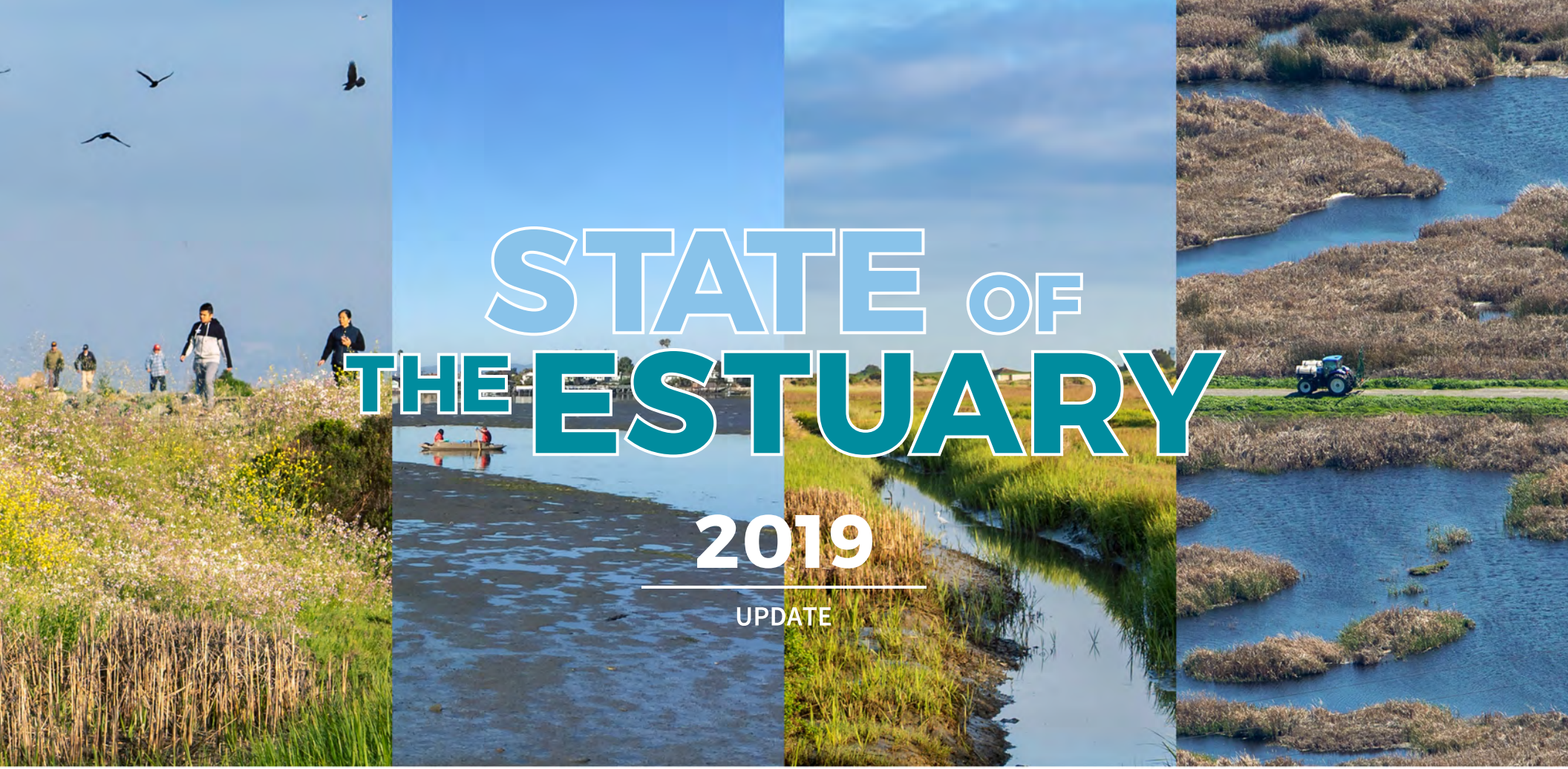


# STATE OF THE ESTUARY

## 2019

UPDATE

### STATUS AND TRENDS OF INDICATORS OF ECOSYSTEM HEALTH

### THE ESTUARY

SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN RIVER DELTA

The San Francisco Estuary Partnership collaborates with partners throughout the Bay and Delta on regional, science-based programs to increase the health and resilience of the San Francisco Estuary. Established as part of the National Estuary Program over 25 years ago by the State of California and the U.S. Environmental Protection Agency, the Partnership manages multi-benefit projects that improve the well-being of wildlife and human communities from the inland rivers to the Golden Gate.

More information can be found at **sfestuary.org**

**SAN FRANCISCO ESTUARY PARTNERSHIP**

375 Beale Street, Suite 700, San Francisco, CA 94105 ©



Please cite as The State of the Estuary 2019, San Francisco Estuary Partnership.

The Delta Stewardship Council was created in 2009 by the California Legislature to advance the state's coequal goals for the Sacramento-San Joaquin Delta through the development and enforcement of a long-term sustainable management plan. Informed by the Delta Science Program and Delta Independent Science Board, the Council oversees implementation of this plan through coordination and oversight of state and local agencies proposing to fund, carry out, and approve Delta-related activities.

More information can be found at **deltacouncil.ca.gov**

# STATE OF THE ESTUARY

## 2019

UPDATE

### STATUS AND TRENDS OF INDICATORS OF ECOSYSTEM HEALTH

### THE ESTUARY

SAN FRANCISCO BAY AND SACRAMENTO-SAN JOAQUIN RIVER DELTA

# SAN FRANCISCO ESTUARY

A NORTHERN CALIFORNIA ESTUARY THAT INCLUDES THE SACRAMENTO-SAN JOAQUIN DELTA, SUISUN BAY, SAN PABLO BAY, AND SAN FRANCISCO BAY

# CONTENTS

# EXECUTIVE SUMMARY

J. LETITIA GRENIER, LEAD SCIENTIST

Photo: Amber Manfree

The San Francisco Estuary is a large and diverse system. Hundreds of miles of coastline stretch from the wide valleys of the Sacramento and San Joaquin Rivers to the steep headlands of the Golden Gate, with vast agricultural fields in the Delta and urbanized shorelines in Silicon Valley and many of the region's cities. The complexity and scale of this system means it can take years to detect and assess changes. This interim **State of the Estuary Report** checks in on a few indicators of health and explores where the assessment should head over time.

In the four years since the **2015 State of the Estuary Report**, two issues have emerged as critical to how we assess the health of the estuarine ecosystem at the heart of the Bay Area and the Delta. First, the health of the Estuary and of the people who live near it and depend on it are inextricably linked. We need a healthy Bay and Delta to protect our shorelines from sea level rise, help keep our waters clean, provide food and habitat for fish and wildlife, and give people a place to enjoy nature. We also need to think more about human communities as we assess the health of natural communities. This focus means addressing environmental injustices that are deeply embedded in our culture and patterns of development. The second critical issue to emerge is the need for a greater focus on landscape resilience—how well the Bay and the Delta are equipped to respond to change—so that people and wildlife can thrive as climate change progresses. Taking these two ideas together, this report focuses on the nexus of social and ecological resilience as we look toward the future.

The first section of the Report updates indicators of ecological health that span the entire extent of the San Francisco Estuary (Bay and Delta). Recent data show continued progress along the trajectories of the past decade. Tidal marsh restoration is proceeding at a brisk pace in the Bay and gaining traction in the Delta, while urban water conservation continues to meet mandated benchmarks, even during the drought. On the other hand, flows through the Estuary and across its floodplains continue to be well below levels that could increase and restore ecosystem health. Freshwater flows are a lynchpin of ecosystem processes that sustain physical habitats, fuel the food web, and regulate water quality. Creative approaches to using and re-using fresh water for environmental purposes are needed. Long-term trend analysis shows that fish communities in the Bay are declining. This analysis scores an index of 10 attributes of a healthy fish community. The index focuses on fish in offshore areas, and may not capture benefits to fish from near-shore wetland restoration projects. Despite this slow decline, fish communities in the saltier parts of the Estuary remain in good condition, while those in the brackish and freshwater areas are in poor condition.

The next section of the report discusses three emerging indicators of Estuary health, offering options for how to assess resilience in future reports. Here, for the first time, the resilience of the Estuary's shores is evaluated through the lens of subsidence and nature-based features. Elevation relative to sea level is a basic currency that must be tracked as the Pacific Ocean rises into the Estuary. The potential for the Estuary shore to be resilient to climate change and continue to provide benefits to people is related to how much of the shore zone is nature-based. The final emerging indicator, urban green space, is a first attempt to assess how access to nature is distributed across more and less advantaged communities. More work is needed to finalize all these emerging indicators before they can be included in any future quantitative assessment of the State of the Estuary.

These emerging and updated indicators will help focus efforts to restore the Estuary's health. In addition to continuing the successful aspects of restoration and conservation that this report describes, we need more investment in creative ways to use and restore flows for environmental health, to expand and build resilient shorelines and to weave considerations of social equity more strongly into efforts to improve environmental health.

# ESTUARY HEALTH SCORECARD 2019

| INDICATOR | STATUS AND TREND | AT A GLANCE |
|---|---|---|
| FRESHWATER FLOW |   | Freshwater flows in the Estuary have been highly altered, causing reductions in inter-annual and seasonal variability, and peak-flows. Freshwater flows into the Estuary in recent years reflect chronic artificial drought conditions, in sharp contrast to unimpaired flows. |
| TIDAL MARSH |   | Tidal marsh acreage throughout the Estuary has declined significantly from the historical amount, but restoration efforts are bringing back this critical ecosystem and associated benefits. Projects in the Bay are making extensive contributions to tidal marsh area, while efforts in the Delta are beginning to make progress towards regional goals. |
| FISH |   | The condition of fish communities varies across the Estuary. In the lower Estuary, fish communities are abundant, diverse, and dominated by native species. However, in the brackish and freshwater upper Estuary, native fish communities are in poor condition. Based on long-term monitoring data, native fish communities across the Bay are declining. In San Francisco and San Pablo Bays, this long-term data set is from sampling only the offshore areas of the Bay and may not reflect benefits to fish populations from recent wetland restoration. |
| BENEFICIAL FLOODS |   | The frequency, magnitude, and duration of floodplain inundation in both the Bay and the Delta are too low to support healthy estuarine habitats and sustain important ecological processes. While conditions have been variable over time, they have, in general, remained poor in the Delta and have declined in the Bay. |
| URBAN WATER USE |   | In both the Bay and Delta, total and per-capita urban water use have declined over the last several decades, despite growing populations. More efficient urban water use means that both regions met and exceeded benchmarks for per-capita use and drought-reduction targets. The regions have modestly increased water use since the end of the drought but still maintained improvements over their 2020 benchmarks for reductions in per-capita use. |

## LEGEND

# MAKING A POINT OF RESILIENCE

CAITLIN SWEENEY, DIRECTOR, SAN FRANCISCO ESTUARY PARTNERSHIP

Now more than ever, it is important to know whether our efforts to repair and restore the San Francisco Estuary are actually working. In a time of shrinking budgets, changing conditions, and mounting pressure to achieve as many benefits as possible with each project, knowing the degree of real progress can be a game changer.

Good data and sound science enable us to show both the public and the private sector the actual degree to which the ecosystem is improving or becoming more resilient. It's not a matter of just checking our work one time and walking away. These checkups must occur many times over many years, especially as we learn from our mistakes and innovate our approaches.

This interim report is made to Delta and Bay Area citizens on the heels of our more comprehensive **2015 State of the Estuary Report**, and the reports that preceded it. The San Francisco Estuary Partnership came into being in 1988 and has been working collaboratively with dozens of federal, state, NGO, community and business partners to protect and restore our Bay and Delta ever since. The Partnership's long-standing effort to assess progress began with early research and biennial conferences, evolved into a collaboration with the Bay Institutes's pioneering 10-indicator Scorecard, and has since expanded to measure specific indicators of water quality, fish community health, habitat extent, and more. Further, we are now measuring them in the same way, year to year, so that results are directly comparable, and also checking the results against management goals set in our multi-partner **2016 Estuary Blueprint**.

I am proud to continue this tradition by presenting this report and our results at the October 2019 State of the Estuary conference. This interim report reviews more recent data on five of the indicators assessed in 2015 for changes and trends — singling out key indicators that address the health of the whole Estuary, not just the Bay or the Delta, and also indicators that reflect public priorities, such as the extent of tidal marsh and the amount of freshwater flows to the system.

Photo: Joe Galkowski

This interim report also identifies and presents three new, emerging indicators that reflect our current concerns about how to respond to rising sea levels and increased flooding, and how to link these endeavors to the plight of communities at risk, or suffering environmental injustices, all around us. Our region is getting hotter, more fiery, and more susceptible to flooding, as well as less livable for many. These new indicators help us assess our resilience to these new challenges and new extremes.

