

Stronger Safer Shorelines

Nature-Based Solutions to Increase Resilience to Climate Change in the San Francisco Estuary

The San Francisco Estuary is home to remarkable habitats, world-class businesses, multiple ports, and millions of residents. Climate change threatens the vitality of the region's unique economic, social, and ecological balance. Working to protect these diverse and valuable resources requires a coordinated effort that spans agencies and interests across the Bay.

Are you a city council member, city manager, or city staff person? This brochure presents an overview of Bay Area models for integrating nature-based infrastructure into approaches to increasing community resilience in the face of anticipated and yet unknown impacts of climate change.

Photo Credit: California Coastal Conservancy

www.sfestuary.org

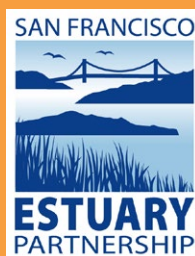




Photo Credit: Cris Benton

WHAT IS RESILIENCE?

Resilience to climate change means cultivating the ability of cities, natural systems, and species to sustain themselves in the face of increased stressors such as extreme weather and rising sea levels. In the San Francisco Estuary, the resilience of cities and natural habitats can be closely connected. Shoreline communities derive flood protection benefits from expanded wetlands adjacent to upland habitats that absorb storm surges and the impacts of sea level rise, while native species benefit from expanded restoration efforts that ensure there is a place to move when the tides gets higher.

These multiple-benefit approaches will not only ensure that San Francisco Estuary communities are better protected in the face of climate change but that our ecosystems and wildlife are as well. Increasing the rate of restoration around the Bay's shoreline is part of the resilience-building equation, since well-established wetlands stand a much better chance of keeping up with sea level rise over time than recently restored ones do.

WHAT IS NATURAL AND NATURE-BASED INFRASTRUCTURE?

Natural and nature-based infrastructure leverages ecological processes to provide multiple biological and physical benefits, such as greater flood protection, improved habitat, better water quality, and carbon sequestration. Infrastructure designs may include a combination of natural systems, new habitats, built structures (such as levees, stormwater facilities, and wastewater pipelines), and upgrades to existing infrastructure (such as creek mouth culverts, barriers, and flood control levees).

The intent of these nature-based infrastructure approaches should not only be to render a single outcome, such as flood protection, but also to improve water quality, create community open space, and build habitat, among a range of possible benefits. These strategies can be applied at multiple scales, from restoring the banks of a creek to planning and building flood protection across an entire region.

The San Francisco Estuary Partnership (SFEP) works with partners throughout the Bay Area and Delta regions to better understand and prepare for climate change impacts to shoreline habitats and communities. This understanding of risks and spirit of partnership guides SFEP's work in promoting natural and nature-based infrastructure in the San Francisco Estuary.



Photo Credit: Jude Stalker



Photo Credit: County of Napa

TIDES OF CHANGE

As global temperatures continue to rise, scientists and planners have started to project how the outcomes of climate change will impact shoreline communities and habitats. Understanding the potential risks to infrastructure, natural habitats, homes, and businesses

allows communities to identify vulnerabilities and respond to new and anticipated threats. Sea level rise, more intense and frequent storm events, and extreme temperatures are the primary climate change-related hazards that can be mitigated with natural infrastructure.



Sea Level Rise

Rising global temperatures have accelerated the melting of the earth's ice caps. These massive reserves of ice, when liquefied, add to the volume of worldwide ocean waters. Additionally, water expands when it is heated, a process called thermal expansion, which accelerates rises in sea levels. Sea level rise will affect coastal communities and tidal estuaries, including the San Francisco Estuary. Potential impacts in coastal areas and bayside communities include:

- Damage to buildings, roads, and other critical infrastructure, such as wastewater treatment plants
- New or prolonged shoreline flooding
- Increased flood events from creeks and flood control channels
- Loss of beaches
- Loss of wetlands and shoreline habitat
- Loss of trails and other shoreline recreational opportunities
- Damage to levees, berms, and revetments



Extreme Temperatures

High temperatures that last for extended periods of time are another anticipated impact of climate change. A rise in average temperatures, as well as an increase in the number of extreme heat events, can:

- Pose health risks to vulnerable populations, such as senior citizens, young children, and those with chronic illness
- Disrupt habitats and migratory patterns
- Exacerbate challenges facing threatened and endangered species



More Intense & Frequent Storms

Increased air and ocean temperatures can alter the patterns of storms and increase their intensity and frequency. In addition to sea level rise, storm surges and heavy rains can:

- Exacerbate flooding
- Damage levees, berms, and revetments
- Damage buildings, roads, and other critical infrastructure, such as wastewater treatment plants
- Disrupt habitats and ecosystems

NATURE-BASED APPROACHES TO ACHIEVING RESILIENCE



Hazard & Climate Adaptation Planning

By considering resilience in planning documents, such as hazard mitigation plans, disaster recovery plans, general plans, urban water management plans, and climate adaptation plans, communities can anticipate and prepare for impacts from sea level rise and extreme weather.

