H.R. 610

SAN FRANCISCO BAY RESTORATION ACT

PREPARED BY: THE (B)ESTUARIES TEAM

ACKNOWLEDGEMENTS

Faculty Advisor: Dr. Howard Apsan

Manager: Kerri Hoolihan

Deputy Manager: Willa Jones Irwin

Team: Stephen Hart, Dengruo Wang, Daniela Varon, Nick Venezia, Hadja Fatoumata Doumbouya, Matt McDavitt, Jiexin Wang, Ilina Hristova, Johnluca Fenton, Aaron Zweig, Namir Ahmad

COLUMBIA | SIPA
School of International and Public Affairs

COLUMBIA
THE EARTH INSTITUTE

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The San Francisco Bay Restoration Act, H.R. 610, seeks to halt and ultimately reverse the continued degradation of the San Francisco Bay Estuary and promote a natural shoreline and healthy ecosystem. The Estuary, home to 1,000 species of animals, serves as the primary source of drinking water for 25 million Californians, contributes $370 billion to the California economy, and supports nearly four million jobs (Pelosi, 2021). Over the last two centuries, unabated urban development surrounding the Estuary has disturbed the balance of its ecosystem and threatened the continued utility of the Bay for human and non-human entities (Cloern and Jassby, 2012). H.R.610 would provide $250 million in federal funding over the next five years and establish a San Francisco Bay Program Office within the Pacific Southwest Regional Headquarters of the Environmental Protection Agency (EPA). The goal of this office is to expand and reinforce the types of wetland and estuary projects already underway via a centralized federal entity. Under H.R 610, the San Francisco Bay Office Program must annually compile a list of funding priorities for projects or studies that advance the goals and objectives outlined by the comprehensive conservation and management plan under the National Estuary Program for San Francisco Bay. The list must include projects or studies aimed at water quality improvement; wetland, riverine, and estuary restoration and protection; nearshore and endangered species recovery, and adaptation to climate change.

Introduction To H.R. 610

Home to over 1000 species, the San Francisco Bay is the largest estuary on the West Coast of North America, encompassing over 101 municipalities, and supporting the world's 19th largest economy. The San Francisco watershed is also a primary source of drinking water for 25 million Californians, irrigation for 700 square miles of agriculture, and houses important economic resources: California's water supply infrastructure, ports, deepwater shipping channels, highways, railroad corridors, and energy lines (EPA, 2021). The watershed also acts as a regulator, assimilating the wastewater of 50 municipal sewage treatment plants, and moderating the regional climate (Cloern and Jassby, 2012.) The development that led to the economic success of the Bay Area came at the expense of the estuary's health and environmental neglect. Failing to account for excessive water demand, pollution, and invasive species among other various ecological issues further exacerbate the conditions. Additionally, the growing intensity of climate change is a significant threat to the Bay's ecosystem and its inhabitants.

H.R.610 seeks to coordinate federal, state, and local resources towards rehabilitating and preserving the ecosystem while strengthening its resilience to climate change. On January 10th, 2021, Rep. Jackie Speier [D-CA14] reintroduced H.R.610 for the 2021-2022 legislative session, an amendment to the Federal Water Pollution Control Act of 1948 that aims to provide additional federal resources, as well as coordinate the state government, local governments and non-state actors towards the environmental maintenance of the San Francisco Bay Estuary. H.R.610 would provide $250 million in federal funding over the next five years and establish a San Francisco Bay Program Office within the Pacific Southwest Regional Headquarters of the Environmental Protection Agency (EPA). The goal is to expand and reinforce the types of wetland and estuary projects underway by nonprofit and government agencies in an effort to re-establish a more natural shoreline and a healthier ecosystem.

95%

of the tidal marsh has been lost since the 18th century

35%

of observed fish in the San Francisco Bay have consumed plastic

Source: Cloern and Jassby, 2012

Environmental Problems

HABITAT DESTRUCTION SPECIES AT RISK

INDUSTRIAL & URBAN POLLUTANTS

SEWAGE SPILLS

CLIMATE CHANGE

1. **Habitat Destruction and Species at risk.**

During the Industrial Revolution, industries diked and filled nearly 95% of all tidal marsh areas of the Bay (Cloern & Jassby, 2012), an essential habitat for the 500 species of wildlife and fish (EPA, 2012). The Central Valley Project (CVP) and the State Water Project (SWP) dammed a large portion of the Bay for agricultural purposes during the 19th century. The Bay loses approximately 50% to 70% of its fresh water to agriculture annually. This creates perpetual drought in the Bay which increases water salinity, affecting fish populations, like the delta smelt (Tobias, 2020).

The introduction of non-native species has had devastating impacts on the Bay ecosystem. One of the primary catalysts of non-native species introduction is the ballast waters from ship transportation of goods and services. This water is transported from a foreign environment into the estuary, thus bringing along various foreign species. These species are often more competitive than indigenous organisms and better suited to withstand environmental changes. This process contributes to the loss of native organisms as resources are consumed by the invasive species and often collapse entire food chains (Cloern & Jassby, 2012).

Picture of Delta smelt

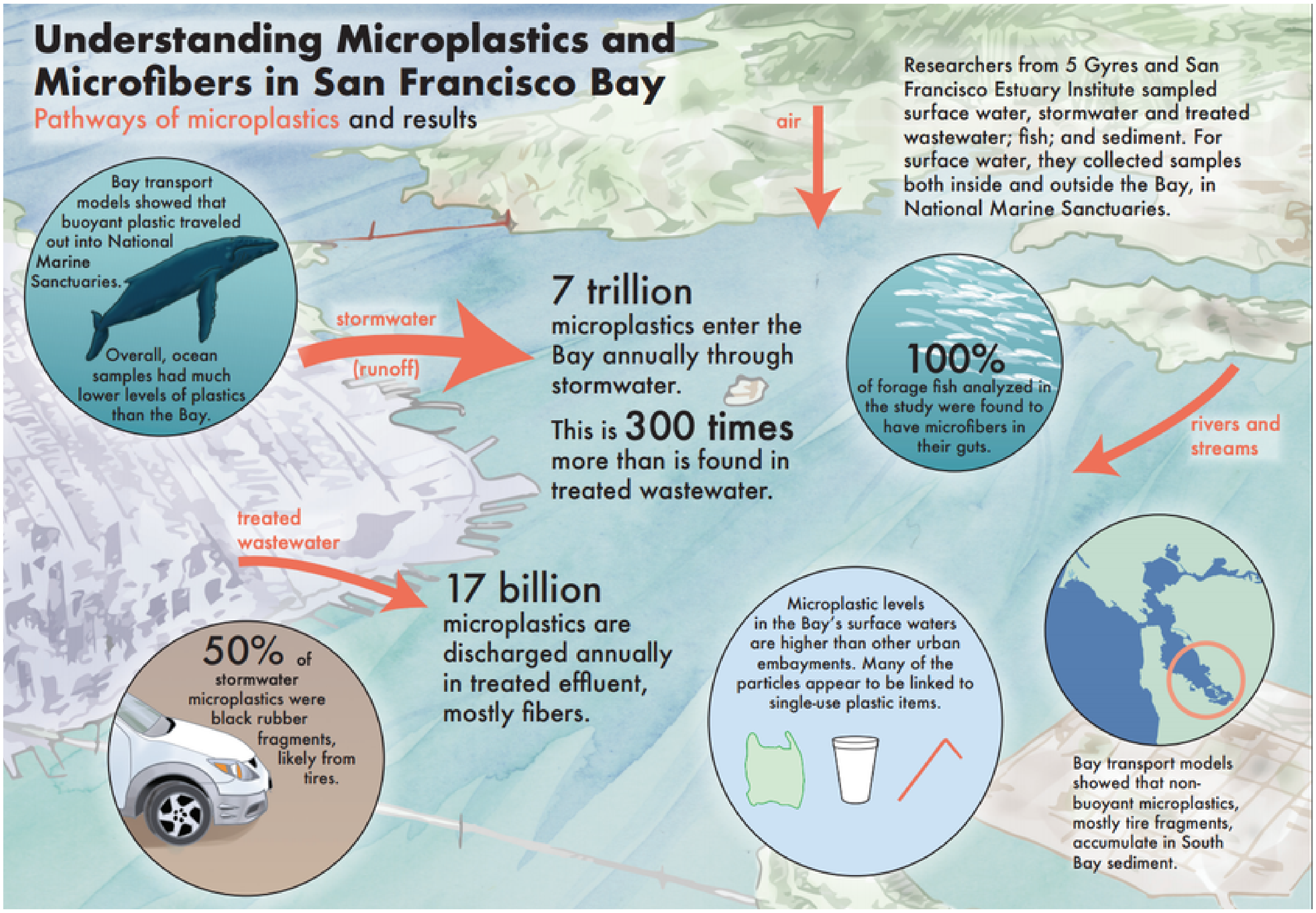
One example of invasive species in the bay is the Delta smelt. Brought in as larvae via ballast waters from ships, these fish aggressively hunt shrimp and rotifers, collapsing the food webs of many native species and leading to a decline in biodiversity. As they have fewer natural predators than the previously balanced ecosystem, they are able to easily multiply which exacerbates the issue. (Sejal, 2009)