Finally, this interim report presents some of the voices of our Estuary, the real people who farm, or manage land, or enjoy waterfront recreation, or who wonder if their proximity to our shorelines and riverbanks will be a good or a bad thing in the future. It is our residents, teachers, students, business owners, and local communities who will really decide the Estuary's health by becoming a part of the solution, as we have tried to show in the VOICES sections of this report.

Looking ahead, we hope you will all become involved in influencing the state of your Estuary, at the heart of your Bay and your Delta. I also call on my colleagues — planners and managers of our environment — to embrace the task of nurturing a broader resilience than we might find within our programmatic or jurisdictional boundaries. The projects we manage and the people and species they affect are all one, and we must recognize and work through the complexities. It will take much more than measures of acreage, elevation, and access to sustain California's ecosystems and residents in the future.

**Caitlin Sweeney, SFEP Director and J. Letitia Grenier, Science Lead.**

Photo: Shira Bezalel

# UPDATED INDICATORS

A look at five central measures of Estuary health — freshwater flow, tidal marsh extent, native fish communities, beneficial flooding, and how much water humans use in urban areas.

Photo: Ben Botkin

# FRESHWATER FLOW

## UPDATED INDICATOR

In the last few years, the San Francisco Estuary has continued to experience a perpetual drought in terms of freshwater flows from the watershed that enter the system, despite variation in precipitation during these years. As discussed in the **2015 State of the Estuary Report**, the amount, timing, and patterns of freshwater flow into the San Francisco Estuary from tributary rivers and streams are critical drivers of the Estuary's health. Freshwater flows control the quality and quantity of estuarine habitat, support key ecological processes, and significantly affect the abundance and survival of estuarine biota, from tiny planktonic plants and animals to shrimp and fish. The mixing of inflowing fresh water and salt water from the ocean creates low salinity, or brackish water habitat for estuary-dependent species. Seasonal and inter-annual changes in inflow amounts trigger biological responses like reproduction and migration, and high flows transport nutrients, sediments and organisms to and through the Bay, promote mixing and circulation, and flush contaminants out to sea.

The San Francisco Estuary receives 90% of its freshwater flow from the watersheds of the Sacramento and San Joaquin Rivers, which drain nearly one third of the state. Both natural factors and human activities affect these inflows. California's Mediterranean climate and unpredictable cycles of wet and dry years produce large inter-annual and seasonal variations in precipitation and runoff. Freshwater flows to the Estuary during a wet, flood year can be nearly ten times greater than inflows during a drought year.

Flows are also affected by people. Dams capture and store runoff from the mountains for release into the rivers flowing to the Estuary at different times of the year, and even for release in later years. Water diversions on rivers and in the Delta, the upstream region of the San Francisco Estuary, also remove water for local agricultural or urban use or for export to other areas of California, reducing the amount of water that flows to the lower Estuary. Climate change is increasingly driving shifts in precipitation patterns and timing of snowmelt, altering the amount, timing, and duration of seasonal flows in the Estuary's tributary rivers. As temperatures warm in inland valleys and California's population continues to grow, both farms and cities will need more water and will also need to use water more efficiently. Conservation and management updates to address future conditions are an urgent priority.

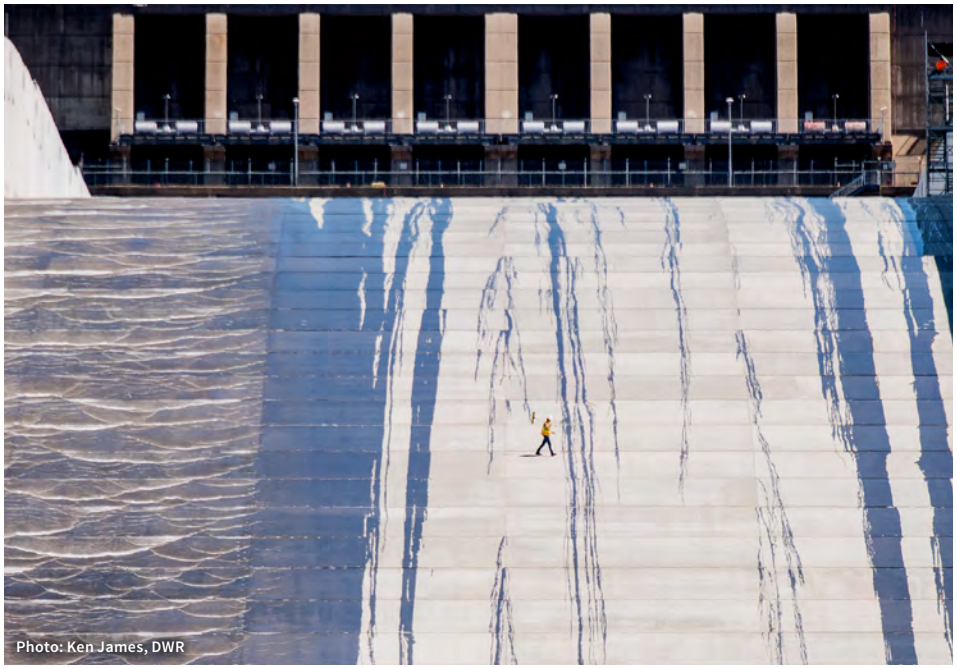
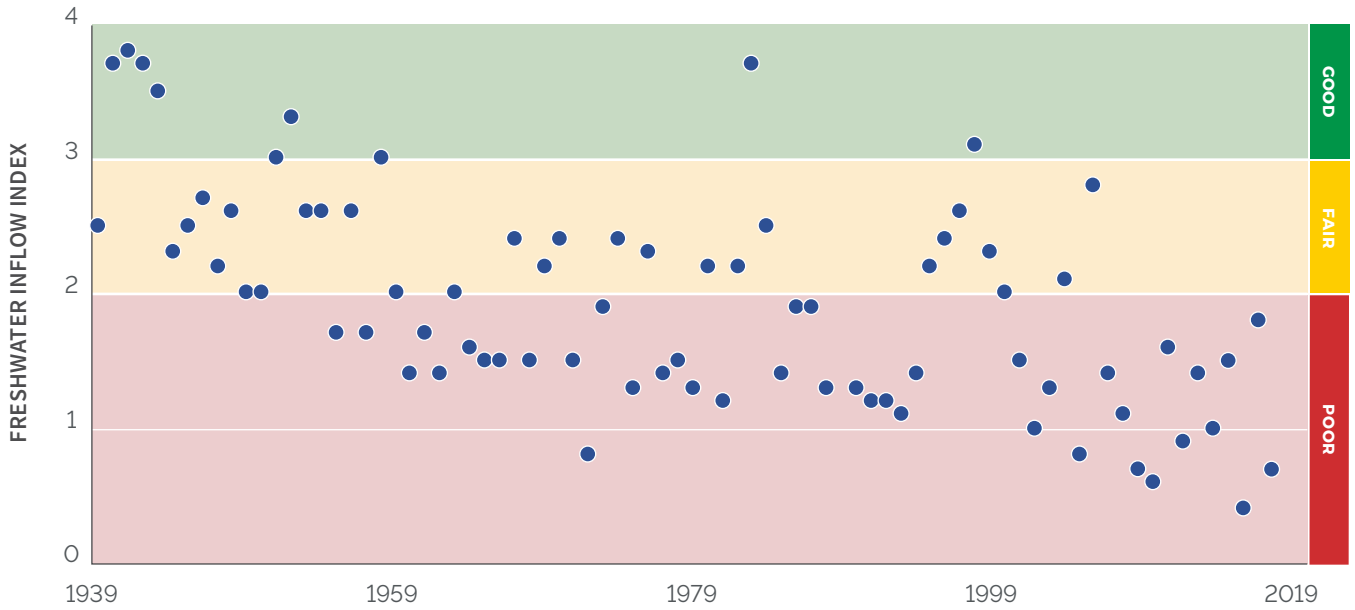


Photo: Ken James, DWR




## INDICATOR

The freshwater flow Index uses ten sub-metrics to assess the amount, timing, and variability of freshwater flow from the Sacramento-San Joaquin watershed into the Delta and the Bay. Most of the sub-metrics are calculated as comparisons between actual freshwater flow conditions and flow conditions that would have occurred on the contemporary landscape if there were no dams or water diversions in the watershed, referred to as unimpaired flow conditions. By incorporating unimpaired inflow into the measurement, the metrics are normalized to account for the natural year-to-year variations in precipitation and runoff in the Estuary's watershed. Thus, the index assesses the degree to which flow conditions have been altered; the index is not a direct measurement of the aquatic habitat conditions (see Open Water Habitat, SOTER 2015, not updated here) or ecological processes driven by freshwater flows (see Beneficial Floods, p. 21).

## STATUS AND TRENDS

The steady decline in the freshwater flow index over the 79 years of record as of 2018 has not changed in recent years covered by this State of the Estuary update. Freshwater flows to the San Francisco Estuary have continued to decline in amount and variability, creating persistent artificial drought conditions. The long-term decline in the index value has been driven by declines in nine of the ten sub-metrics of freshwater flow conditions (i.e., all of the metrics except Annual Delta Inflow). The four lowest values have all occurred in the last decade (2009, 2010, 2016, and 2018), with the record low in 2016 and the third lowest value in 2018.

## FRESHWATER FLOW

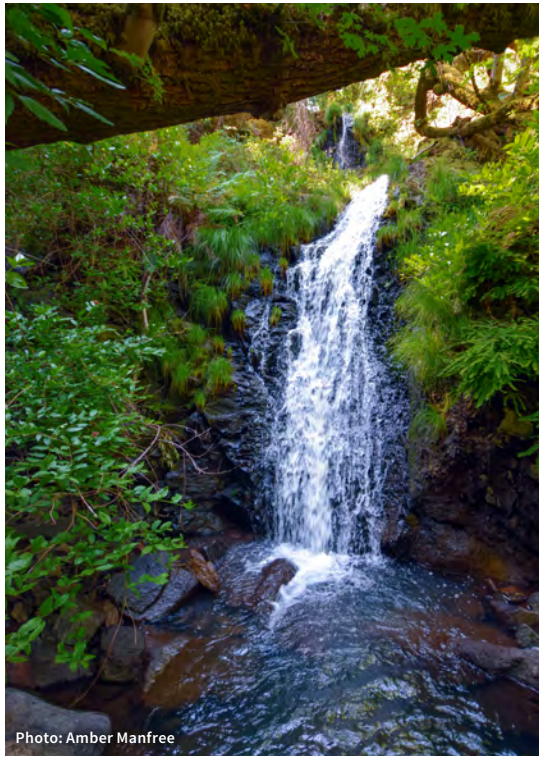


Photo: Amber Manfree

## STATUS AND TREND


LEGEND

| | | | | |
|---|---|---|---|---|
| STATUS | Good | Fair | Poor | |
| TREND | Improving | No Change | Declining | Mixed |

# TIDAL MARSH

## UPDATED INDICATOR

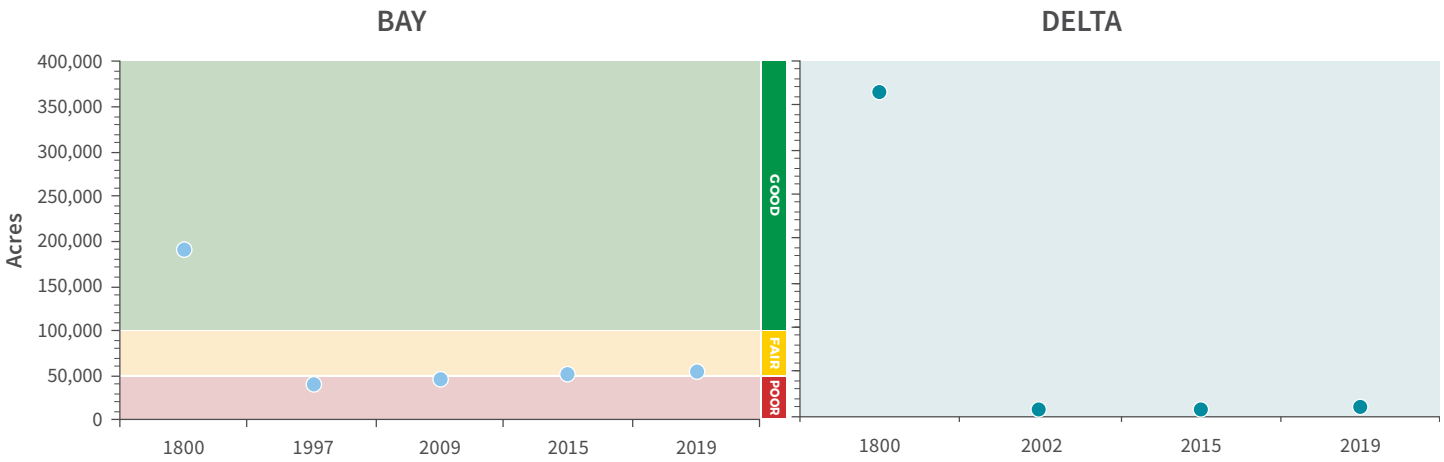
Over the last 200 years, humans transformed and developed almost 90% of the Estuary's marshes, a major landscape change described in the **2015 State of the Estuary Report**. In the last few decades, however, people have come to realize how valuable estuarine wetlands are to the region and its future resilience, and scientists and resource managers have been working hard to restore Bay and Delta wetlands. These restorations create complex habitats that span important ecological gradients (such as tidal to non-tidal and salt to freshwater), providing a range of options for marsh species and helping improve the overall health of the Estuary.