Local governments across the Bay Area and the Delta already develop plans to address anticipated impacts of potential hazards in their communities, such as earthquakes, landslides, and flooding. Integrating natural infrastructure into hazard mitigation and climate adaptation planning has a number of key benefits:

- Recognizes the value of shoreline habitats in protecting adjacent communities from hazards such as flooding
- Identifies vulnerabilities of natural resources to hazards and establishes programs and policies to protect them
- Applies nature-based resilience solutions to protect communities from the impacts of climate change



Habitat Creation, Restoration, and Enhancement

Tidal habitats, oyster and eelgrass beds, restored beaches, creeks, and other natural and nature-based features of estuary shorelines can make the region more resilient to rising sea level, drought, water pollution, and other future stresses.

The San Francisco Estuary is home to a number of valuable and threatened species and habitats. The historical development of tidal marshes and the ongoing urbanization of transition zones between marshes and uplands have reduced habitat availability, while hardscape environments increase the speed and decrease the quality of stormwater runoff. In addition to existing pressures from urbanization on native species, anticipated impacts of climate change, including sea level rise, more extreme storms, rising temperatures, and drought, pose threats to the vitality of the region's wildlife.



Multi-Benefit Projects

Working with representatives from different stakeholder groups and agencies can allow for integrated projects that benefit both natural assets and shoreline communities in the region.

Natural and nature-based infrastructure is a key component in planning and implementing projects to meet multiple objectives, including flood protection, habitat creation, and water quality improvements. A multi-benefit project might expand a wetland to provide additional habitat for threatened species, while also developing a natural levee that reduces the risk of storm surges for shorefront cities. A flood control channel can be redesigned to take advantage of natural processes to deliver sediment to tidal marshes while reducing maintenance dredging costs and increasing flood capacity.

CASE STUDIES

Oro Loma Horizontal Levee

In the face of rising tides near essential wastewater treatment plant facilities, planners, engineers, and scientists came together to design and construct an experimental horizontal levee, which mimics the natural slope of historic wetlands into upland areas. This project, located on a 10-acre field next to the Oro Loma Sanitary District's San Lorenzo wastewater treatment plant, takes in treated water from the Oro Loma facility at the top of the horizontal levee and lets it flow through the soil to sustain and be treated by native plants.

Resilience Outcomes:

- Creates wildlife habitat with vegetated levee
- Removes nutrients that jeopardize water quality
- Protects critical infrastructure and adjacent communities by slowing storm surges and buffering rising seas

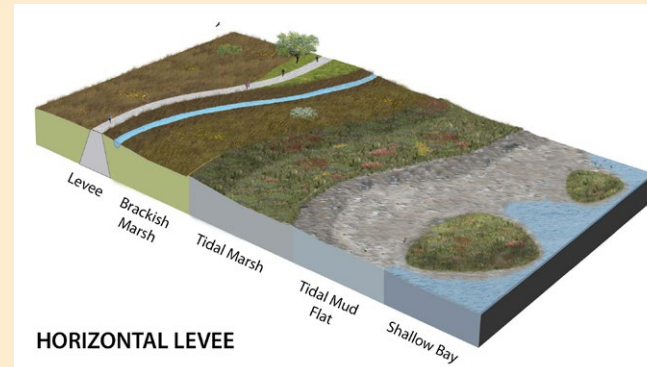


Photo Credit: City of San Jose/Hargreaves Associates



Yosemite Slough

The two-phase restoration of Yosemite Slough will result in restoration of 34 acres of habitat, including 10 acres of tidal wetlands, bird nesting islands, and transitional areas to buffer sensitive habitats. The slough is the largest contiguous wetland area in San Francisco County. The completed Phase I transformed a site covered with dilapidated warehouses, contaminated soils, and construction debris into 7 new acres of fully restored tidal wetlands.