2. Industrial and Urban Pollutants

Sewage input and urban pollutants (such as agricultural and industrial runoff) are factors that have degrading effects on the water quality, biodiversity, and commercial aspects of the ecosystem in the bay. Currently, 1,300 industrial projects in the region add new pollutants to the Bay daily. These pollutants include nitrogen and phosphorus, heavy metals, pharmaceutical waste, organic matter, microplastics, and bacteria and threaten the survival of aquatic life. The additional nutrients brought into the system are absorbed by algae populations leading to harmful algal blooms. This induces higher productivity and growth rates compared to the state at normal nutrient levels. As a result, algae crowd the water surface, preventing solar light penetration and oxygen dissolution into the water. When the algae die, they are decomposed by bacteria in a process that requires oxygen and further depletes the system creating a “dead zone”. While the aquatic basin remains a relatively closed system, organisms beneath the surface start to compete for the remaining dissolved oxygen and food supply. Consequently, life underwater in that zone is slowly asphyxiated (Cloern & Jassby, 2012).

Additionally, urban stormwater also brings microplastics (San Francisco Baykeeper, n.d.). Research shows that every year, nearly seven trillion microplastics are discharged into the San Francisco Bay. Fish in the ocean ingest microplastics, which leads to the process of bioaccumulation. This process is defined as the continuous build-up of a certain substance in an organism over a specific period of time, which becomes particularly hazardous if the rate of absorption of that substance exceeds the rate of excretion. A study shows that 25% of fish at California's markets contain microplastics that humans then consume. Not only are microplastics polluting the aquatic environment and killing off fish, but they are also being ingested by humans and leading to health concerns, particularly in the endocrine system.

Raw sewage in San Francisco



Microplastics and Microfibers in San Francisco Bay

A CREDIT CARD

Equivalent weight of microplastics on average per week that is ingested by humans (WWF 2019)

Microplastics act as transport surfaces that can carry hormone-disrupting chemicals into us directly or via seafood we consume. In addition, there is evidence of the microplastics further breaking down into smaller chemical components that act as endocrine disruptors. Endocrine disruptors are chemical compounds that are able to mimic endogenous hormones (those we naturally produce), as they have similar chemical structures. (Capriotti, 2020)

One common example of an endocrine disruptor is Bisphenol A (BPA) which, though now illegal, is still present in the environment today. Some of the effects of the hormone-mimicking contaminants include interference with estrogen or androgen systems affecting reproductive functions, or interference with the thyroid system affecting metabolism. That is why many forms of prostate/testis cancer, mammal/vaginal cancer, and diabetes/obesity diseases are connected to endocrine (Rogers, 2019).

3. Sewage Spills

San Francisco Bay is also filled with sewage pollutants. These pollutants cause infections and stomach disorders in humans who drink or come into contact with the polluted waters. Industrial and urban run-off pathogens can be lethal to both plant and animal life in the Bay. The majority of sewage treatment plants in the area were constructed in the mid 20th century and can no longer sustain the larger population, which causes pipes to rupture and sewers to overflow, spilling its content onto streets and eventually into the Bay (San Francisco Baykeeper, n.d.).

Sewage Spill in San Francisco Bay

4. Climate Change

Climate change is placing additional strain on an already stressed ecosystem. Scientists believe that in 2015 climate change caused an unprecedented number of starving seals and sea lions, as well as other organisms in the Bay Area.

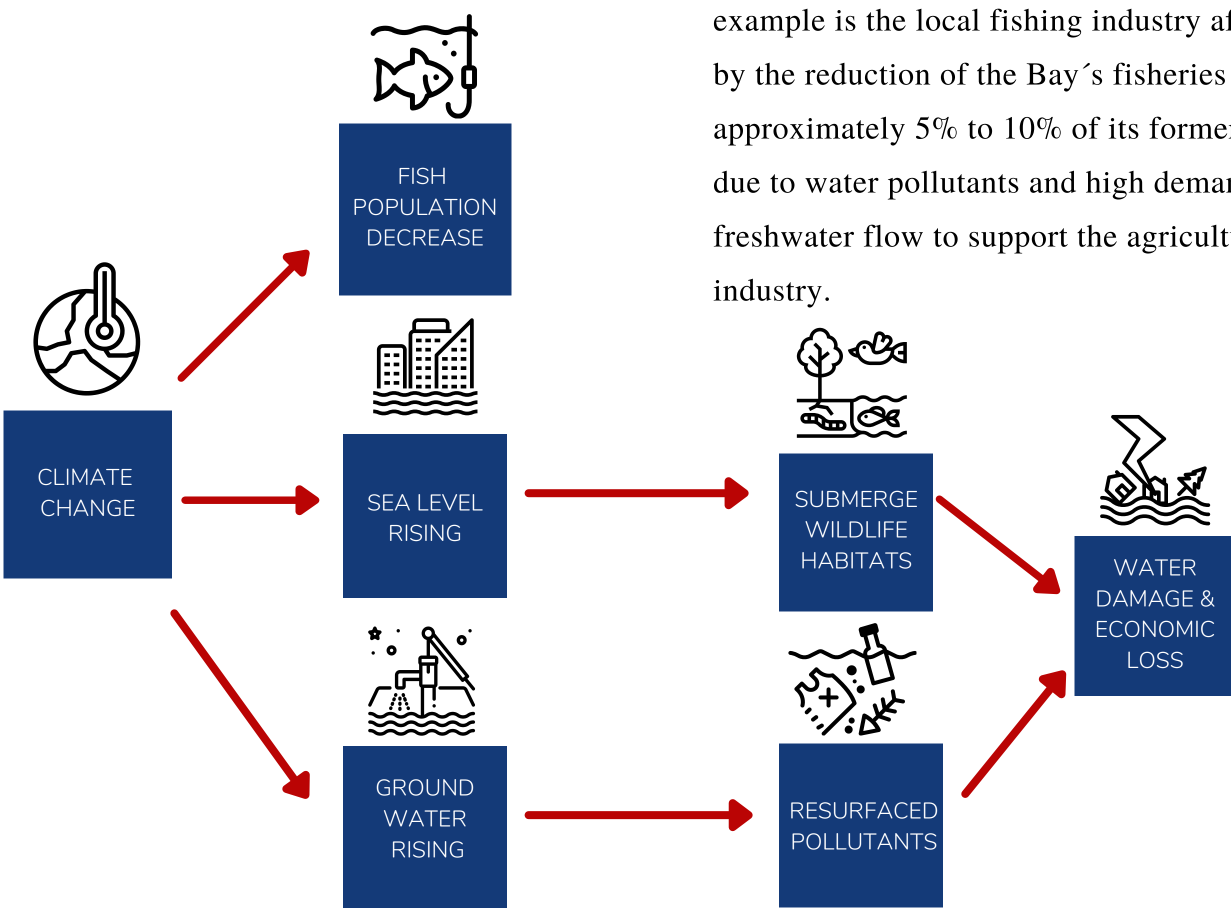
Fishermen, specifically those involved in salmon and crab fisheries, are noticing that the seasons are starting later--the crab season started four and a half months late in 2016--and are producing fewer catches.