Tidal marshes provide a wide array of ecosystem services. These include providing habitat for wildlife including several rare native species, acting as nurseries for young fish, stabilizing shorelines and buffering them from storm damage, absorbing floodwaters, filtering out contaminants, and sequestering carbon. These habitats on the doorstep of millions of people also provide places to be in and appreciate nature, and to engage in scientific study, education, and recreation.

As restoration work continues in the Bay and Delta, and as taxpayers invest in these habitats through the Bay Restoration Authority and other initiatives, it is important to track increases in tidal marsh acreage and impacts on the state of the Estuary. As the total area of tidal marsh in the Estuary increases, so will the abundance and diversity of the plants and animals associated with this ecosystem. Steady improvements resulting from these investments will be challenged by rising sea levels, however, increasing the urgent need for efforts to keep marshes resilient and functional.

| Recent Restoration Sites | Year Opened to Tidal Action | Planned Area of Tidal Wetland Restoration (Acres) |
|---|---|---|
| **BAY** Tidal Wetland Restoration Since 2015 Report | | |
| Corte Madera Marsh Ecological Reserve Restoration – Greenbrae Gas Pipeline Emergency Replacement Project | 2015 | 0.27 |
| Sears Point Wetland and Watershed Restoration Project | 2015 | 970 |
| Bair Island Restoration (Inner) | 2015 | 276 |
| Dotson Family Marsh Restoration | 2017 | 150 |
| Corte Madera Ecological Reserve Expansion and Restoration | 2018 | 5 |
| **TOTAL (BAY)** | | **1401** |
| **DELTA** Tidal Wetland Restoration Since 2015 Report | | |
| Decker Island | 2017 | 140 |
| Yolo Flyway Farms | 2018 | 300 |
| **TOTAL (DELTA)** | | **440** |

# TIDAL MARSH




## INDICATOR

This indicator quantifies tidal marsh extent in the Bay and Delta, which have different benchmarks for restoration progress. For the Bay, scientists and managers set a long-term goal of 100,000 acres (approximately one-half of the tidal marsh area ca. 1800) in the **1999 Baylands Ecosystem Habitat Goals Report**. This goal reflects consensus on the habitat needs of native tidal marsh species and necessary improvements to ecological functions and biodiversity in the Bay. No similar quantitative, consensus-driven goal currently exists for the Delta. Three reference values help put the current extent of tidal marsh in the Delta into context: the pre-19th century extent of tidal marsh in the Delta was 360,000 acres; 78,000 acres are currently marsh or diked lands at intertidal elevations; and, if the California EcoRestore Goals were achieved, the total marsh extent in the Delta would be 17,000 acres (see Technical Appendix for details). Marsh patch size, which was evaluated in the 2015 Report, is not included here because it is changing slowly as restoration progresses.

## STATUS AND TRENDS

Estuary-wide tidal marsh extent has grown by more than 1,800 acres since the 2015 Report, most of that within the Bay. Combined with restored tidal wetlands that could transition to tidal marshes in the future, the total extent of tidal marshes exceeds one-half of the regional goal of 100,000 acres in the Bay. In the Delta, the extent of tidal marsh and restored tidal wetlands that could transition into tidal marshes is approximately 8,300 acres. While this extent is expected to increase in coming years as more EcoRestore projects are implemented, this number is still well below the reference acreages discussed above. Although substantial work remains to achieve restoration targets, the extent of tidal marsh in both the Bay and Delta is improving.

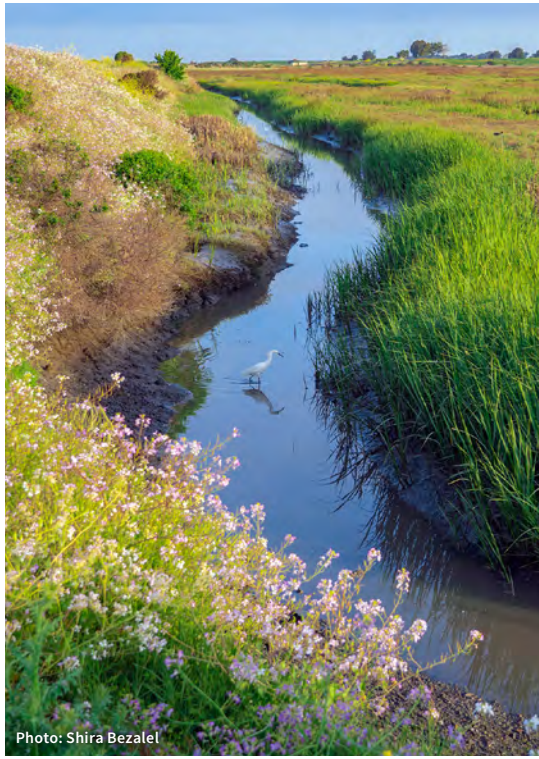
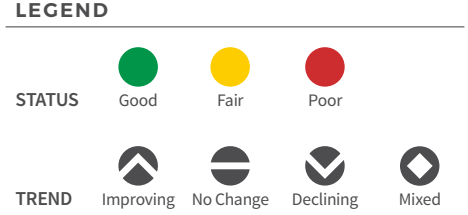


Photo: Shira Bezalel

## STATUS AND TREND


Over the last few decades, major efforts have been made to improve the quality of the Estuary's environment and natural habitats. Simultaneously, many more miles of shoreline — sites once off limits and used for industry and the military — are now open to the public all around the Bay and up in the Delta. These investments have not only improved water quality and reduced fish contamination but have also welcomed more people to the Estuary's shores, sloughs, rivers and open waters. As a result, thousands of residents are now taking advantage of growing opportunities for play and recreation in and around the Estuary. Research shows that having nature accessible near daily activities improves human health and restores the mind.

Around the Bay itself, there are different ways to recreate. Some people just like to be near it either on the shore or in the water. Compared to 1965 when only four miles of trails were available for public use on the shoreline, today's access is monumental. The San Francisco Bay Trail has completed 355 of its planned 500 miles.

The trails are popular, and people use them to walk, jog, hike, bike, or take their dogs for a stroll. Some return to the same spot daily, while others have more ambitious goals. Barbara Christianson, Sally Dinwoodie, and a group of friends are circumnavigating the entire Bay Trail, segment by segment. After two years of walking the trail once a month, they are more than halfway around. They have traversed beautiful neighborhoods, homeless camps, and wildlife refuges.

"There's so much you haven't seen that you think you have," says Christianson. "We only got in trouble once for trespassing," she adds.

Those who hike the Bay Area Ridge Trail, which has dedicated 360 miles of its 550-planned miles, often have stellar views of the Bay. Those who enjoy being on the water can now take advantage of the San Francisco Bay Water Trail, which links launch sites and camp sites for kayaks and other non-motorized small boats. Nearly half of its 45 of 111 planned launch sites have been designated since 2011.

Since much of the Estuary is so shallow, small human-powered vessels allow everyone from those sampling water quality in the margins to those surveying bird nests on offshore islands to gather information and experience sloughs and backwaters firsthand. Such field observations are key to understanding the effects of our restoration actions on species.

Some people like to get close to the wind and water by sailing. Others are passionate about introducing young people to the sport.

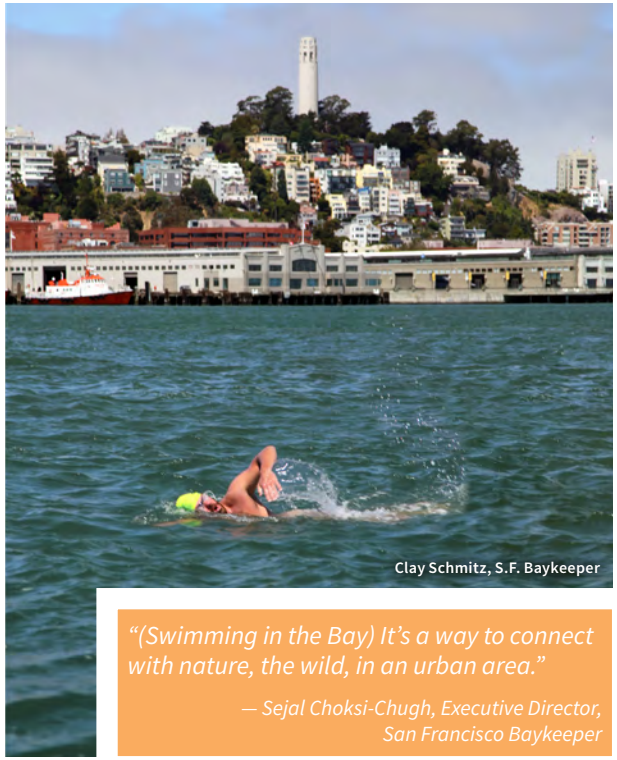
It is estimated that five percent of students who live in the Bay Area have never been out on the water, said former Call of the Sea staff member Mary Rutz. Call of the Sea takes 5,000 students sailing each year. The kids can be scared, at first.

"They are holding onto the gangway, and there's lots of chatter and squeals," says Rutz, who adds that after a three-hour sail that changes. "It's a total transformation. They are literally dancing as they go back up the gangway to leave."

Treasure Island Sailing Center, which runs the Set Sail Learn program, puts more than 1,000 kids in boats each year. Introducing children to the estuarine world on their doorstep does more than give them a taste of nature.

"We feel that sailing, and learning to sail, is the best way to develop life skills such as decision making, communication, grit, and teamwork," says executive director Travis Lund.

Perhaps the most intimate way to experience the Estuary is to swim in it. "Swimming in the Bay is one of my favorite things in the world," says Fran Hegeler, vice president of San Francisco's South End Rowing Club. "There's something about swimming in the water with other creatures. It is spiritual and connects you to the earth."



Clay Schmitz, S.F. Baykeeper

*"(Swimming in the Bay) It's a way to connect with nature, the wild, in an urban area."*

*— Sejal Choksi-Chugh, Executive Director, San Francisco Baykeeper*

Swimmers witness environmental changes firsthand. "We know when there are things going on in the water because we swim in it," says Hegeler, who gives as an example the disappearance of sea stars. "Sea stars were everywhere a number of years ago, and all of a sudden they died."

The San Francisco Baykeeper encourages swimming in the Bay. "It's a way to connect with nature, the wild, in an urban area," says executive director Sejal Choksi-Chugh.

In the Delta region, boating, hunting and fishing around waterways have been the pastime of generations, and a way of life for farmers and local residents. Delta residents celebrate the arrival of sandhill cranes every year with a festival, embracing the elegant bird as a beloved icon of their shared landscape.

"It's a Garden of Eden here," says Steve Heringer, whose family has farmed in the North Delta since the 1860s and who delights in the sight of turtles sliding into Elk Slough, and egrets fishing nearby.

In the last few decades, progress has also been made toward a continuous recreational corridor trail network through all five Delta counties under the Great Delta Trail Master Plan. This corridor would link the San Francisco Bay Trail system and planned Sacramento River trails with present and future Delta trailways.

Whether people are near, on, or in the Estuary, those who commune with it are more likely to be aware of its health and the need to invest in its future. Bay Area residents even voted recently to tax themselves to further restore the natural health of the Estuary shore.

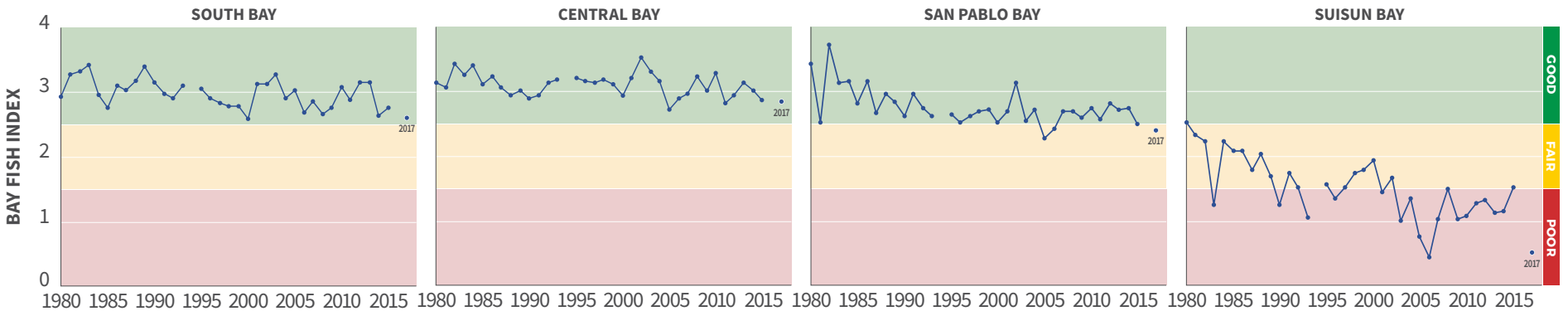
"People recognize the Bay as an important resource," says Laura Thompson, project manager for the San Francisco Bay Trail. "They want to get close to it."