Resilience Outcomes:

- Provides habitat for wildlife and improves water quality
- Prevents erosion along the San Francisco shoreline
- Buffers storm surges and minimizes impacts from sea level rise
- Gives residents a clean, natural recreation area
- Increases awareness of restoration and natural habitats through youth education and community involvement



Photo Credits: California State Parks Foundation



Photo Credit: Judy Irving, Pelican Media



Photo Credit: Cris Benton

South Bay Salt Ponds

The South Bay Salt Pond Restoration Project is the largest tidal wetland restoration project on the west coast, with more than 15,000 acres of former commercial salt ponds restored to a mix of tidal marsh, mudflat, and other wetland habitats. The project provides much-needed habitat for endangered and other native species, provides large areas of contiguous habitat to boost biodiversity, and improves water quality through restoration of the tidal cycle.

Resilience Outcomes:

- Provides thousands of acres of habitat for native species
- Improves public access and expands public awareness of the restored habitat and risks posed by climate change
- Protects surrounding communities with tidal marshes

Living Shorelines

This multi-objective habitat restoration project used a living shorelines approach to enhance and protect physical and biological resources along the coast of San Rafael and Hayward. The project constructed oyster reefs and eelgrass beds, providing habitat and associated ecosystem services.

Resilience Outcomes:

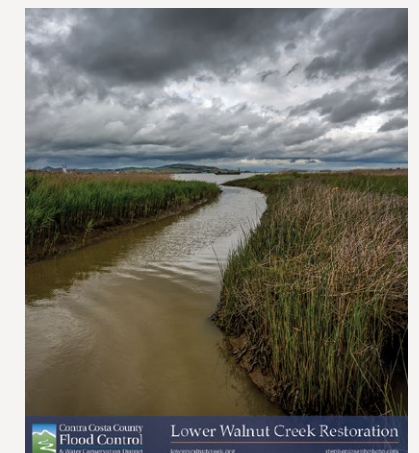
- Installed and increased eelgrass which is habitat-critical for Bay Area native species
- Installed habitat for Olympia oysters, attracting over four million oysters
- Enhanced habitat complexity and function at the project site, increasing invertebrate, fish, and bird abundance
- Reduced wave energy by 30% at the project site with new reef structures, protecting the shorelines

Flood Control 2.0

The project is a regional effort aimed at helping restore stream and wetland habitats, water quality, and shoreline resilience around San Francisco Bay. The project leveraged local resources from several flood control agencies to redesign major flood control channels to provide both future flood conveyance and ecological benefit under a changing climate.

Resilience Outcomes:

- Increases community awareness and education through engagement
- Advances strategies for flood control
- Provides multi-benefit conceptual models and cost-saving restoration options for other flood control channels



Central Coast County Flood Control Lower Walnut Creek Restoration

STEPS TO STRENGTHEN YOUR COMMUNITY

Interested in learning more about how to build resiliency in your community? The following steps can get you started. Discover these resources and learn more at www.sfestuary.org/resiliency.

1. Planning for Change

Incorporating the anticipated impacts of climate change into planning efforts can help protect essential infrastructure and strengthen the fabric of the entire Bay and Delta regions. A number of regional organizations, including SFEP, the San Francisco Bay Conservation and Development Commission (BCDC), the Association of Bay Area Governments (ABAG), and the Metropolitan Transportation Council (MTC), have developed plans and resources to assist communities in preparing for climate change.

2. Data & Research

A number of tools have been developed for use by land managers and governments to consider the impacts of climate change on their project or community. SFEP has worked with scientists, researchers, and nonprofits to compile data about the Bay into accessible resources, and ongoing monitoring offers insights into the best ways to manage change.

3. Project Implementation

Leveraging the region's wealth of experts, funding, and political assets necessary to implement successful resilience projects can help your community achieve multiple goals and support the overall health and safety of the estuary. Multi-benefit projects can use natural infrastructure to build resilience, reduce pollutants, create valuable shoreline open space, and restore essential habitat for species.

ONLINE RESOURCES

- Regional plans and guidance documents, including Plan Bay Area
- Adaptation and natural infrastructure case studies, such as those developed in the Adapting to Rising Tides project
- Sample policies, provided through ABAG's Resilience Program
- Comprehensive mapping resources, including sea level rise projection viewers
- Quantitative outcomes from natural infrastructure projects in other Bay Area communities
- Overview of funding opportunities to design and implement multi-benefit natural infrastructure projects
- Case studies from successful multi-benefit projects in the region

www.sfestuary.org/resiliency



ABOUT SFEP

The San Francisco Estuary Partnership (SFEP) was established more than 25 years ago by the State of California and the US Environmental Protection Agency to prepare and implement a plan to better protect and restore the estuary. SFEP is one of 28 National Estuary Programs across the country. Today, SFEP manages over \$100 million in regional restoration, water quality, and climate resiliency projects. The partnership is a program of ABAG. Visit us at:

www.sfestuary.org