Rising sea levels due to climate change will likely submerge wildlife habitats, including wetlands, diminishing available land for biota and migratory birds. The additional flooding will further increase pollutants in the Bay as receding waters carry industrial and urban waste. Inundated lands will also suffer water damage and cause greater economic damage to the region (Sejal, 2015). Groundwater rise, another consequence of climate change, resurfaces pollutants that have been buried for over a century.

Many of these pollutants are leftover from when industries dumped massive amounts of pollutants into the Bay prior to any environmental regulations in the early to mid 20th century (Klivans, 2020). Increasing pollutants and the diking of tidal marsh causes artificial droughts, biodiversity loss, health hazards for humans, animals, and plants living in and around the Bay, among others. Without the long-term restoration of the bay, these negative consequences will continue to create chain effects and exacerbate environmental problems and their impacts on human, animal, and plant populations.

Who is impacted?

The degradation of San Francisco Bay affects the health, well-being, and livelihoods of the 3.5 million people who depend on it. An example is the local fishing industry affected by the reduction of the Bay´s fisheries by approximately 5% to 10% of its former size, due to water pollutants and high demand for freshwater flow to support the agricultural industry.



The fisheries of Chinook salmon, one of the most important species in the San Francisco Bay, is currently collapsing. Millions of Chinook salmon traveling between sea and river delivered vast amounts of rich ocean nutrients inland, feeding whales, seals, birds, bears, wolves, coyotes, humans, and even shrubs and trees. If Chinook disappears, the ecosystem in the Bay will collapse (Tobias, 2020.) The salmon industry alone generates approximately $1 billion for the region and is likely to experience lower fishing yields without additional government intervention (Teh, 2021).

The San Francisco Bay Conservation and Development Commission (BCDC, 2019) has identified 8 specific groups that bay pollutants impact the most: Renters, very low-income, non-U.S. citizens, people with disabilities, communities of color, single-parent households, 65 and older and living alone, and individuals without a high school degree. These groups are mainly located in low-level areas near the Bay, like Oakland, Alameda, and Marin County are at higher risk of polluted groundwater rising as an effect of climate change. Water that rises can have detrimental consequences for human and ecological health by resurfacing hazardous compounds that have been buried underground for years.

This exemplifies how the environmental problem of San Francisco Bay degradation can deepen social inequalities among Bay Area communities.

Why government action is needed?

Only the Federal government can effectively approach the complex environmental problem that San Francisco is currently facing because of the lack of capacities of local and regional authorities to coordinate an integrated approach to the problem. Just at the local level, there are 9 counties and 101 municipalities with jurisdiction on the Bay, which must prioritize local issues and demands. Although the Interim Federal Action Plan was developed to coordinate federal restoration efforts across the watershed, the US Government Accountability Office states that not all entities are using the plan. Many of the federal and non-federal restoration projects are also hindered by stratified efforts (GAO, 2018). In this context, H.R 610 proposes a governance model focused on a centralized program that provides improved coordination and communication across efforts. This is crucial for the long-term restoration, maintenance, and improvements of national environmental efforts.

Proposed Solutions

Water Quality Management	Habitat Restoration	Invasive Species Management	Climate Change Adaptation

1. Water Quality Management

Water Quality Management seeks to reduce the amount of polluted runoff, with a focus on reducing fertilizer runoff and improving urban planning and infrastructure development.

The reduction of fertilizer comes from an adjustment of agricultural practices. The first is no-till farming, which reduces the amount of fertilizer needed by leaving the organic matter in the soil. When a field is tilled, the leftover products from the last harvest such as roots, stems, and leaves are ground and churned, resulting in nutrient susceptibility to wind and water erosion. By allowing the roots to remain as is, nutrients are left in the soil for the following harvest requiring less or no fertilizer for comparable yields (Spears, Stefanie).

Another way to reduce fertilizer use is through the implementation of smart technologies, such as a Global Positioning System (GPS). By taking samples of soil from multiple locations in the field and analyzing how much fertilizer is needed in those specific locations, farmers can then use GPS integrated farming equipment to only spread what is needed and avoid potential overfertilization. Cost reduction due to decreased fertilizer usage will offset technology upgrades (University of Illinois). In addition, vegetative buffers between urban environment streams and waterways as well as infrastructure runoff can help control polluted runoff. Polluted runoff can include anything from gasoline and oil to animal waste or other household chemicals.

Narragansett Bay

Artificial Reef

The Narragansett Bay has struggled with many of the same water quality issues as the San Francisco Bay. Advocacy groups like Save the Bay have teamed up with local volunteers and businesses to help transform certain areas into stormwater capture systems. By building buffers that capture these pollutants, they are held in one place and kept from spreading in an open body of water (Save the Bay).

2. Habitat Restoration

The two methods for restoring habitats in the San Francisco Bay suggested include the restoration of wetlands and the implementation of artificial reefs.

Wetlands serve as an important habitat for many species in the San Francisco Bay but the development involves careful analysis as not all areas are suited for wetland restoration.

Factors such as soil chemistry, amount of rainfall, and tidal inundation are all important factors in determining the feasibility of developing a wetland in that particular area (NRCS). Artificial reefs are also a viable option for biodiversity restoration as they provide habitats for both corals and fish populations. They can be made of wood, cinder blocks, or even old tires but those that are long-lasting are typically made of limestone, steel, or concrete. In addition, these reefs provide economic benefits by attracting divers, snorkelers, and anglers for recreational activities (NOAA).

3. Invasive Species Management

The primary method for Invasive Species management in the San Francisco Bay esturary is use of herbicide.

One example of an introduced invasive species is the non-native Spartina alterniflora, introduced by the U.S. Army Corps of Engineers to spur the recovery of California Ridgway's Rail, a native bird that had previously been in decline (Casazza et al., 2016). After rapid proliferation and an eventual hybridization with a local species, this invasive species began to threaten to turn the wetlands into meadows, eliminating shorebird habitats and pushing native vegetation toward extinction (National Geographic Society, 2012).

Today, the population of invasive Spartina grasses has been reduced by nearly 97% due to the effective use of an herbicide. When applied to plants, herbicides are absorbed by roots and foliage and transported via the phloem and xylem of the plant to its growing region. Herbicides block a specific enzyme that directs the synthesis of certain amino acids which then disrupts protein synthesis and leads to interference of cell growth of stems, roots, and leaves (California Invasive Species Council, 2021). An important component to the effectiveness of these chemicals is the addition of surfactants.

