Effects of the Goals Project
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Good afternoon. I have been asked to address the effects of the goals project. I will try to address the effects by answering three very broad, technical questions.

Slide 1 (this text)
What has the project taught us
about the bay and its watersheds?

Slide 2 (this text)
If the goals were achieved,
what might be
the environmental effects?

Slide 3.(this text)
What are the uncertainties
and how might they be addressed?

Slide 4 (slide 1 repeated).
Let's take the first question.

Slides 5 -9.
Habitat shots
The goals project provided new focus on (slide 5) the tidal flats, (slide 6) tidal marshes, (slide 7) tidal reaches of creeks, (slide 8) moist grasslands, and (slide 9) diked baylands as the upland edge of the Bay and the bayland edge of watersheds.

There is a better regional sense of the baylands as habitats, how many kinds there are, what are their distribution, and what ecological services do they provide. One effect of the project is that there is much more known about the baylands as structural parts of the larger ecosystems of the bay and its watersheds.

Slide 10
Regional Historical View (EcoAtlas with shaded relief)
Let's take a look and some of what we have learned about the structure of the baylands.

For reasons of topography, geology, and climate, the baylands differ among the subregions.

Slide 11.

Suisun Subregion Present View (EcoAtlas with shaded relief)
Suisun Marsh is part of the ancient delta of the Sacramento - San Joaquin river system that was partially drowned by rapidly rising seas a few thousand years ago. In some places, only small portions of the larger ancient islands have survived. Elsewhere the islands and their surrounding channels are intact, although most are diked and no longer experience the tides.

Slide 12
Suisun Subregion Past View. (EcoAtlas with shaded relief)
Small amounts of rainfall and gentle topography account for broad expanses of short-lived seasonal wetlands, including vernal pools, and sparse riparian zones along very small creeks. Due to the paucity of freshwater inputs from local watersheds, the overall salinity gradient was reversed, with more saline conditions developing away from the bay, where there was less tidal flushing and salts accumulated.

In brackish conditions that typify Suisun, tidal marsh plants grow low in the intertidal zone, such that low areas that might otherwise be tidal flats are colonized as tidal marsh. Middle elevations in the marsh that otherwise would have channels are broad drainage divides. The broad divides between the channels of brackish marsh tend to have large, shallow, natural ponds, or tidal marsh pans. Most of the large populations of migratory waterfowl that used to frequent Suisun Marsh were supported by these pans and the surrounding tidal marsh sloughs.

Slide 13
Contra Costa Shoreline Change (Josh has original that must be scanned)
Suisun is also known as the null zone of the Estuary, or the zone of maximum turbidity, which is characterized by large loads of suspended sediments, silts and clays, carried through the Delta to the bay in seasonal pulses, varying from year to year. This may help to explain the dynamic nature of the marsh shoreline in Suisun, which, as illustrated here, can naturally advance into the bay or retreat as much as 500 feet in just a few years. The natural shoreline of southern Suisun seems to expand and contract with changes in sediment supply.

Slide 13
North Bay Past View. (EcoAtlas with shaded relief
Every watershed of the North Bay has a brackish tidal reach, resembles in brief form the conditions of Suisun. But the North Bay gets more rain, has steeper topography and coarser sediments for the most part, and so it tends to have more creeks, with more robust riparian ecosystems, and fewer natural seasonal wetlands. Overall, the North Bay baylands are more saline than Suisun Marsh, and there tends to be more extensive tidal channels with smaller drainage divides, and more numerous but smaller pans.

Large tidal flats were associated with local watersheds having naturally large sediment loads but insufficient discharge to maintain a channel all the way through the shallow bay. It seems that the distribution of tidal flats was historically dependent on local sources of sediment.

Slide 14

Central Bay Past View (EcoAtlas with shaded relief
The Central Bay is a subregion of short intertidal gradients and high energy. The wind and waves have taken a "bite" out of the shoreline directly opposite the Golden Gate. There used to be (and are in some places there still are) sandy beaches, shallow lagoons, and cliffs above the bay. The ecology is more marine than elsewhere in the Estuary. Whales occasionally visit Central Bay.

Slide 15
South Bay Past View (EcoAtlas with shaded relief
The South Bay is distinguished by large watersheds with broad valleys and alluvial fans having high watertables. The gentle topography has permitted the slow winnowing of fine sediments down across the plains toward the baylands. The grain size of the soil and its permeability tends to decrease with distance away from local creeks, many of which used to be intermitant, making their way to the bay some years and not others. Seasonal high groundwater rising to the surface along the uphill side of the impermeable soils supported large willow groves. Seasonal wetlands captured the rainfall on the fine-grain soils and prevented much direct runoff onto the marshlands. The upland edge of tidal marsh near these soils therefore tended to be hyper-saline, too salty to support much plant growth. Long, shallow tidal marsh pans were indicative of the poorly drained, hyper-saline uplands ecotone.

The salt marshes of South Bay had the greatest amount of channels and the largest number of pans. Abundant tidal flats were associated with the mouths of the larger streams and the shell hash of natural oyster beds.

Slide 16
Full Regional Past View (EcoAtlas with shaded relief

Some of the differences in baylands habitats among the subregions are variations on a theme.

For example, a mosaic of moist grasslands, riparian forest, and high tidal marsh seems to have existed near the mouth of every significant creek. In the South Bay, the mosaic included willow groves, and the riparian forest included cottonwoods and sycamores. In Central Bay and North Bay, the riparian forests mostly included bay, ash, and live oak. All along the scalloped shores of Central Bay and eastern North Bay were pocket beaches, many with small lagoons behind sand dunes.

Much of this detail of habitat is the natural result of local climate and topography. Where these factors have not significantly changed, nature would tend to produce the same arrays of bayland habitats.

