponds, we've got pickleweed and other plant species coming in, then you'll start getting more of the marsh being composed of organic material." As to where the material is coming from, "That is the big question, and we don't know exactly. We can't trace a little molecule to see where it came from, but historically, South Bay has been very sediment-rich. It's kind of a laqoon, once the tide goes through



*the Dumbarton Narrows, there's a large lagoon, so just geographically, it's kind of prone to having sediment accumulate in that area. Historically, it's had extensive mud flats, which also speak to the large amounts of sediments that are down there. It does not look like at this point from our preliminary data that it's coming from the erosion of the mud flats. It's just floating sediment that's in the water, that's coming in on the tide, and then settling out. But that's something that we do want to track very closely."*

**Question: How do all these entities and interdisciplinary people working on birds, hydro analysis, people that know about sediments – obviously they have a lot to say to each other. How do you guys interact?**

*Dr. Valoppi: "I'm the lead scientists, so I get information from the scientists through preliminary reports, preliminary data, drafts, etc. We don't wait for things to be published. Then I transmit that information to the managers. I'm on the management team; I attend all the management team meetings. We can also have calls where important, breaking information will transmit directly to the managers. More formally, we have working groups – there's a mud flat working group, a mercury working group, and a bird working group, and a pond management working group. Those groups are comprised of the researchers in those topic areas as well as the managers. ... They meet sometimes physically, sometimes through a webinar, and that's where the latest results can be transmitted, and the researchers can relay that to the managers, or the managers can ask questions of the researchers."*

*"A lot of it is me transmitting the information," she continued. "At all of our management meetings, we have a science update where I give an update. Sometimes it's a half an hour, sometimes it's the whole meeting, depending on what the issue is. So we have a lot of different forms that we're created for the managers to get the information from the researchers. We also have an annual researcher manager meeting where all day, the researchers and managers talk about various topics that we organize."*

*"Many of you went to our science symposium, we have that every other year, and that's a more in-depth look geared more toward the stakeholders and the general public, but our scientists get to present their results there as well. And I also do these little cliff notes of where I will send out email summaries of a couple paragraphs of a study that our researchers have done, and send it out to our management team, as well as to our science team, so the fish researcher knows what's happening with the bird research and vice versa, so the science team is aware of what other people are doing. ... Yes, I keep very busy, providing a lot of information to the managers."*

**For more information ...**

- [Click here for more on the South Bay Salt Pond Restoration Project website.](#)

- [Click here to watch the video of this brown bag seminar.](#)

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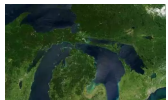
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*The diary of a confessed obsessive-compulsive California water news junkie*

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