Surfactants are additives that are designed to improve the dispersing, emulsifying, sticking, absorbing, and pest penetrating properties of the spray mixture. They can make herbicides more effective by allowing the chemicals to bind easily to the cuticle of leaves. A common application of surfactants is in bars of soap which allows the soap to effectively reach and clean your skin without being repelled by the water on the surface of your skin (Spartina Project, 2005). While using herbicides is an important solution to invasive plant control and ecological restoration in the Bay, their application must be carefully controlled. Through the eradication of the invasive spartina species, the following findings were generated to guide future efforts:

- *Start with coordinated and assimilated desired future conditions*
- *Establish a clear consensus on baseline conditions*
- *Identify the information needed for management actions. Conduct risk assessments and other surveys*
- *Use projects in alternate area to account for the fact that one method might not work everywhere*
- *Quantify effects and benefits to other ecosystem nearby*
- *Collaborate, sharing data and having consensus on methods used for the restoration project*

(Yahnke et al., 2012).

4. Adaptation to Climate Change

The final offered solutions seek to address rising sea levels along the San Francisco Bay coast. This is a particularly important issue as it appears to disproportionately impact low-income communities who are lacking the infrastructure for protection and the platform to be heard (Stock, Stephen, et al).

As previously mentioned, artificial reefs are a viable solution to rising seas and storm surges as they have been shown to reduce wave energy and strength by 30 to 70 percent (Plumer, Brad).

A second solution to rising sea levels focuses on sediment buildup in wetlands. Wetlands rely heavily on sediment buildup which not only contributes to the area those wetlands constitute (and their overall ability to expand) but also determines the height and type of biota able to grow and thrive in those areas.

Sediment build up in wetlands

The proposed solution to stimulating sediment buildup is via the effective management of local streams and the manual transport of sediment from external locations management of streams that enter into the wetlands is essential as those freshwater sources carry with their sediment and nutrients. This freshwater inflow is an important part of stimulating plant growth and revegetation of tidal wetlands which exhibits a positive feedback loop in regards to sediment retention. As sediment and nutrient-rich freshwater flow from local streams through the wetlands, sediments and nutrients are deposited to the plants in the area, stimulating growth, and leading to denser and larger vegetative areas that can then capture and hold more sediment (San Francisco Estuary Institute, 2015).

The manual transport component of this solution is the physical moving of dredged or excavated sediment into focus areas. Sediment is often removed from the ocean or bay in order to create shipping or flood control channels but can also be imported from local rivers, streams, reservoirs, or other sources (San Francisco Estuary Institute, 2015). A strategic topographic comparison analysis of where sediment is most needed and where it is removed to create channels could lead to a more efficient system of sediment removal.

POTENTIAL IMPACT OF SOLUTIONS CASE STUDY: CHESAPEAKE BAY

The potential of the San Francisco Bay Restoration Program can be seen through an analysis of the Chesapeake Bay Restoration Program. The Chesapeake Bay is the largest estuary in the United States. Located between the northern portion of Maryland and the southern portion of Virginia, it has important features for the ecology and economy of the two states.

Human occupancy had heavy negative impacts on the health of the bay. An example of the negative impact of the development and the flux of habitants is the reduction of crabs and oysters. Nutrient pollution and urban runoff have been identified as agents of water quality decline, leading to the decline of shellfish due to overharvesting.

The Chesapeake Bay Restoration Act of 1979 was the first initiative explicitly created by congress to restore and protect an estuary. It is praised for its successful implementation, mainly through successful collaboration with stakeholders, including federal agencies, state agencies, local governments, academic institutions, businesses, nonprofits, and advocacy groups. Records from 1985 - 2016 have shown positive indicators of successes ranging from reduction of agricultural runoffs in water to acres of shoreline restored.

Relevant findings illustrated the potential positive effects of a coordinated federal program towards an estuary system similar to the San Francisco Bay and the potential impacts the San Francisco Bay Program could ultimately have. Research has attributed this decrease to the efforts of the Program to decrease sewage runoff from the wastewater treatment plants that surrounded the Bay via plant upgrades (Zhang et al., 2018).

Challenges & Controversies of Proposed Solutions

1. **Environmental Dredging**

To remove contaminated sediments, environmental dredging is often utilized. Despite the millions of dollars being spent on environmental dredging projects in Superfund sites and other heavily contaminated areas, this remediation approach raises important scientific issues and controversies to be considered. Calculating the number of contaminated sediments is difficult due to the uneven thickness distribution of contamination, both of which may affect the accuracy of sampling results. Dredging can also cause contaminant release from disturbed sediments into the overlying water through "resuspension" or the transport of contaminated sediments during operations and residual contaminated sediments that remain following operations. Disrupting sediment beds to remove contaminated sediments can expose aquatic organisms to toxic contaminants buried deep within, further affecting water quality and ecosystemic balance. Lastly, there are challenges in measuring changes in environmental conditions, such as contaminant concentrations in water and fish, because these might not occur after remediation of a single area. Environmental dredging is also known to have negative impacts on aquatic ecosystems and wildlife, such as coral reefs.

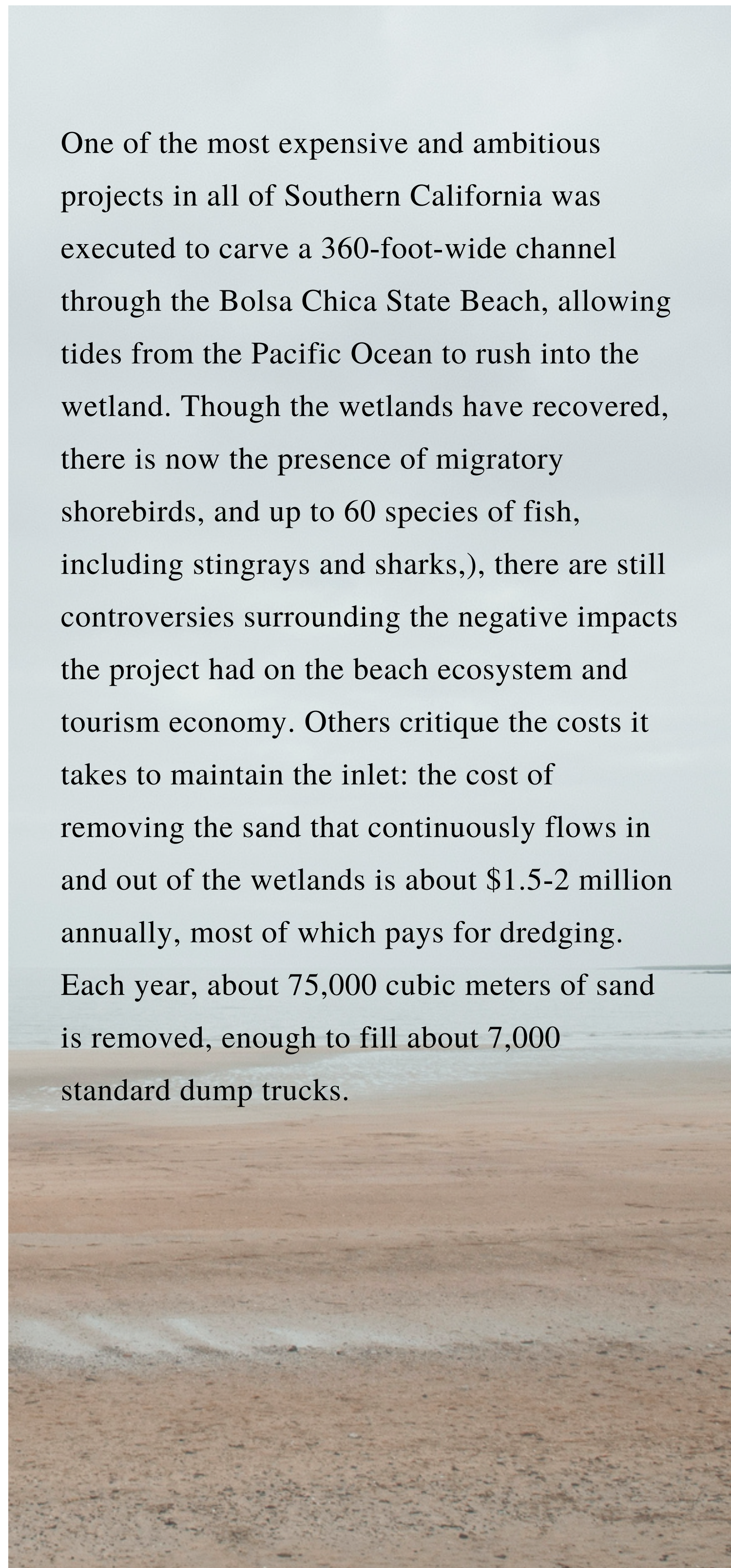
Picture of General Electric dredging in the hudson river