# FISH
## UPDATED INDICATOR

The San Francisco Estuary is home to a diverse fish community that includes several species and unique populations that are found nowhere else on Earth. The Estuary provides habitat for commercially important Chinook salmon and Pacific herring, as well as rare and endangered species, such as the Central Valley steelhead, green sturgeon, longfin smelt, and Delta smelt. Of the over 100 fish species found in the Estuary, some use its waters as spawning and rearing habitat for their young, while others pass through the Bay and Delta as they migrate between the Pacific Ocean and the rivers of the watershed. Fish populations that are native to the San Francisco Estuary play an important role in local food webs, feeding humans and other animals as well as providing nutrients and energy to related ecosystems.

Many stressors negatively impact native fish in the Estuary. Loss of tidal marsh and floodplain habitats, pollution, and alteration of the amount and timing of freshwater flows have all been linked to the decline of native fish. Measures of fish abundance, diversity, species composition, and distribution are useful biological gauges for these environmental conditions in the Estuary. An abundant, diverse community of fish that is dominated by native species, which in turn are widespread throughout their native range, is an indicator of a healthy Estuary. Restoring a healthy fish community throughout the Estuary will require focused attention on the upper Estuary, where conditions are currently the poorest. Conditions favorable to some species today may shift in the future as the water in the upper Estuary becomes warmer and saltier with climate change.

## BAY FISH COMMUNITIES



# FISH

Photo: Scott McReynolds

## INDICATORS

Fish communities differ between the salty Bay and the brackish and fresh waters farther upstream in Suisun Bay and the Delta. As such, the State of the Estuary fish analysis has different indicators for the Bay (lower Estuary) and Delta (upper Estuary).

The Bay Fish Index uses ten metrics to evaluate the status and trends of the Estuary's fish community in four sub-regions: South, Central, San Pablo and Suisun Bays. The metrics evaluate different attributes of the fish community: abundance, diversity, species composition, and distribution. The results for each of these attributes were aggregated into a Fish Index score for each of the four sub-regions. These analyses rely on data from the Interagency Ecological Program's Bay Study which samples fish in the offshore waters of the lower Estuary. New data from shallow areas restored to tidal influence in the South Bay are now available to understand how these habitats are used by fish, and they will be incorporated into future iterations of this report as appropriate.

The upper Estuary fish indicator uses data from three long-term sampling programs. The approach mirrors that used in the Bay Fish Index but offers a different perspective focused solely on the upper Estuary.

The benchmarks (or reference conditions) for the Bay Fish indicator are based on measured values from 1980-1989 (the earliest years for most of the surveys), maximum measured values for the Estuary or sub-regions, recognized interpretations of ecosystem health, and best professional judgment. The upper Estuary fish indicator mirrors this approach for setting benchmarks.

**Fish researchers from different agencies collaborate on Suisun Marsh sampling.**

Photo: Amber Manfree

## STATUS AND TREND


LEGEND

| | | | | |
|---|---|---|---|---|
| STATUS | Good | Fair | Poor | |
| TREND | Improving | No Change | Declining | Mixed |

# FISH
## UPDATED INDICATOR

### STATUS AND TRENDS

In the lower Estuary, the condition of the Bay fish community differs among the four sub-regions. Fish abundance, diversity, species composition, and distribution were all highest in Central and South Bays, where overall conditions (the Fish Index) were consistently good. Conditions in San Pablo Bay were generally good but with lower abundance levels and higher prevalence of non-native fish species. Fish communities in Suisun Bay were in poor condition, with relatively low abundance, diversity, native species composition, and distribution.

Although the overall score for Bay fish was good, the condition of the fish community has been declining in all sub-regions of the Bay over the entire 38-year study period. Declines in Bay fish indices were most dramatic in Suisun and San Pablo Bays, driven by drops in metrics of abundance, species composition, and, in Suisun, distribution. This trend is based upon fish sampled in the offshore waters of the lower Estuary. The trend for fish in the shallow margins of the Bay is unknown, as no regional long-term data set exists for that habitat type. Recent data from South Bay show that restored wetlands there are highly used by fish, including endangered longfin smelt.

In the upper Estuary, fish communities are in poor condition in most sub-regions examined, with mixed trends. The state of these communities reflects a long-term decline derived from many factors described earlier, and from shorter-term adverse conditions imposed by the 2012-2016 drought and related water management actions. As an exception to the overall trend, proportion of native fish showed an improvement in Suisun Marsh during the last five years.

**To assess restoration success, researchers measure the carcasses of salmon returning to spawn in Putah Creek.**

Photo: Robin Meadows

## UPPER ESTUARY FISH COMMUNITIES

| UPPER ESTUARY INDICATORS | SUBREGION | STATUS | TREND |
|---|---|---|---|
| **Native Fish Abundance** | Suisun Marsh | Fair | Declining |
| | Suisun Bay Pelagic | Very Poor | Declining |
| | Central-West Delta Pelagic | Very Poor | Declining |
| | Delta Beach Zone | Very Poor | Declining |
| **Percent Native Fish** | Suisun Marsh | Poor | Improving |
| | Suisun Bay Pelagic | Poor | Stable |
| | Central-West Delta Pelagic | Very Poor | Stable |
| | Delta Beach Zone | Very Poor | Declining |
| **Percent Native Species** | Suisun Marsh | Poor | Stable |
| | Suisun Bay Pelagic | Fair | Stable |
| | Central-West Delta Pelagic | Very Poor | Declining |
| | Delta Beach Zone | Very Poor | Stable |


Photo: James Ervin


Photo: James Ervin


Photo: James Ervin

# BENEFICIAL FLOODS

## UPDATED INDICATOR

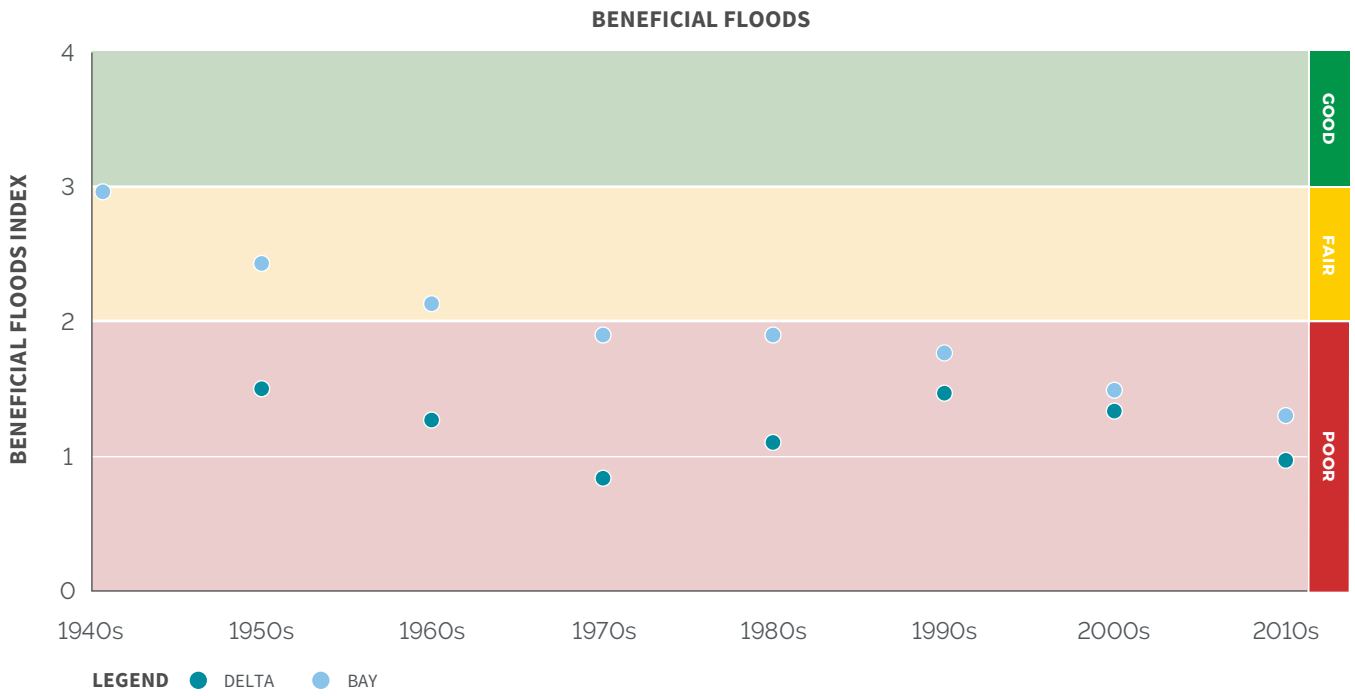
Before people built dams, diversion structures, and levees on most of the rivers in the Sacramento-San Joaquin watershed, the rivers would flood, spilling over their banks when snow melted each spring. This process sent high volumes of fresh water into the Estuary and created shallows and floodplain habitat important to the health of the estuarine food web.

Dams and diversions substantially modified the frequency, magnitude, and duration of high volume flows through the Delta and into San Francisco Bay. Although seasonal high flows occur less frequently now, when they do occur they still drive multiple ecological processes. These include activating food webs on tidal and fluvial floodplains and creating large areas of productive, low-salinity habitat in Suisun and San Pablo Bays.

Today, resource managers are working to reestablish historical floodplain habitat and riparian woodlands in some locations, giving rivers more room to move and flood. There are also efforts to release water from dams at strategic times to simulate natural flows. Accommodating beneficial flooding, and absorbing more future flooding caused by climate change, is possible with good design, multi-benefit project planning, and science to measure outcomes. However, the extensive alteration of Estuary waterways development right up to the edge of so many rivers and shores makes strategies such as setting back levees to reestablish floodplains challenging in some locations. Since the **2015 State of the Estuary Report**, the capacity of older upstream water storage facilities (Oroville) and watershed drainage infrastructure to handle high rainfall events such as occurred in the very wet winter of 2017 has been put severely to the test. Updating aging dams and diversions based on new conditions and science, and expanding current efforts to open up floodplains and build multi-benefit infrastructure, will be key to the region's future resilience.

**High water event at Cosumnes River Preserve delivers sediment and nutrients to Delta habitats.**

Photos: Judah Grossman, The Nature Conservancy




## INDICATOR

This beneficial flooding analysis uses two separate indicators for the Bay and Delta to measure and evaluate the frequency, magnitude, and duration of ecologically important high-volume flow or flood events. The first indicator measures floodplain inundation by evaluating seasonal inflows to the Delta from the Yolo Bypass, the large, partially managed floodplain immediately upstream of the Estuary in the lower Sacramento River basin. The second indicator measures flood events by evaluating high volume freshwater flows to the Bay. The benchmarks for evaluation of both indicators are based on three types of data: unimpaired flow (see Freshwater Flows p. 11) and flood data records; biological information on floodplain habitat, productivity dynamics, and use for spawning, rearing and migration; and current regulatory standards for minimum Bay inflows. Status was determined by evaluating flows according to reference conditions for frequency, magnitude, and duration. These three scores were then averaged for an overall score of the indicator status.

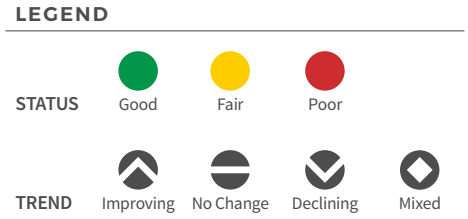
## STATUS AND TRENDS

The frequency, magnitude, and duration of floodplain inundation and high-volume inflows to the Estuary continue to be too low to drive or support important ecological processes in the lower watershed and Estuary. Bay and Delta flood flows have not met primary reference conditions in nine of the last ten years. The exception was 2017, the seventh wettest year in the 88-year data record. Overall, flood conditions have fallen below the standard needed to support healthy estuarine habitats, sustain critical ecological processes, and meet regional management goals (**Estuary Blueprint 2016**).

## BENEFICIAL FLOODS

Photo: Amber Manfree

## STATUS AND TRENDS

# URBAN WATER USE

## UPDATED INDICATOR

Human water use reduces the amount of fresh water available for other beneficial uses, such as sustaining the Estuary's native species, habitats, and other ecosystem services. Withdrawals of surface and groundwater for use by the communities and farms in and around the San Francisco Estuary total about 2.1 million acre-feet per year (maf/yr), with about half going to homes, businesses, institutions, and industries and half used for agriculture. About 90% of the agricultural use is in the Delta and drawn from local channels.