In a sense, the historical or native landscape can serve as a template for landscape restoration, showing how much of what kinds of habitats tend to evolve where, due to persistent natural processes.

Slide 17

Regional Salinity Gradients (color version)
An essential aspect of the ecological complexity of the baylands is the numerous and variable salinity gradients associated with creeks and rivers large and small. These gradients also still exist, and form part of a physical template for habitat restoration.

Slide 18 (slide 2 repeated).

If the goals were achieved,
what might be the environmental effects?

Slide 19
Baylands nature shot
There will be public places where almost nobody goes. There will be a sense of nature and wildness that the bay system has not been able to provide in more than a century.

Slide 20
Waterfowl taking off
There will be habitat for more waterfowl and shorebirds and other migratory birds. This will be achieved in large part by the careful management of strategically located diked marshlands and salt ponds.

Slide 21
List of protected species of the baylands, showing which would be recovered.
Some species of plants and animals will be taken off the lists of threatened, rare, or endangered species. Achieving the goals will be especially helpful for protected birds, including the California clapper rail, black rail, snowy plover, least tern, and intertidal song sparrows. The salt marsh harvest mouse would be saved, as well as some protected species of plants, including perhaps the Susiun thistle, Mason's lilaeopsis, and soft bird's-beak. The effect on fishes could also be significant, for species that use tidal marsh channels, including Delta smelt.

Slide 22 (This text)

Will the tides get cleaner?

Slide 23
IR aerial of Petaluma marsh showing channels
We often think of the tidal marsh as a water filter. We know that the marsh along the channels filters sediments and the associated pollutants.

Slide 24
Transect of sediment cores
…. We can see some evidence of how the filter works.

In these colored x-rays, the green represents organic soils, mostly peat developed in-place by the growth of roots and accumulation of plant litter from vegetation living in the marsh. The black areas represent inorganic soils, mostly silts and clays carried into the marsh by the tides.

Each core shows the peat soil development and mineral sediment filtered by the marsh vegetation from about 1800 to the present.

We can see that most of mineral sediment gets filtered out of the tides within a few feet of the channel bank. We can also see that before about 1850, before the advent of much European landuse, and before sediment from the hydraulic mining in the Sierra Nevada had washed into the bay, the marsh soils contained almost no mineral sediment, even along the channels.

We can also see that the hydraulic mining debris forms a rather thin layer on top of the marsh, even for a marsh that has never been diked, that has always been exposed to the tides.

Since most of the dikes were constructed last century, they mostly surround marshland that received very little hydraulic mining debris.

From this brief overview of sedimentation in the baylands we can conclude that the character of the sediment varies from place to place within and marsh, and from marsh to marsh within the baylands ecosystem.

And that most of the filtering action of the marsh is restricted to the edge of the tidal channels.

Slide 25
Coast Survey map embedded in ecoatlas.
But the goals would restore a large part of the filter, with thousands of miles of channels. Would the restored filter cause the bay waters to be cleaner, to be more transparent? Probably.

Slide 26 (This text)
Will there be enough sediment?

Will there be enough mineral sediment in the tides to build all the new tidal marshes? No one knows, especially in the context of global warming and more rapid sea level rise. We understand that most of the natural marshes require plant growth more than mineral sediments to keep up with the existing and historical rates of sea level rise, but that new marshes depend more on mineral sediments.

Perhaps there will be enough sediment to maintain the restored marshes, but will there be enough for their initial restoration? In some cases there may be required the careful placement of fill to get the marsh started.

Slide 27 (This text)
Will navigation be improved?

Slides 28-31
USGS San Pablo Bay bathymetric change series

Tidal marsh reclamation caused the tidal portions of rivers, creeks, and major sloughs to narrow and shoal. There used to be natural channels leading from local watersheds to the deep channels of the bay. These were maintained by the flow of the tides to and from the marshlands. Restoring part of the tidal marsh will restore part of these flows, and this will locally reduce the need for dredging.

This series of maps showing change in depth of San Pablo Bay was produced by Bruce Jaffe and his colleagues at the Geological Survey in Menlo Park. We see a see that as the tidal marshlands along the Napa, Sonoma, and Petaluma Creeks were reclaimed, the deep water channels of these creeks between the marshlands and the main shipping channel became filled with sediment. The channels that exist now are created and maintained by expensive dredging. Restoring the marshlands should reduce the need to dredge.

Slide 32 (This text)

What are the uncertainties?

Slide 33 (fill frame with text)

Natural Thresholds and
Management Cues

We have already touched on some of the big technical questions: how will the goals affect navigation, water pollution, and endangered species, and will there be enough sediment to restore tidal marshes?

For all of these questions the data are lacking to provide exact answers. We lack the data to explain the relationships between the amounts bayland and the amounts or levels of the ecological benefits or services they provide. We don't know exactly how much tidal marsh is required to recover the endangered species, or how much diked marsh is needed to support all the waterfowl, or what is the relationship between the amount of tidal marsh and the amount of pollution control or level of improved navigation, or how much variability in salinity or water supply is optimal for baylands plants fish and wildlife.

We understand what the habitats are, how they evolve, and what benefits they provide, but we lack the data to completely describe how the amount of benefit relates to the amount of habitat.

Slide 34 (scan the original)

Integration Map

The goals provide the first consensus scientific view of how much of what kinds of baylands are needed where, to restore the health of the baylands ecosystem. But more or less of this or that habitat may be required. We will need to monitor our progress as the goals are achieved, and adjust them for new understanding, to prevent unnecessary work, and to optimize the distribution and abundance of the baylands.

We have questions, but they can be answered.

Thank you.