Investigations have concluded that coral polyps undergo significant stress from high suspended-sediment concentrations and the blocking of light necessary for algal symbiosis. Increased sedimentation can also cause smothering and burial of coral polyps, and the shading, tissue necrosis, and population explosion of bacteria within coral mucus (Gustavson K.E, et al., 2008)

2. Habitat Restoration Issues

The success of an ecological restoration project depends on avoiding three main issues: technical failures (lack of scientific information), economic constraints, and social disagreements. An example of disagreement in a proposed wetland restoration project is the carving of channels to allow sea tides back into wetlands, a type of hydrological correction. The objectives are typical to improve waterfowls' ability to feed and shelter themselves, restore wetlands' role as a nursery for fish, foster populations of small marine organisms, and create nesting grounds for rare birds. This approach generates concerns about the many negative possibilities it comes with: increased ocean water turbidity caused by dredged sediment during construction, wetlands becoming more vulnerable to offshore oil spills and other pollution, and destroying nesting areas for marine wildlife.

Others note the possibility of negative social impacts, like the increase of saline groundwater in nearby residential areas and impacts on local economies that depend on beach activities like tourism.



One of the most expensive and ambitious projects in all of Southern California was executed to carve a 360-foot-wide channel through the Bolsa Chica State Beach, allowing tides from the Pacific Ocean to rush into the wetland. Though the wetlands have recovered, there is now the presence of migratory shorebirds, and up to 60 species of fish, including stingrays and sharks,), there are still controversies surrounding the negative impacts the project had on the beach ecosystem and tourism economy. Others critique the costs it takes to maintain the inlet: the cost of removing the sand that continuously flows in and out of the wetlands is about $1.5-2 million annually, most of which pays for dredging. Each year, about 75,000 cubic meters of sand is removed, enough to fill about 7,000 standard dump trucks.

Background Picture: Spartina alterniflora, an aquatic invasive species

3. Controversies on Invasive Species

(1) The problem of Invasive Species

Scientists argue that not all invasive species are destructive, calling for a more nuanced approach to evaluating whether the presence of a species is harmful or beneficial. Some believe that a species' "nativity" depends on subjective timescales and that nowadays, it is virtually impossible to determine what species were native to San Francisco Bay. Additionally, some scientists argue the impact of invasive species should be based on the net biological, social, and economic impacts, disagreeing with methods that focus only on their negative effects (Gbedomon et al., 2020).

(2) The solution to Invasive Species

There is no consensus on the most effective approach. Some suggest the future of environmental management should accept invasiveness in 'novel ecosystems,' rationalizing defeat or conciliation as the morally acceptable course of action in an era of globalization. Some ecologists believe that attempting to restore ecosystems to original conditions is a waste of resources. Others are divided between being reactive (dealing with a settled invasive species through mechanical, biological, or chemical responses) and proactive (preventing invasive species from entering a new area), each of which carries its own controversies.

(3) Biological Control as a solution

Biological control is introducing a natural predator of an invasive species to mitigate its impact. The introduction of any species will always impact the abiotic and biotic components of an ecosystem. The question then becomes whether the positive benefits of that species outweigh any negatives. In 2019, scientists gathered evidence on effective biological control in invasive weed in North America. With approximately 350 documented releases of different types of species in North America, over 40 of them (about 11.4%) have been determined to have attacked non-target organisms.

In cases where animal biological controls were used to eradicate a certain species of plant, 89% of non-target attacks were to plants in the same family of the target plant. Of the species analyzed, about 15% spread to new, unintended regions and eventually colonized. What this analysis denotes for San Francisco Bay is that biological control is a risky endeavor. While it may have applications in eradicating one species, there is a strong chance that it may have negative impacts on other surrounding species, particularly if the surrounding biota is similar to that target species.

With the 350 documented release of species in North America, 11.4% attacked non-target organisms, 15% spread to new, unintended regions.

4. Controversies on Climate Change Adaptation Measures

Tidal gates are a common flood prevention structure for low-lying communities in the tidal zone. Tidal gates close during incoming (flood) tides to prevent tidal waters from moving upland and they open during outgoing tides to allow upland water to flow into the receiving body of water. This solution has many issues related to physical and biological negative impacts on estuaries like the San Francisco Bay. Physical effects of tidal gates include elimination of upland tidal flooding and changes in the velocity, turbulence, and pattern of freshwater discharge that fluctuates between water stagnation and flushing flows.

In turn, these changes in the circulation of water between both sides of a dike cause alterations in water temperatures, soil moisture content, sediment transport, and channel morphology. The biological effects of tide gates are related to changes to the composition of aquatic plants and obstacles to fish migration. As an example, estuaries play a critical role in juvenile salmon (like the Chinook Salmon present in San Francisco Bay) survival transitioning from fresh to saltwater by providing a productive feeding area, a refuge from marine predators, and more. Finally, tidal gates don't foster bayland ecosystems to increase their resilience, which some scientists suggest is the key to handling sea level rise.

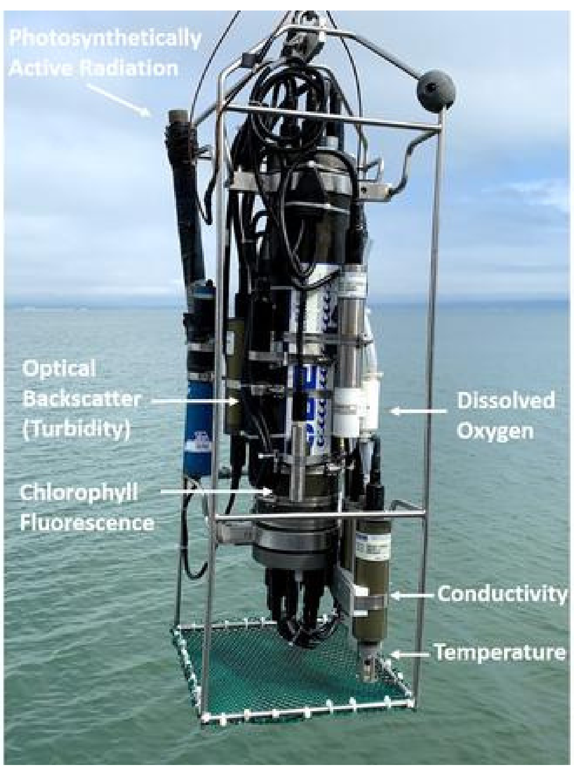
Picture of The Palo Alto Tide Gate Structure

Measuring Success

1. Water Quality Improvements

(1) Measurements in place

Federal measurement and monitoring of water quality in the San Francisco Bay began in 1969, with the installation of the first United States Geological Survey station dedicated to the Bay. Over time, the network of USGS sites has expanded to over 40 measuring stations across the bay and estuary system charting indicators, including microbial biogeochemistry, the bioaccumulation and cycling of contaminants including petroleum hydrocarbon, metals, mercury, PCBs, and selenium, trends in disturbances by introduced species, ecosystem metabolism, phytoplankton communities, and zooplankton ecology (Schraga and Cloern, 2017).