About 75% (0.84 maf/yr) of the Estuary's urban water use is in the cities and towns in the watersheds surrounding the San Francisco Bay. Most of the Bay region's urban water supply — nearly 75% in an average year — is imported, primarily from the Delta and Sierra rivers, with smaller amounts from the Russian River and Lagunitas Creek. As a result, the Bay region relies more on imported water than any other region in the state. Less than 10% of the Bay Area's urban supply is withdrawn from surface water in local watersheds, such as the Napa River and Alameda, Coyote, Los Gatos, and San Mateo Creeks. The remaining 15% is from groundwater, which is a locally significant supply source to urban users in the Santa Clara and Livermore Valleys, and in Fremont and the North Bay. Non-potable recycled water is a small (about 5%) but growing supply source in the Bay region.

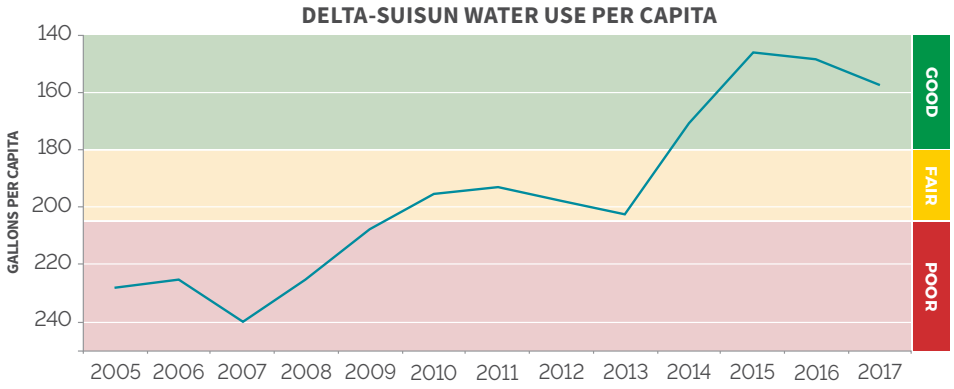
About 25% (0.27 maf/yr) of the Estuary's urban water use is from the communities within and adjacent to the Delta's Secondary Zone and Suisun Marsh, including the City of Sacramento. Over 80% of the supply for those communities comes from the diversion of surface water from the Sacramento and San Joaquin Rivers in the Delta and their tributaries. Groundwater is an important supply for communities such as Stockton, Sacramento, Brentwood, and Discovery Bay.

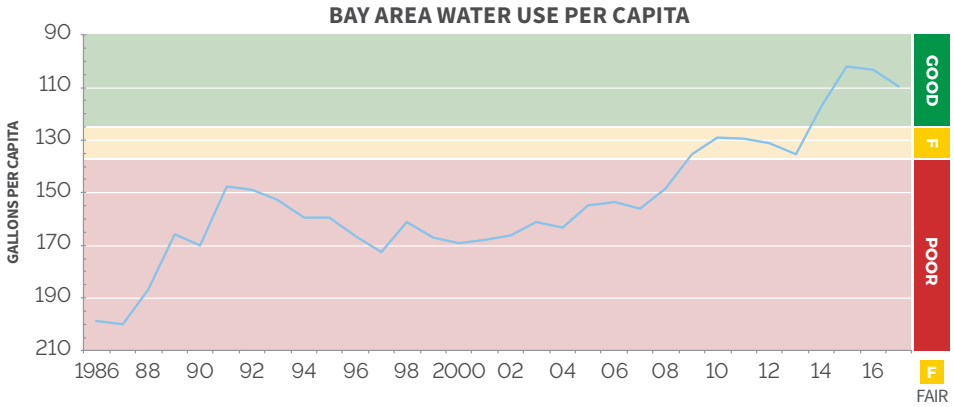
Although greater precipitation and runoff in recent years have eliminated mandatory conservation, conserving water is still a priority for urban water suppliers and the state. Water conservation increases water supply reliability, reduces vulnerability to earthquakes and droughts, and cuts the costs of treating and transporting water. As previewed in the **2015 State of the Estuary Report**, the 2012-2016 drought mobilized collective action and stimulated changes in how we use water. Although the long-term decrease in the Estuary's urban water use is a hopeful trend, the challenges and threats of recurring drought, warming temperatures, population growth, and greater stresses on freshwater-dependent ecosystems require still more efficiency and less dependence on using potable water to meet urban water needs. Another drought is inevitable, and this indicator will continue to track whether urban water users have made conservation a way of life.

## INDICATOR

This update to the urban water use indicator includes estimates of Delta use for the first time. Due to differences in data availability, the indicator is separated into two regions — Bay and Delta-Suisun. The Bay indicator measures both the total urban water use and just the residential portion (single and multi-family) in two ways: the annual potable volume in acre-feet, and the per-person use in gallons per capita per day (gpcd or per-capita use). Residential use is not part of the 2019 indicator discussed here, but is assessed in the 2015 Report Technical Appendix for the Bay region. The new Delta-Suisun region indicator only measures the total urban water use and the total per capita use (data were not available for residential use and the total use for longer periods). These measures of potable or drinkable water do not include recycled water (see the 2015 Technical Appendix for additional details).

The benchmarks used to evaluate progress on this indicator are targets based on the goals of the state's 2009 Water Conservation Act (SBX7-7), which established targets for reductions in per-capita use by 2015 and 2020. For the Bay region a regional target of 125 gpcd for 2020 and 137 gpcd for 2015 was previously determined by the state. For this report's Delta-Suisun region, there is no state established regional goal, but one was determined for 2015 (205 gpcd) and 2020 (180 gpcd) by calculating a 10% reduction (for 2015) and 20% reduction (for 2020)




from the 2005 regional gpcd, determined by population-weighting the individual suppliers' gpcd values. Additional targets from which to evaluate progress in total and residential use, including the State Water Board's 2015 and 2016 requirements to reduce total use during the drought, are discussed in the Technical Appendix.

## STATUS AND TRENDS

In the four years since the **2015 State of the Estuary Report**, both Bay and Delta-Suisun regions maintained the longer-term trend of reduced potable water use despite modest increases by some retail suppliers since the drought. Consistent with the trends in coastal California, the Bay region used 27% less potable water in 2017 than in 1986, despite a 31% increase in population over the same period. This combination indicates that water is now being used much more efficiently on a per-capita basis; the 110 gallons per capita per day in 2017 is a little more than half of the 200 gallons used 30 years ago.

Although water use in the Delta-Suisun region was evaluated over a much shorter time period, 13 years versus the 32 years in the Bay region, it also showed the same trend of increasing population, decreasing total water use, and increased efficiency. Overall, per-capita use declined by 31% in the Delta-Suisun region.

The 20% per-capita use reduction target for 2020 was achieved in the Bay and Delta-Suisun regions by 2014 and continued to drop through 2015 and 2016. The two regions also achieved drought-imposed reduction targets in total volumetric water use by 2016. Many individual suppliers easily achieved their 2020 benchmarks for reductions in per-capita use. The 8% gpcd increase in the two regions since the drought was expected, and can be attributed to population and economic growth, as well as increases in outdoor water use after the drought, particularly in the hotter inland regions.

Despite the recent increases in per-capita use, dramatic and sustained long-term gains in water-use efficiency have been achieved because of existing regulations, plumbing standards, technological progress on appliance and industrial efficiency, and landscape transformations lowering potable water use. To provide ongoing potable water-use savings, efficiency efforts will need to encompass greater use of locally derived, non-potable sources, such as recycled wastewater for direct and indirect potable uses as well the onsite reuse of graywater, rainwater, and stormwater.

## URBAN WATER USE


Photo: Sally Dinwoodie

## STATUS AND TRENDS


LEGEND

STATUS: Good, Fair, Poor

TREND: Improving, No Change, Declining, Mixed


Scientists and resource managers constantly evaluate indicators of Estuary health—from inflows of freshwater to numbers of native fish to the growth of wetlands around the Bay—but citizens who own land around the edges of the Estuary and its rivers and streams are also doing their part, hands-on, to help, sometimes partnering with NGOs and government agencies and sometimes on their own. Their actions, from giving floodplains back to large rivers to sharing crops with wildlife to stabilizing creek banks, are improving water quality and providing much-needed habitat for wildlife.

On the Napa River, two vintners gave up two and a half acres of fertile grape-growing land to restore a stretch of river that had become choked with silt. Water quality in the river was so poor in the Rutherford Reach that the San Francisco Bay Regional Water Quality Control Board was preparing to list it as impaired and to impose strict water use limits on riverside landowners. Instead, the landowners partnered with Napa County on a $20 million restoration project that reconnected the river to its floodplain at strategic locations, allowing sediment to fall out in the right places and providing spawning habitat for salmon. The vintners think their flexible, cooperative approach to restoration on private land could be an example for others, and in fact a new nine-mile stretch downstream is now being restored.

"We're just caretakers of the land," says Bruce Cakebread, one of the property owners. Both he and Michael Honig of Honig Winery & Vineyard, another riverside landowner, say their decision to get their neighbors on board for the restoration project was a matter of principle, a sense that the river gave them what they have—including the rich soil they use to grow grapes—and this project was a way to give back. "Not every piece of ground has to have a grapevine in it. This is just adjusting the balance," Cakebread says.

The property owners formed a new Maintenance Assessment District for the reach—for the next 20 years they will voluntarily pay a small amount toward removing invasive species and repairing any stream bank erosion that occurs.

In Hamilton City, west of Chico, the U.S. Army Corps of Engineers partnered with The Nature Conservancy and River Partners to purchase flooded almond fields in order to set back a levee on the Sacramento River, giving the river room to move and reconnect with its floodplain. Close to 1,500 acres of new riparian vegetation between the river and the levee are busy sequestering carbon, while local farmers continue growing almonds and other valuable orchard crops behind the new setback levee.

The landowners in the local reclamation district will pay for maintenance of the setback levee. The Nature Conservancy's Ryan Luster says local farmers became an amazing resource for the project, providing their expertise to help plant hundreds of acres of native trees—at an industrial scale—in the new floodplain.

On a much smaller scale, three private property owners along Codornices Creek in Berkeley restored a stretch of creek flowing through their yards in 2019, hiring a restoration firm to pull back the creek banks to give the creek room to move and create a floodplain, and planting hundreds of native plants to shade the creek's waters for the threatened steelhead trout that live downstream. "We have always loved living on a creek, and we've always hated the concrete walls that stopped this section of creek from living up to its potential. We knew that if we restored the creek we could have willow trees and water striders, and maybe frogs and even fish someday," says resident Juliet Lamont.

And in the upper Estuary, farmers are growing crops that feed migrating birds, nurturing willows and sycamores along streams and rivers traversing their land, and welcoming fish, birds and wildlife onto their property. In the North Delta, Russell van Loben Sels, whose family has farmed the Delta since 1876, grows minimum-till corn on about 70 acres next to the Stone Lakes National Wildlife Refuge, a practice that leaves about five percent of the kernels after harvest. "The kernels are all on top, sandhill cranes love it," he says. "All they have to do is hop across the levee and into the field." Before the refuge was established, he only saw a few cranes in his field; now he sees around 100. Other Delta landowners, like fifth generation pear-grower Tim Neuharth, share their vision of a sustainable Delta economy and environment through farm tours.

With floods, wildfires, algal blooms, and other impacts to water quality and the health of native species on the rise, working with farmers and private landowners to expand stewardship of the Estuary will become yet more urgent and important.


Photo: Chessa Moreno

*"We're just caretakers of the land."*

*— Vintners Bruce Cakebread & Michael Honig*
*(latter pictured above in Napa River)*

# EMERGING INDICATORS

A look at three cutting-edge indicators of Estuary resilience developed since the **2015 State of the Estuary Report**. These emerging indicators offer vital insights into the frontiers of Estuary management based on science. In the future, these indicators will be refined with additional input from scientists and stakeholders to identify appropriate datasets, approaches, and benchmarks for meaningful and replicable tracking of these aspects of resilience.