A Conductivity, Temperature, and Depth (CTD) instrument package

(2) Indicators of Success

Currently, at the federal level, there is no uniformly established threshold for water quality success in a large wetland ecosystem. Instead, the EPA simply offers a framework for how to create a water quality standard at the state level. As such, the indicators of water quality success in the bay have been set via the California State Resources Board. The Board sets quality standards for all California marine ecosystems, which also applies to the Bay estuary system. Examples of these quality standards are listed below.

Marine Water Quality Objectives for Toxic Pollutants for Surface Waters (all values in ug/l)

Compound	4-day Average	1-hr Average
Arsenic[b, c, d]	36	69
Cadmium[b, c, d]	9.3	42
Chromium VI[b, c, d, e]	50	1100
Copper[c, d, f, l]		
Cyanide[g]		
Lead[b, c, d]	8.1	210
Mercury[h]	0.025	2.1
Nickel[b, c, d, l]	8.2	74
Selenium[i]		
Silver[b, c, d]		1.9
Tributyltin[j]		
Zinc[b, c, d]	81	90
PAHs[k]		

2. Wetland Protection

(1) Measurements in place

A key indicator of wetland protection used in the San Francisco bay is the total acreage of functioning wetland. This indicator has been tracked by multiple government agencies already working to restore the bay including the San Francisco Bay Estuary Partnership (SFBEP) and the San Francisco Bay Restoration Authority (SFBRA).

A 2019 report from the SFBEP, for example, documented 78,000 total acres of wetlands and marshlands in the bay compared to the estimated 360,000 acres of wetlands in 1800. The same report also estimated the growth of 1,800 acres of wetlands acreage between 2015 and 2019 thanks in large part to the restoration efforts of local authorities.

(2) Indicators of Success

A long-standing benchmark for success in wetland protection and restoration has been the goal of reaching 100,000 acres of wetland coverage in the bay set in the 1999 Baylands Ecosystem Habitat Goals Report. This value has served as a guidepost particularly for the efforts of the SFBEP and their measurement of success in wetlands protection. Thus far, SFBEP has accomplished 12% of their bay-wide restoration goal and 65% of their delta restoration goal to restore 8,000 acres of wetlands.

South Bay salt ponds before and after restoration

(3) Results and Analysis

The current framework for measuring wetland protection and success is rather singular and needs to be expanded under HR 610 and the Bay Office's eventual initiatives. While total wetland coverage and total wetland restoration are important metrics, they fail consider important complementary influencers of wetland health such as prevalence of nonnative species, the amount of human interference in the system (via pipelines, litter, and artificial channels), and water flow rates into and out of the wetlands. The heightened presences of nonnative and human interference, and decreased water flow rates could each have deleterious impacts on the health of a wetland and are currently not considered in the bay's wetlands analysis.

3. Invasive Species Eradication

(1) Measurements in place

The Invasive Spartina Project (ISP) was established in 2000 with the intention of addressing the widespread effects of invasive species. The state-led Coastal Conservancy and Federal-led US Fish and Wildlife Service (USFWS) focused on restoring tidal marsh habitats for species, such as the salt marsh harvest mouse and migratory waterfowl. The process of invasive species eradication started in 2005, with efforts implemented and documented by the aforementioned agencies.

(2) Indicators of Success

According to the 2017-2018 Monitoring and Treatment Report, the area of the Bay covered by the ISP project is 70,000 acres. On this acreage, The USFWS has successfully dealt with various invasive species. For instance, one example is the sabellid worm parasite, which was infecting abalone across the bay. With the use of mechanical control, USFWS was able to completely eradicate the sabellid worm population (confirmed by biological surveys conducted a decade later).

Normal and infested farmed red abalone

(3) Results and Analysis

Existing partnerships between numerous stakeholders, including local, state, federal, and private members of all 9 counties, have contributed towards the project's completion since 2019. The San Francisco Bay Area Inventory and Monitoring Network recently introduced an early action monitoring system that signals the presence of a new invasive species. This network is likely to reduce the number of invasive species entering the bay annually.

4. Adaptation to Climate Change

(1) Measurements in place

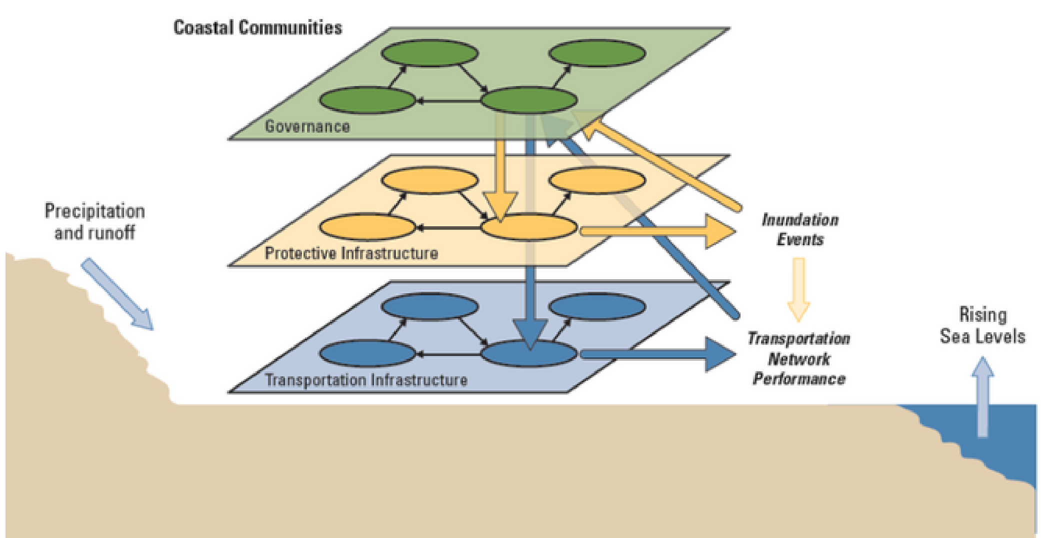
Shore resilience is of high importance for coastal communities, and Resilient Infrastructure as Seas Rise (RISeR) is working with various stakeholders to ensure equitable coastline buffering. RISeR recently developed a new and advanced sea-level rise modeling system in San Francisco Bay. The system incorporates hydrodynamic processes to:

- Map the most vulnerable coastlines in the bay.
- Analyze where redirected water from buffered coastlines will travel.

Through this multi-layered analysis, RISeR ensures that buffering against the sea-level rise in one district will not lead to greater inundation in other areas.

(2) Indicators of Success

After completing their initial assessment of the San Francisco Bay, RISeR created a report indicating how they would incorporate their learnings to transform transportation infrastructure, protective infrastructure, and governance in place. RISeR coordinates these efforts with the assistance of educators at the University of California, Berkeley, USGS, and The San Francisco Stakeholder Advisory Group.



CONCLUSION

> *H.R.610 improves coordination from San Francisco to Washington DC as it revives our wetlands to protect our coastal communities, improves our water quality, strengthens our climate resilience, including by combating sea level rise.*
>
> Nancy Pelosi, Floor Speech on H.R. 610

The San Francisco Bay Restoration Act, H.R.610, will provide federal funding for the maintenance of the San Francisco Bay Estuary. It will increase the coordination between government and local partners to reinforce existing and new projects that establish more natural shorelines and healthier ecosystems.