Photo: Barbara Christianson

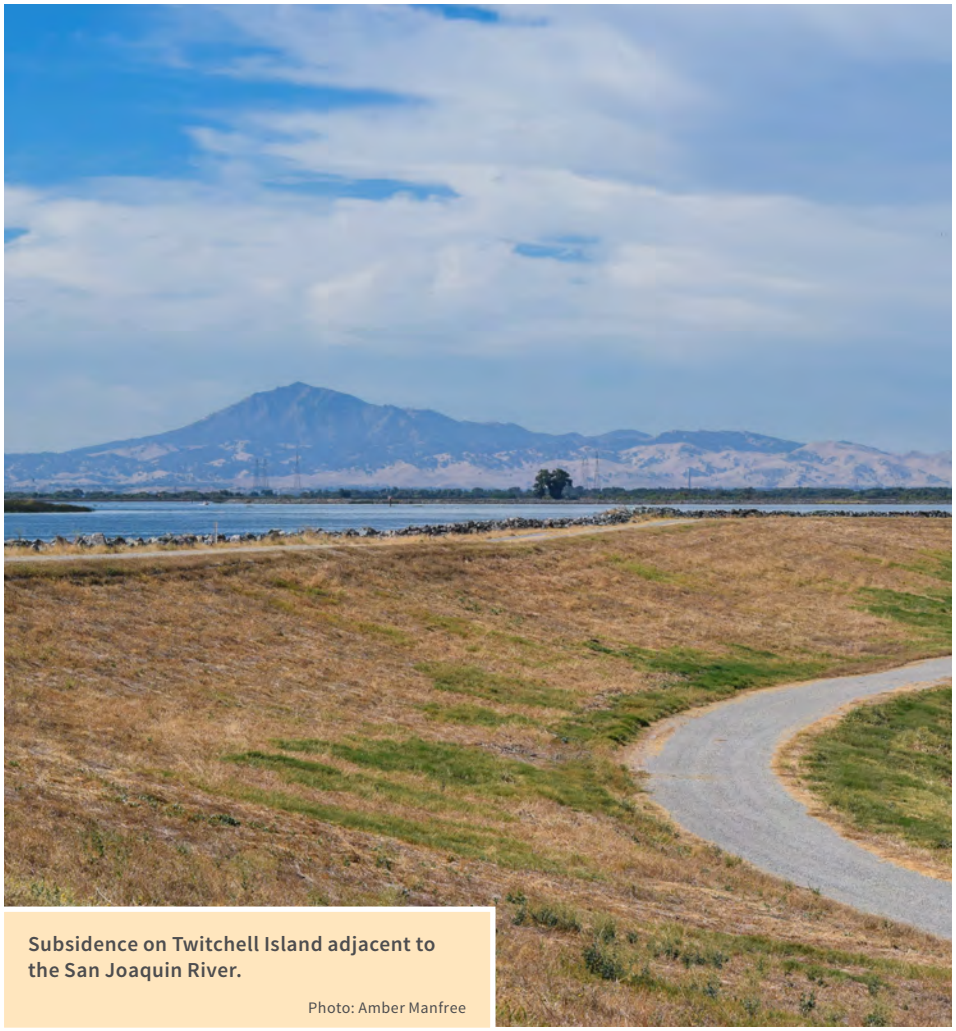
# SUBSIDED LANDS

## EMERGING INDICATOR

Significant portions of previously tidal areas in the Bay and Delta have been diked off and disconnected from tidal action to accommodate agriculture, urban development, duck ponds, salt ponds, and a diverse set of other land uses. The low elevation of these areas places them at increased risk of flooding as sea level rises and intense rainstorms become more common. In addition, many of these former tidal marshes and mudflats have subsided significantly below sea level —in some areas as low as 25 feet —as a result of sediment oxidation and compaction. Subsidence and these accompanying processes exacerbate flood risk, contribute to greenhouse gas emissions, and reduce the potential for restoring important intertidal habitat types. In addition, subsided lands in the Delta put the reliability of the state's water supply at risk by increasing the likelihood of saltwater intrusion.

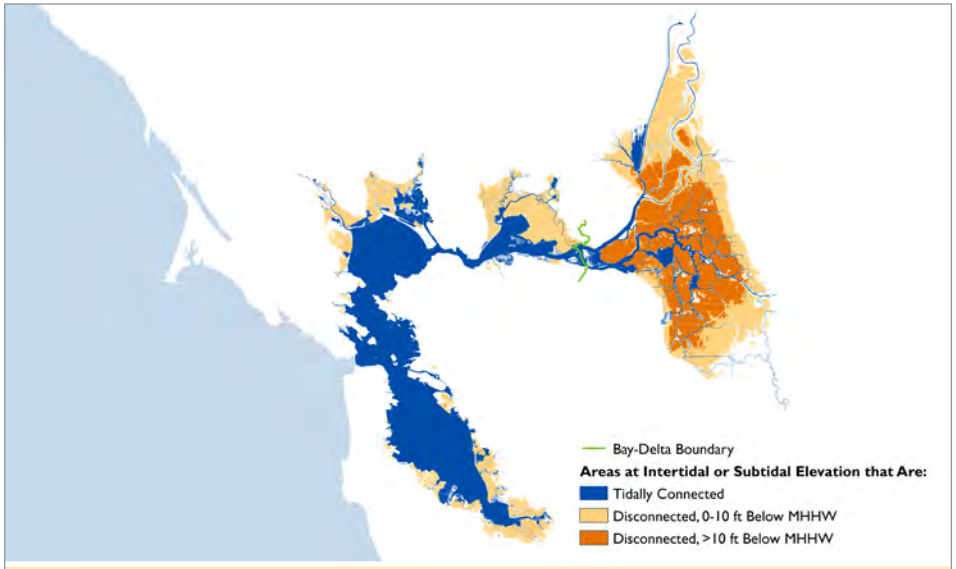
Land uses that keep the soils wet—like managed ponds and wetlands—generally halt or limit subsidence, while land uses that keep soils dry most of the year—like agriculture and urban development—generally allow subsidence to continue.

Changes in elevation can indicate the degree to which key biophysical processes, such as sediment deposition and marsh accretion, are occurring. These processes allow mudflats and tidal marshes to maintain their elevations relative to the tide, and can mitigate risk from storm surge, erosion, and sea level rise, thus contributing to shoreline resilience. The **2015 State of the Estuary Report** explored recent changes in sediment circulation and compared them to historical conditions. In the years since, an even more precise understanding of the interplay between elevation, subsidence, sea level, restoration, and sediment transport has been emerging.



**Subsidence on Twitchell Island adjacent to the San Joaquin River.**

Photo: Amber Manfree




**The map shows areas of the San Francisco Bay and Sacramento-San Joaquin River Delta at intertidal or subtidal elevation, and whether they are connected to or disconnected from the tides. Darker orange areas are tidally disconnected areas that have experienced more severe land subsidence.**

## INDICATOR

This emerging indicator summarizes current elevations in the Bay and Delta at a broad scale. It quantifies the amount of land below the average daily high tide ("mean higher high water" or MHHW) that is diked off from tidal action, and categorizes land use and elevation within these areas. This new analysis reflects the current state of the Estuary and does not incorporate planned restoration.

## EARLY RESULTS

Overall, the San Francisco Estuary encompasses 400,000 acres of land at intertidal or subtidal elevations that are now disconnected from the tides. This represents a larger area than the acreage still influenced by tides every day. Approximately three quarters of these lowlands behind levees exist in the Delta, while the Bay hosts the remaining quarter. The former suffers from more severe subsidence than the latter, due to the Delta's deep historical peat soils.

In the Delta, there are more than 160,000 acres of tidally disconnected land at elevations of 10 feet or more below MHHW.

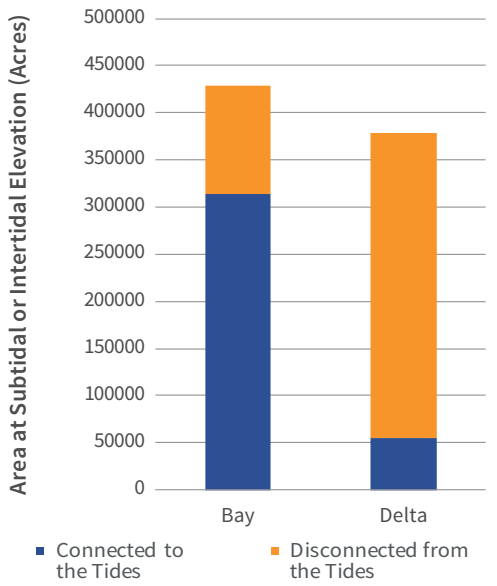
In the Bay, less than 500 acres are 10 feet or more below MHHW.

Land uses vary across the two regions in these low-lying areas. Agriculture dominates land use in the Delta's disconnected areas, while managed wetlands, managed ponds, agriculture, and urban areas predominate in the Bay. About 75% of the Bay's disconnected lands at or below tidal elevation host the types of wetlands or aquatic habitats that halt or limit subsidence (including unvegetated flats, marsh, seasonal wetlands, slope and depressional wetlands, managed ponds, and managed wetlands); only 4.5% of the analogous lands in the Delta host these land uses.

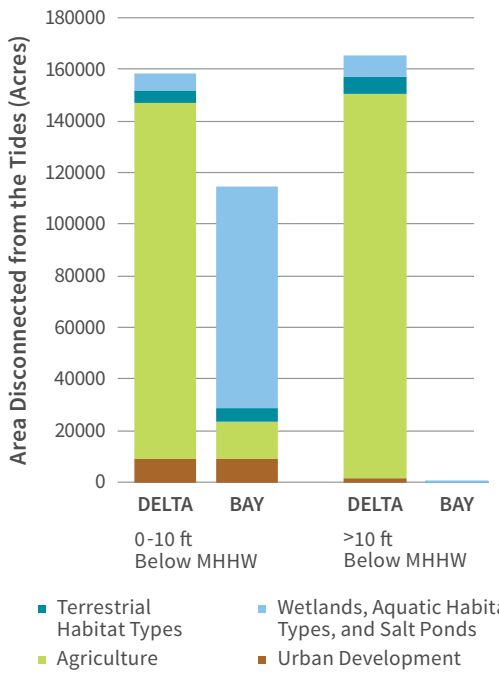
As land continues to subside, sea levels rise, and flooding from creeks and groundwater becomes more prevalent, greater intervention will be required to maintain and protect farms, cities, and other land uses in areas below MHHW. In some of these areas it could be more cost-effective (and beneficial for the environment) to restore tidal habitats or to convert to habitat types that reduce the rate of subsidence. Many large-scale restoration projects have already occurred in formerly disconnected areas and others are underway.

Future iterations of this analysis will gauge how well wetland restoration, as well as other interventions like sediment augmentation, change elevations in the region and enhance resilience.

## INTERTIDAL AND SUBTIDAL LANDS




## LAND USE



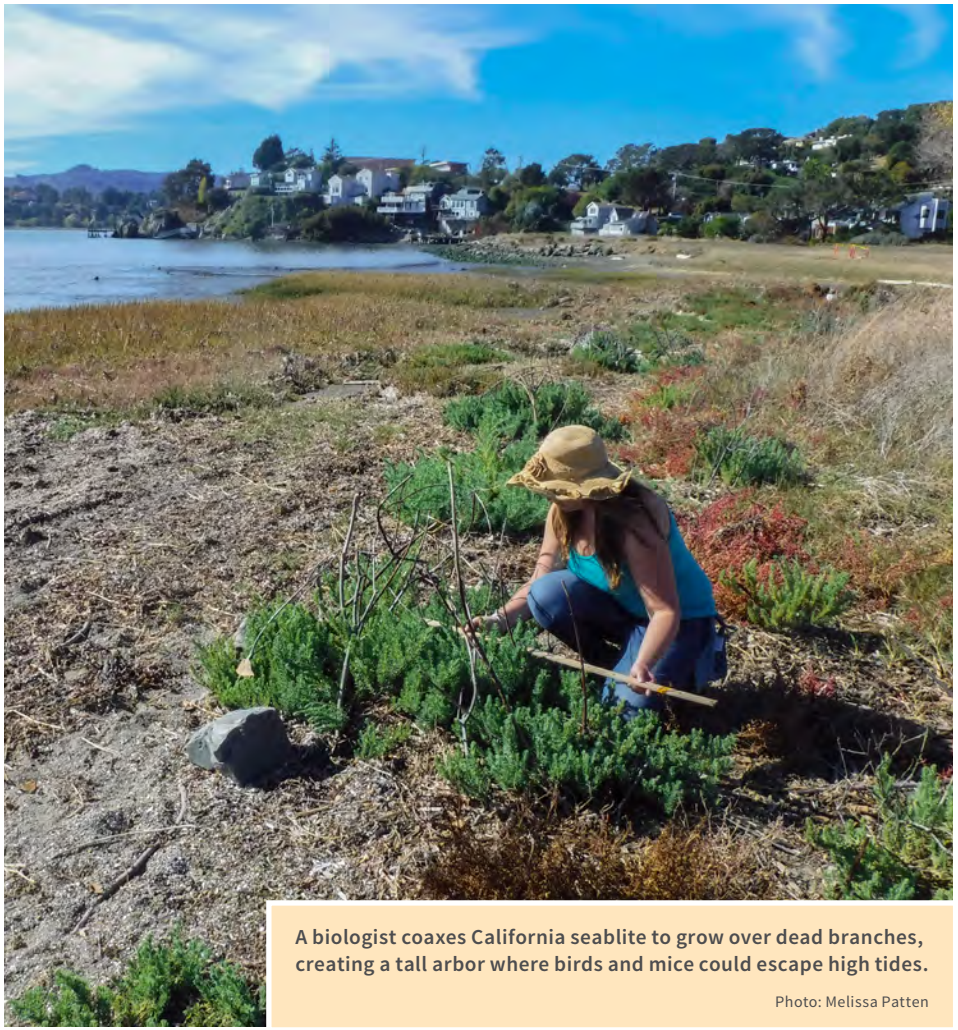
# SHORE RESILIENCE

## EMERGING INDICATOR

As the place where land and water meet, the Estuary's shore is both an important area for people to live, work, and play and a critical zone for resilience to climate change. As climate change accelerates, impacts from sea-level rise, more intense storms, and rising groundwater are expected, incurring steep costs to protect infrastructure, property, and people in these areas. In looking to the future, landowners and planners are considering how the Estuary's shores can be made more resilient and how they can continue to provide benefits for people and nature, despite the expected climate-related perturbations.