The proposed solutions include stronger pollution regulation, habitat restoration, invasive species management, and climate change adaptation. They will improve water quality, increase the acreage of functioning wetlands, protect native species, and build coastal resilience.

H.R. 610 will support the recovery of an ecologically significant area to fully support the wild species, human communities, and industries that rely on it. If implemented appropriately, the San Francisco Bay Restoration Act will be a significant step towards an equitable restoration of the bay.

REFERENCES

California Invasive Plant Council. (2021, August 09). Invasive Spartina eradication. Retrieved August 10, 2021, from *https://www.cal-ipc.org/project/invasive-spartina-eradication/#:~:text=To%20date%2C%20the%20overall%20population,acres%20of%20Ridgway's%20rail%20habitat.*

California State Lands Commission, U.S. Fish and Wildlife Service, “EIR/EIS for the Bolsa Chica Lowlands Restoration Project”

Casazza, M. L., Overton, C. T., Bui, T. D., Hull, J. M., Albertson, J. D., Bloom, V. K., . . . Takekawa, J. (2016). Endangered species management and ecosystem restoration: Finding the common ground. Ecology and Society, 21(1). doi:10.5751/es-08134-210119

Comin, F. A., Menendez, M., Pedrocchi, C., Moreno, S., Sorando, R., Cabezas, A., . . . Ciancarelli, C. (2005). Wetland restoration: INTEGRATING SCIENTIFIC-TECHNICAL, economic, and social perspectives. Ecological Restoration, 23(3), 182-186. doi:10.3368/er.23.3.182

EcoAtlas SFBRA Dashboard. (n.d.). Retrieved July 30, 2021, from *https://www.ecoatlas.org/dashboard/sfbraDashboard.php*

Environmental Protection Agency. (2021). EPA-About a Watershed. Retrieved August 09, 2021, from *https://www.epa.gov/sfbay-delta/about-watershed*

Francingues, K. E., & Wolfe, J. D. (2008). Evaluating the effectiveness of contaminated-sediment dredging. Environmental Science & Technology, 42(14), 5042-5047. doi:10.1021/es087185a

National Academies Press, N. (2007). Sediment Dredging at Superfund Megasites: Assessing the Effectiveness. Retrieved from *https://semspub.epa.gov/work/HQ/174467.pdf*

Sea Grant Oregon State University. (2004). “The Effects of Tide Gates on Estuarine Habitats and Migratory Fish”. Retrieved from *https://seagrant.oregonstate.edu/sites/seagrant.oregonstate.edu/files/sgpubs/onlinepubs/g04002.pdf*

Gbedomon, R., Salako, V., & Schlaepfer, M. (n.d.). Diverse views among scientists on non-native species. Retrieved August 10, 2021, from *https://doi.org/10.3897/neobiota.54.38741*

Hinz, H. L., Winston, R. L., & Schwarzländer, M. (2019). How safe is weed biological control? A Global review of direct Nontarget Attack. The Quarterly Review of Biology, 94(1), 1-27. doi:10.1086/702340

Improving water quality. (2018, November 09). Retrieved August 10, 2021, from *https://www.savebay.org/bay_issues/water-quality/.*

Invasive plants early DETECTION (U.S. National PARK SERVICE). (n.d.). Retrieved August 10, 2021, from *https://www.nps.gov/im/sfan/invasive-plants.htm*

Kvasnicka, J., Burton, G. A., Semrau, J., & Jolliet, O. (2020). Dredging contaminated sediments: Is it worth the risks? Environmental Toxicology and Chemistry, 39(3), 515-515. doi:10.1002/etc.4679

Mellen, G. (2016, August 24). 10 years after Bolsa chica inlet Opened, funds to maintain it are drying up. Retrieved August 10, 2021, from *https://www.ocregister.com/2016/08/24/10-years-after-bolsa-chica-inlet-opened-funds-to-maintain-it-are-drying-up/*

National Geographic Society. (2012, October 15). Ecosystem invaders: Spartina. Retrieved August 10, 2021, from *https://www.nationalgeographic.org/article/ecosystem-invaders-spartina/.*

REFERENCES

Opinion: "novel ecosystems" are a trojan horse for conservation. (n.d.). Retrieved August 10, 2021, from *https://ensia.com/voices/novel-ecosystems-are-a-trojan-horse-for-conservation/*

Palo Alto Flood Basin Tide Gate Structure Replacement Project. Santa Clara Water Valley. (n.d.). Retrieved June, 2020, from *https://www.valleywater.org/sites/default/files/Palo%20Alto%20Flood%20Basin%20Tide%20Gate%20Structure%20Replacement%20Project_fact%20sheet.pdf.*

Plumer, B. (2014, May 14). Want to protect cities from the rising seas? Try coral reefs. Retrieved August 10, 2021, from *https://www.vox.com/2014/5/14/5714440/coral-reefs-protect-cities-flooding-storms*

RISER SF Bay. (n.d.). Retrieved August 10, 2021, from *http://riser.berkeley.edu/*

San Francisco Bay Estuary Institute (2005, May 4). Use of Imazapyr Herbicide to Control Invasive Cordgrass (Spartina spp.) in the San Francisco Estuary. Retrieved from *https://spartina.org/referencemtrl/SF-Imazapyr-EA.pdf.*

Zhang, Qian, Rebecca R. Murphy, Richard Tian, Melinda K. Forsyth, Emily M. Trentacoste, Jennifer Keisman, and Peter J. Tango. pg 1617. 2018. “Chesapeake Bay’s Water Quality Condition Has Been Recovering: Insights from a Multimetric Indicator Assessment of Thirty Years of Tidal Monitoring Data.” Science of The Total Environment 637–638 (October): 1617–25. *https://doi.org/10.1016/j.scitotenv.2018.05.025.*

Yahnke, A. E., Grue, C. E., Hayes, M. P., & Troiano, A. T. (2012). Effects of the HERBICIDE Imazapyr on juvenile Oregon spotted frogs. Environmental Toxicology and Chemistry, 32(1), 228-235. *doi:10.1002/etc.2048*

US EPA, O. (2017, November 2). Wetlands [Reports and Assessments]. *https://www.epa.gov/report-environment/wetlands*

Society of Ecological Restoration “USA:California Restoring Bolsa Chica Lowlands Restoration Project” . *https://www.ser-rrc.org/project/usa-california-restoring-bolsa-chica-wetlands/#:~:text=Key%20Lessons%20Learned-,The%20Bolsa%20Chica%20wetland%20restoration%20was%20the%20largest%20coastal%20wetland,of%20the%20Bolsa%20Chica%20Wetlands,The%20Bolsa%20Chica%20wetland%20restoration%20was%20the%20largest%20coastal%20wetland,of%20the%20Bolsa%20Chica%20Wetlands*

Stephen Stock, R. (2020, February 26). 'Unlike any disaster we have EVER SEEN,' SAYS state agency about rising seas in Bay Area. Retrieved August 10, 2021, from *https://www.nbcbayarea.com/investigations/unlike-any-disaster-we-have-ever-seen-says-state-agency-about-rising-seas-in-bay-area/2236314/.*

San Francisco Baykeeper. (n.d.). Controlling Urban Storm Water Pollution, Retrieved June 13, 2021, *from https://baykeeper.org/our-work/controlling-urban-storm-water-pollution*

Toxic pollutants and chemicals of concern. (2021, April 30). Retrieved from *https://baykeeper.org/our-work/toxic-pollutants-and-chemicals-concern*

US EPA, O. (2016, May 5). Templates for Developing Wetland Water Quality Standards [Data and Tools].

“Floor Speech on H.R. 610, the San Francisco Bay Restoration Act.” 2021. Press Release. Nancy Pelosi, Speaker of the House. https://www.speaker.gov/newsroom/61521-2.