Natural systems, like marshes and other wetlands, can be resilient assets along the shore. Tidal marshes can gain elevation as sea level rises by accumulating sediment and plant matter. Research shows that wetlands can provide effective shoreline protection during storm events and have relatively low long-term maintenance costs. When these areas are subject to the full influences of tide, freshwater flows, sediment sources, and connectivity for living organisms, they often return other significant benefits, like processing nutrients for better water quality, sequestering carbon, supporting endangered species, and fueling the food web for fish and other wildlife.

In contrast, the levees and seawalls that often protect developed and agricultural areas are static features that require ongoing maintenance and rebuilding. Where these land uses have been placed over peat soils, the dry land loses elevation, exacerbating the risks from sea-level rise. Halting and reducing subsidence along the shore is a key factor for resilience. Areas of semi-natural ecosystems, like managed wetlands and ponds, provide many benefits, although they tend not to be as resilient as fully natural systems. For example, diked wetlands can support wildlife and prevent land subsidence to some degree, although they cannot grow vertically at pace with sea level rise, the way some tidal marshes can.



**A biologist coaxes California seablite to grow over dead branches, creating a tall arbor where birds and mice could escape high tides.**

Photo: Melissa Patten

# SHORE RESILIENCE

## INDICATOR

This emerging indicator categorizes the Estuary's heterogeneous shore to provide an example of how the potential for resilience could be tracked over time. The categories are intended to demonstrate a spectrum of resilience from relatively low (developed and agricultural land) to intermediate (diked and managed wetlands) to relatively high (ecosystems subject to key land-surface processes, like flooding and sediment dynamics).

The shore zone was assessed via a three-step process:

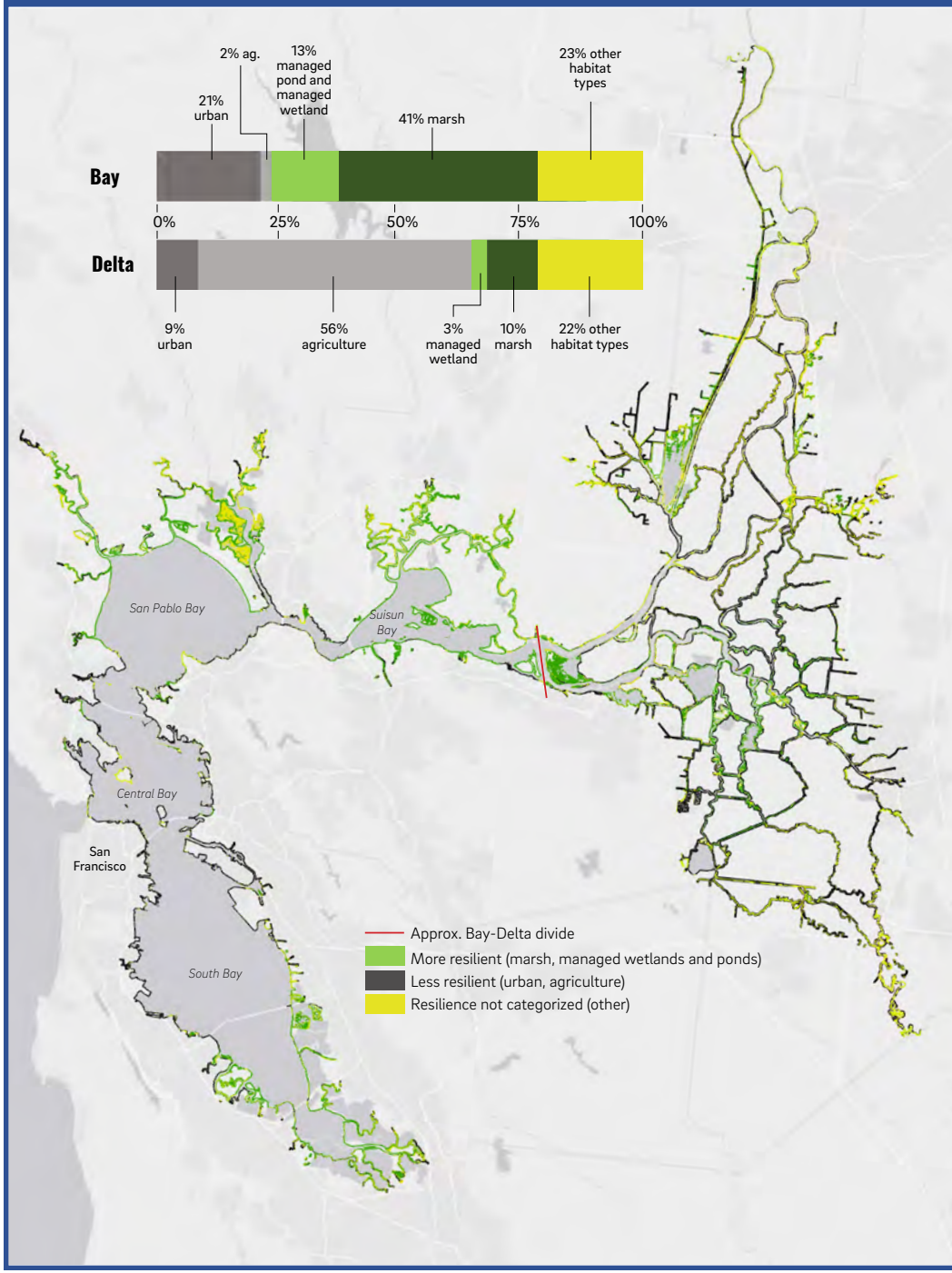
1. Define and delineate on a map the land-water interface.
2. Characterize land use within a 100-meter shore zone landward of that line.
3. Classify each reach of the shore zone, based on land use and ecosystem type.

This indicator requires further development to better capture important features of resilient shores. For example, levee data sets for the Delta might be further refined and integrated with shore type to allow a more nuanced categorization based on elevation and land-water connectivity. In addition, improvements in how the shoreline is delineated and categorized could be made with more spatial data and analysis and greater scientific input.

## EARLY RESULTS

In the Bay, more than half of the shore (54%) supports natural and managed wetlands that can help impart resilience. In the Delta, only 13% of the shore supports these ecosystems. Over time, this indicator could track management actions to protect cities and agriculture using adaptation strategies that include nature-based shores.

As this indicator is refined in future analyses, differences between the Bay and Delta are important to keep in mind. In the Bay, the shore zone is primarily located around the periphery, transitioning upslope to terrestrial areas. In the Delta, on the other hand, much of the shore is along leveed channels bordering subsided islands. These differences mean that the types of benefits provided by shore ecosystems and land uses vary across the Bay and the Delta. Thus, each region may have different nature-based or multi-benefit shore types that are more appropriate. In the Bay, for example, suitable projects may include beach and oyster reef restoration to reduce erosion; in the Delta, they might favor wetland restoration to halt subsidence and regain elevation. As novel shore features, such as ecotone levees and tule farming, are piloted and mapped, this approach could be expanded to track them.

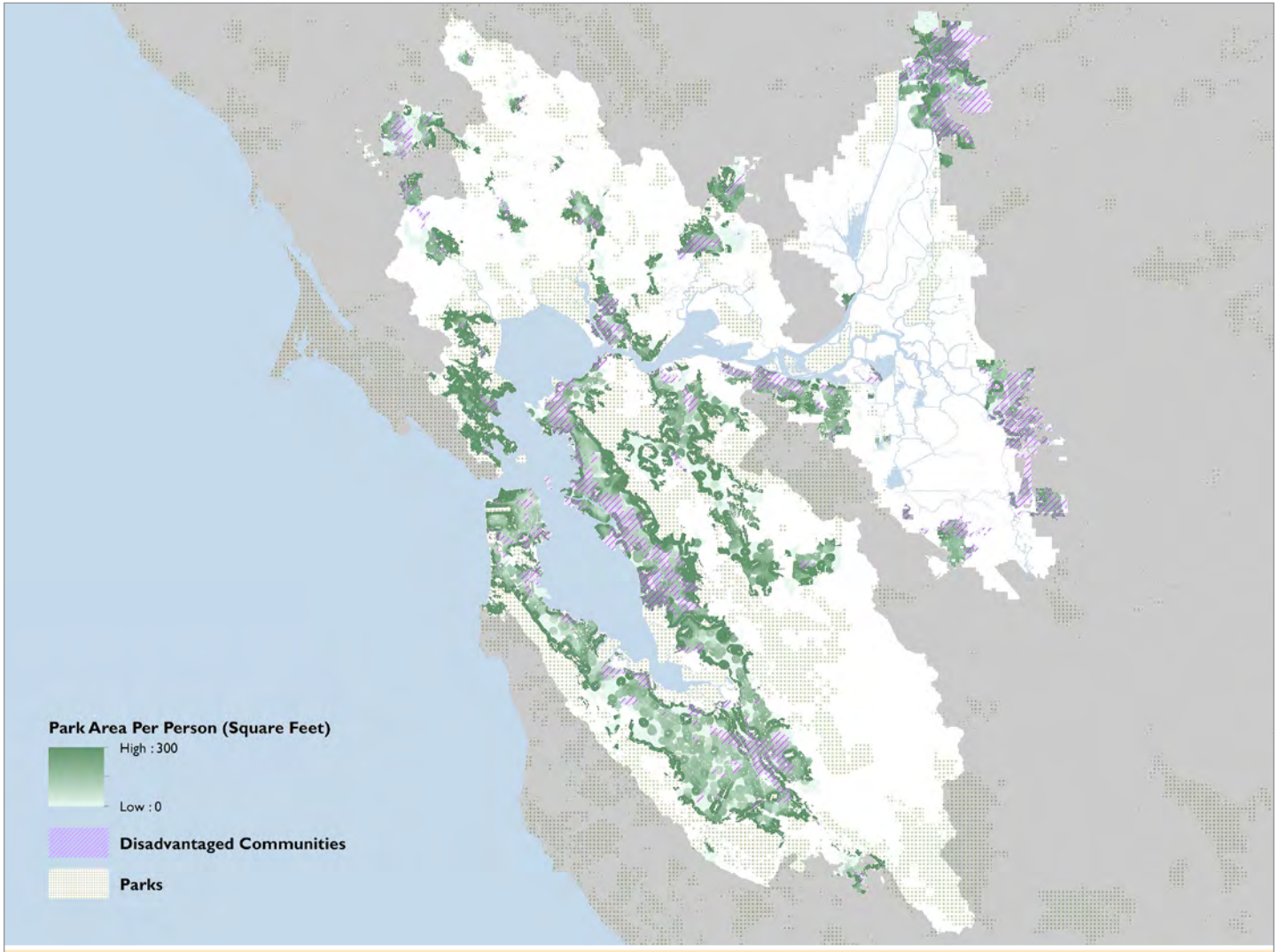


# URBAN GREEN SPACE

## EMERGING INDICATOR

Open spaces within urban areas provide diverse benefits for wild animals, plants, and people that live nearby. Green spaces decrease urban runoff, improve downstream water quality, and provide habitat for native wildlife, while also benefiting human health and wellbeing. Urban parks improve local air quality and reduce local temperatures, contributing to lowered rates of childhood asthma and heat-related deaths in nearby areas. Exposure to urban parks is also associated with improved mood, increased physical activity, lower heart rate, and other human health benefits.

Park and population distributions together determine how equitably people benefit from parks. A park's accessibility influences how frequently people visit it and how likely they are to reap health benefits from it. Parks should be vibrant and well used; however when people do not have much park space in their neighborhoods relative to the number of people, parks can become overcrowded, and facilities strained. The distribution of parks is inequitable in many cities in the US, as lower-income communities of color tend to have less access to parks than more affluent communities. This disparity has strong implications for disadvantaged communities, given the many health benefits that regular access to nature provides.




**The map shows the amount of nearby park area per person in urban areas around the Estuary. Park area per person is a ratio that takes into account the total acreage of green space within a half mile of one's home and the number of people living within a half mile of that green space. Areas on the urban edge with sparse populations and expansive nearby parks exhibit the highest park area per person, whereas points in more populated areas and with fewer, smaller parks exhibit lower values.**

# URBAN GREEN SPACE

## INDICATOR

This emerging indicator calculates the area of park per person in urbanized locations across the Estuary. It incorporates two metrics: the area of park accessible within a ten-minute walk (half mile) of one's home, and the number of people sharing that park area to approximate the relative benefit individuals can derive from parks.

To understand disparities in the distribution of these benefits, park area per person in the region is compared to park area per person in disadvantaged communities, as identified by the California Environmental Protection Agency (CalEPA), the California Department of Water Resources (DWR), and the Metropolitan Transportation Commission (MTC). The CalEnviroScreen 3.0 (CalEPA) disadvantaged community designation is based on pollution, health, and socioeconomic indicators, while the DWR disadvantaged communities designation is based solely on income. The MTC communities of concern designation factors in income, race and several other demographic factors. Together, these disadvantaged community designations include low-income neighborhoods, those with a majority of people of color, and those that experience high pollution levels. This analysis overlooks some complexities of park access, such as routes of access and the relative quality of various parks. However, this approach—using public data—can easily be tracked through time.

This indicator highlights park access in disadvantaged communities to evaluate how accessible parks are for communities most in need. While this indicator assesses disparities in park benefits across the region, addressing the disparities is not as simple as constructing new parks. Without concurrent policies to keep residents in their homes and ensure housing affordability, park creation may exacerbate existing gentrification and displacement trends. Addressing park access disparities thus requires community-driven processes and local and state policies that prevent these outcomes.

## EARLY RESULTS

Most urban areas around the San Francisco Estuary exceed the national average in terms of park access. More than 75% of the residents of many cities in the Bay and Delta live within a ten-minute walk of a park, which is 20% higher than the national average. However, the amount of accessible public land varies from community to community. In disadvantaged communities, parks tend to be smaller with more potential users nearby than in other areas. Residents of disadvantaged communities are therefore likely to experience fewer of the mental, physical, and social health benefits associated with parks. The information discussed here is a prototype of what a full-fledged urban greening indicator could be in future **State of the Estuary Reports**. Such an indicator would allow us to track changes in public access to green space over time, as cities add new parks and plazas, as communities grow and change, and as shorelines adapt to rising sea levels. This indicator could be made more robust by including factors such as park quality and routes of access, and by tracking whether increases in publicly accessible green space correlate with increases in gentrification and displacement. Access for all will remain a key factor in Estuary resilience.


Photo: Shira Bezalel


If publicly accessible green space were divided among all people living within a half mile of it, the median resident of the Estuary would have 91 ft² of park.

Meanwhile, the median resident of a disadvantaged community in the region would have 61 ft² of park (over 30% less space).

# VOICES

## Weaving Justice into Environmental Management

Photo: Karl Nielsen

Regional efforts that support the health of the Estuary are enriched when voices from communities are front and center. Planners and project managers work in a complex landscape where restoration, water quality, and climate resilience intersect with racial and environmental justice, tribal sovereignty, public health and much more. Listening to and aligning with underrepresented voices provides essential community-based insights into resilience.

"Many of the same drivers that put the health and function of San Francisco Bay so at-risk have also placed certain communities at-risk," says Josh Bradt, an environmental planner with the San Francisco Estuary Partnership.

The impacts of impaired estuarine health are not felt equally. Discriminatory government policies implemented over decades have resulted in disproportionate environmental burdens on, and adverse health outcomes for, many low-income communities of color. For years, these communities have urged a transformation in the ways that scientists, policymakers, and managers envision a healthy estuary.

Today, leadership and vision from community advocates are beginning to shift the conversation, as they work with organizations like the San Francisco Estuary Partnership to ensure more inclusive approaches to conservation and restoration around the Estuary.

One connection between Estuary and community health is rising seas and flooding. Flooding can disproportionately affect low income communities of color along riverbanks or the Estuary's shoreline. Housing policies and practices placed these communities in floodprone areas alongside industrial uses. Underinvestment in these areas has since resulted in inadequate infrastructure to handle storm surges and heavy rainfall.

"The shoreline communities are now the frontline communities," says Sheridan Enomoto, a San Francisco Bayview Hunters Point community organizer.

Future flooding and other climate impacts, however, may not be the most pressing of community concerns. This is more the case with residents of frontline neighborhoods that face multiple stressors on a daily basis.

"Most people are just thinking in the now, they barely know where they are going to get their next meal from, let alone thinking about [flooding or sea level rise] in 50 years," says Marquita Price, a planning officer for the East Oakland Collective. "We can at least supplement people's basic services so they can actually focus on how environmental or climate change issues impact their lives."

In Marin City, topography sets up the community for flood problems. "It's a bowl," says Terrie Green, a Co-Director of Shore Up Marin City, pointing out the steep mountain slopes on three sides

which direct runoff directly into the city's downtown, while on the fourth side Richardson Bay often overflows Highway 101.

Another connection between Estuary and community health is poor water quality, long recognized by regulators as a risk to both humans and wildlife. Efforts to address these risks at the policy level, however, do not always reach the more critical Estuary residents, who experience these threats from the dinner table to the tap to the backyard. Subsistence fishing remains a common practice, and is often the only option for many Estuary residents with fish-based traditional diets. Yet many fish caught in Bay and Delta waters contain unhealthy levels of mercury and PCBs.

Drinking water can also be unhealthy in some Estuary communities. Families in the San Joaquin Valley, for example, find themselves with well water laced with arsenic and nitrates from agricultural runoff. "Our water was poisoned," says community advocate Hugo Trujillo. "Our children couldn't eat the local vegetables." Matheny Tract in Tulare County has relied on a contaminated two-well system for decades, and residents have little recourse. "It's expensive," Trujillo says, "You have to drive miles into the city just to get water." Meanwhile, families in San Francisco's Hunters Point, like other communities near contaminated former industrial sites around the Bay, still live surrounded by what city native and public affairs consultant Theo Ellington refers to as a "toxic soup," even after decades of promised cleanups.

Another nexus between environmental quality and social justice is proximity, as well as access, to open space or recreational opportunities. Research shows that access to nature helps people live healthier, happier lives. These benefits are distributed unequally across the Bay Area, with poorer communities— often of color— continually facing under-investment including but not limited to less green space (see p.33). Adding to this complexity, urban greening or creation of open space can drive up rent prices and displace the very people for whom the park was created. Communities have consistently called for

Photo: Nick Sebastian

*"The shoreline communities are now the frontline communities."*

*— Sheridan Enomoto, San Francisco Bayview Hunters Point community organizer*

direct collaboration and engagement in the siting and development of green space so that benefits are developed for existing residents, to improve the quality of their neighborhoods, and prevent displacement.

As communities lead the way and government agencies build skills to partner and collaborate, solutions are emerging that work to address historical patterns of injustice, and seek to benefit all Estuary residents.

**North Richmond community meeting.**

Photo: Courtesy of SFEP

Residents in frontline communities, with lived experience and long-term relationships in their neighborhoods, possess local knowledge that is crucial to developing sensitive solutions. During the 2018 Resilient by Design Bay Area Challenge, Marin City community members and designers reimagined flood risk management using permaculture techniques to slow, store, and divert excess water flow. A key component of their work was building homegrown expertise through a permaculture design course with local residents. The work sought to show what resiliency planning looks like "when community voices take the lead," said Pandora Thomas of the design team.

Public agencies throughout the state are making efforts to understand and adopt environmental justice (EJ) principles, including centering community voices to ensure historic patterns of injustice become an issue of the past. Community advocates and EJ and social equity consultants are beginning to serve as guides, translators and bridge builders to the process, connecting these disparate perspectives in an effort to create both a healthy and equitable estuary. There are many lessons yet to learn about how to accomplish this objective, but the following takeaways provide a powerful glimpse into some of the fundamental considerations and requirements for this to work.

As an EJ advocate and consultant, Mari Rose Taruc has pressed agencies to ask themselves if their programs are "culturally relevant." If an agency wants to develop inclusive programming, she says, it needs to tap into activities and practices that exist in the communities it wants to serve. "People of color might use the land differently than white folks," she says.

José G. González, another EJ consultant, also cautions against making disadvantaged communities the "objects of programming." He says "It's not about empowering people, it's about helping them demonstrate the power they already have." González is the founder emeritus of Latinos Outdoors, and he pushes agencies at the forefront of Estuary management to "support the community voices that are already there."

As it stands, Taruc thinks that too often "the burden is placed on community members to prove that there's a problem." That responsibility slows down the development of solutions, she says.

One step González believes agencies can take to shift that burden is to incorporate "quantitative community feedback loops, like in an ecological system." The goal is to tap into community feedback as a standard procedure.

Longtime EJ advocate Phoenix Armenta believes it's crucial to collect quantitative information on community health. "Data is what moves government and people to action," she says.

Just as physical scientists measure restoration outcomes in the Estuary, Taruc says it is crucial for regulatory bodies to clarify goals and measure if they're making progress in a community. "That data is important for an agency to grade itself on, in terms of who's at the table, and [the degree of] that representation and investment."

Even as environmental justice has become more of a priority, funding hasn't kept up. When longtime community organizers consult on equity policy, they should be seen as experts in their field, and be compensated accordingly, says Armenta.

Meaningful engagement comes from maintaining investments in relationships, whether an agency establishes an ongoing presence in the communities it serves or pulls up more seats at the drawing table to include and fairly compensate community leaders. In any case, prioritizing equity will likely feel disruptive to business as usual. As Taruc reminds the agencies she consults for, that's the point. "Structural racism is so pervasive that things feel like normal. What happens when we interrupt that normalcy and then measure [the results]?"

"We can't restore ecological health without also restoring our social fabric," says Letitia Grenier, Resilient Landscapes Program Director at the San Francisco Estuary Institute. "This is beyond what those of us working on the Estuary's ecosystem can do by ourselves, but we recognize they must be addressed in concert."

# LOOKING AHEAD

This report is one in a series of **State of the Estuary Reports** to periodically update the Delta and Bay Area communities on the health of our Estuary.

Photo: Nick Sebastian

# PURSUING RESILIENCE

The **State of the Estuary Report** is a trusted source of the most up-to-date, scientific information on the health of the San Francisco Estuary's wildlife and ecosystems. The report summarizes long-term datasets from both the Bay and Delta across a broad spectrum of health indicators. Methods used to compile this powerful picture of how the Estuary is doing have been steadily fine-tuned by the partners contributing to the report over more than a decade.

This 2019 update covers an interesting period in which the Estuary experienced both severe drought conditions and a rebound to non-drought conditions. In the past, in response to similar shifts in conditions, some species and landscapes recovered quickly, and others did not. Some may have been too weakened by long-term stresses, while others may be strengthened by continued ecosystem restoration activities on many levels. The current datasets that underpin this last period reflect a lot of variability. It will be important, therefore, to keep an eye on these indicators to see if recent trends continue.

Also during the update period concerns about environmental equity, regional affordability, and the safety of disadvantaged communities in the path of sea level rise have come to the fore. The partners contributing to this report intend to make stronger links to these issues and voices in future updates.


Photo: Nick Sebastian

The San Francisco Estuary Partnership intends to continue periodic reporting on the status and trends presented in its 2015 and 2019 reports. Maintaining continuity with past analyses, and responding to new priorities and changing conditions, supports science-based management of the Estuary environment. The Partnership also believes that providing succinct, accessible results in a report format is useful to busy decisionmakers, and helps focus attention on an ever more complex picture of social-ecological resilience.

As people around the Bay and in the Delta work to save water, restore flows, sustain native species, and adapt to new extremes, our options are shrinking. What is commonplace now may not be sustainable in the future. Those of us engaged in reporting on, analyzing, and adapting to these challenges need to both stick it out and step it up. Resilience is not built or regained overnight. The task of deepening our understanding of the ecosystem we all live in, and rely on, reflects our shared sense of responsibility and hope for the future.


Photo: Joe Galkowski

# ASSESSING THE STATE OF THE ESTUARY

This 2019 report provides an update to selected indicators from the **2015 State of the Estuary Report**. The indicators revisited for this report were chosen because there was data available to provide an Estuary-wide update, and because they each represented one important attribute of Estuary health—water, habitat, wildlife, processes, and people. In combination, these indicators provide an updated snapshot of the overall health of the Estuary.

The three emerging indicators included in this report were developed as a step toward including resilience in a more significant way. The focus of these emerging indicators was decided, in part, by considering whether relevant, frequently updated datasets were available, and whether they could be analyzed in a cost-effective way in the future.

Decisions about what to include in this report were made by a Steering Committee of advisors from the San Francisco Estuary Partnership, the Delta Stewardship Council, and the U.S. Environmental Protection Agency, in collaboration with the San Francisco Estuary Institute.

More information about the 2015 Report and the Technical Appendices can be found at **sfestuary.org/our-estuary/soter/**


Photo: Nick Sebastian

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