Cloern, James E., and Alan D. Jassby. 2012. “Drivers of Change in Estuarine-Coastal Ecosystems: Discoveries from Four Decades of Study in San Francisco Bay.” Reviews of Geophysics 50 (4): RG4001. https://doi.org/10.1029/2012RG000397.

REFERENCES

Environmental Protection Agency (2012) Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: EPA's Action Plan

Environmental Protection Agency (2021) About a Watershed. Retrieved August 09, 2021, from https://www.epa.gov/sfbay-delta/about-watershed

Tobias, J. (2020, April 21). The Extinction Crisis Devastating San Francisco Bay. Retrieved June 13, 2021, from https://www.thenation.com/article/environment/extinction-san-francisco-bay/

Choksi, Sejal. "The Hostile Takeover of San Francisco Bay." San Francisco Baykeeper, May 2009, https://baykeeper.org/news/column/hostile-takeover-san-francisco-bay.

Moore, J. D., Marshman, B. C., Robbins, T. T., & Juhasz, C. I. (2013). Continued absence of sabellid fan worms (Terebrasabella heterouncinata) among intertidal gastropods at a site of eradication in California, USA. CALIFORNIA FISH AND GAME, 99(3), 7.

Klivans, L. (2020). Groundwater Beneath Your Feet Is Rising With the Sea. It Could Bring Long-Buried Toxic Contamination With It. KQED. Retrieved June 11, 2021, from https://www.kqed.org/science/1971582/groundwater-beneath-your-feet-is-rising-with-the-sea-it-could-bring-long-buried-toxins-with-it

US Government Accountability Office (2018) "San Francisco Bay Delta Watershed: Wide Range of Restoration Efforts Need Updated Federal Reporting and Coordination Roles"

Capriotti, Martina. "Microplastics as Carriers of Endocrine Disruptors." Earthzine, 23 Apr. 2020, https://earthzine.org/microplastics-as-carriers-of-endocrine-disruptors/.

Rogers, Paul. "Things You Do Every Day Are Causing Trillions of Pieces of Microplastic to Flow into San Francisco Bay." The Mercury News, The Mercury News, 2 Oct. 2019, www.mercurynews.com/2019/10/02/7-trillion-pieces-of-microplastic-wash-into-san-francisco-bay-every-year-new-study-shows/.

Sejal, C.-C. (2015). Bay Crossings Column. Retrieved June 13, 2021, from https://baykeeper.org/news/column/global-climate-change-already-affecting-san-francisco-bay

Bp_ch3+tables.pdf. (n.d.). Retrieved July 30, 2021, from https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/basinplan/web/docs/bp_ch3+tables.pdf

BCDC - The San Francisco Bay Estuary. (n.d.). San Francisco Bay Conservation & Development Commission. Retrieved June 11, 2021, from https://www.bcdc.ca.gov/bay_estuary.html

Rogers, P. (2019, October 2). Things you do every day are causing trillions of pieces of micro-plastic to flow into San Francisco Bay. The Mercury News. Retrieved June 11, 2021, from https://www.mercurynews.com/2019/10/02/7-trillion-pieces-of-microplastic-wash-into-san-francisco-bay-every-year-new-study-shows/

Teh, C. (2021). California Releasing 17 Million Salmon Into the SF Bay to Boost Economy. Retrieved June 13, 2021, from https://www.insider.com/california-release-salmon-into-sf-bay-boost-fishing-industry-2021-6

GRAPHICS ACKNOWLEDGEMENTS

Abalone diseases and pests. [Photograph] CDFW Prod. (n.d.). https://wildlife.ca.gov/Conservation/Laboratories/Shellfish-Health/Abalone-Diseases.

Barrientos, J. (2015, December 2). Photo by Joseph Barrientos on Unsplash. [Photograph] Beautiful Free Images & Pictures. https://unsplash.com/photos/Ji_G7Bu1MoM.

Brown, T. (2020, August 6). New book about saving narragansett bay. [Photograph] Rhode Island Monthly. https://www.rimonthly.com/new-book-about-saving-narragansett-bay/.

Bolton, C. (2019, April 25). Polar bear drowning. [Photograph] Poetry for Healing. https://poetryforhealing.com/2019/04/25/polar-bear-drowning/.

Bolsa Chica BEACH Campground. Bolsa Chica Beach Campground - Orange County. [Photograph] (n.d.). http://www.californiasbestcamping.com/socal_beaches/bolsa_chica.html.

Felver, R. (n.d.). Chesapeake Bay water quality INCHES toward a new record. [Photograph] Chesapeake Bay Program. https://www.chesapeakebay.net/news/blog/chesapeake_bay_water_quality_inches_toward_a_new_record

Goldberg, T. (2020, December 23). State investigates SECOND OUTAGE-CAUSED Ebmud sewage spill in months. [Photograph] KQED. https://www.kqed.org/news/11852567/state-investigates-second-outage-caused-ebmud-sewage-spill-in-months.

Golden gate Bridge. Ambrosia. (n.d.). [Photograph] https://ambrosiamag.com/products/golden-gate-bridge.

Ian, T. (2019, June 10). Photo by The Ian on Unsplash. [Photograph] Beautiful Free Images & Pictures. https://unsplash.com/photos/jdDs4BHIvEk.

LSU. (n.d.). Louisiana state University. [Photograph] New Study Shows Rapid Marsh Channel Bank Sediment Build Up Does Not Equate Land Loss Resilience. https://www.lsu.edu/mediacenter/news/2016/05/09oceanography_geologymariotti.as.php.

Lutz, S. J. (1970, January 1). Wetland restoration in CA and blue carbon. [Photograph] Wetland Restoration in CA and Blue Carbon. http://bluecarbonblog.blogspot.com/2011/09/wetland-restoration-in-ca-and-blue.html.

Mckinley, J. (2016, September 8). G.E. spent years cleaning up the Hudson. was it enough? [Photograph] The New York Times. https://www.nytimes.com/2016/09/09/nyregion/general-electric-pcbs-hudson-river.html.

Noaa. (2019, July 1). Photo by NOAA on Unsplash. [Photograph] Beautiful Free Images & Pictures. https://unsplash.com/photos/Z2gm_Ml_qzk.

Rashtipour, S. (2018, April 24). Photo by sasan RASHTIPOUR on Unsplash. [Photograph] Beautiful Free Images & Pictures. https://unsplash.com/photos/IPk2WD-kglo.

SF Bay Microplastics. 5Gyres.org. (n.d.). https://www.5gyres.org/sfbay-microplastics.

Tamminen, T. (2021, March 20). Op-Ed: California needs to repeat history by passing new clean water laws. [Photograph] Los Angeles Times. https://www.latimes.com/opinion/story/2021-03-20/california-nation-clean-water-laws.

Valley Water News. (2020, June 15). Palo Alto TIDE gates, which prevent flooding in low-lying areas On peninsula, to be replaced. [Photograph] Valley Water News. https://valleywaternews.org/2020/06/15/palo-alto-tide-gates-which-prevent-flooding-in-low-lying-areas-on-peninsula-to-be-replaced/.

Wikimedia Foundation. (2021, July 9). Golden gate Bridge. [Photograph] Wikipedia. https://en.wikipedia.org/wiki/Golden_Gate_Bridge.

Wikimedia Foundation. (2021, May 19). Delta smelt. [Photograph] Wikipedia. https://en.wikipedia.org/wiki/Delta_smelt.

Wikimedia Foundation. (2021, July 28). San Francisco Bay. [Photograph] Wikipedia. https://en.wikipedia.org/wiki/San_Francisco_Bay.

Riser, Berkeley, http://riser.berkeley.edu/

Rebecca Fu, 2021 [Table of Contents]