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A FLOATING WETLAND HANDBOOK

for
SAN FRANCISCO'S
SOUTHEAST WATERFRONT

ABOUT THIS HANDBOOK

This study was completed during the Piero N. Patri Fellowship for Urban Design, 2014. Piero N. Patri, FAIA (1929-2006), a notable architect, urban designer and planner, born and raised in San Francisco, dedicated his life to his work and to the improvement of the city. In honor of Piero's commitment to good planning and urban design, his family established the endowed Piero N. Patri Fellowship in 2006. Major contributors included Patri-Merker Architects and many of Piero's friends, clients, and colleagues. Piero was the first chair of the SPUR Environmental Design Committee, and in 1961, was the principal author, along with a team including his brothers Remo and Tito, of one of SPUR's first community plans: The Montgomery Center Plan. This plan was a visionary scheme that rethought the interconnection of the Financial District to the city.

In the last years of his life, Piero proposed a parkway through the central and southeastern neighborhoods of San Francisco. Such a parkway would connect these under-served neighborhoods to the Embarcadero, promote economic development and housing potential, and would provide public accessibility to, and enjoyment of the scenic southeastern waterfront. Piero's goals aligned with a vision for the Blue Greenway, a waterfront and recreational boat trail, originally developed by the Neighborhood Parks Council (NPC) and SPUR. NPC, the Mayor's Blue Greenway Task Force, and the Port of San Francisco's Blue Greenway Project have further developed Piero's vision into the Blue Greenway Planning and Design Guidelines.

This handbook is the result of the eighth annual Patri Fellowship completed during the summer of 2014 by Andrea Haynes. By exploring the ecological, aesthetic, and recreational benefits possible through floating wetlands, this project continues the work of previous fellows in finding creative solutions to the challenges faced by San Francisco's southeast neighborhoods. Andrea Haynes completed her Master's of Landscape Architecture degree at Cornell University just prior to embarking on the Patri Fellowship.

Many thanks to the Patri family, the Patri Fellowship Committee and to SPUR, AECOM San Francisco, Bionic Landscape, and the Port of San Francisco for their generous support.

For BCDC application: Commission has 30 days to determine if the application is complete Commission then has up to 90 days to approve or deny a complete application, Complete administrative permit applications are typically processed in about five to eight weeks.

For more information on the WQCB permitting process, see http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml. WQCB does accept the JARPA form and requires a $640 deposit against total fee to be assessed (total fees for restoration projects are $640)

PAGE 32 Species suggestions courtesy of the knowledgeable and experienced wetland restoration staff of Save the Bay. Bay Natives Nursery is one potential source for plant material

THANKS TO

THE PATRI FELLOWSHIP COMMITTEE:
TITO PATRI, LANDSCAPE ARCHITECT
JOHANNA PATRI, LAND USE PLANNER
DAVID STEIN, LAND USE PLANNER
SCOTT PRESTON, AECOM DESIGN + PLANNING
PATRICIA FONESCA, AECOM DESIGN + PLANNING
HOGAN EDELBERG, AECOM DESIGN + PLANNING
NOAH CHRISTMAN, SPUR
KRISTY WANG, SPUR
MARCEL WILSON, BIONIC LANDSCAPES
SARAH MOOS, BIONIC LANDSCAPE
DAVID BEAUPRE, PORT OF SAN FRANCISCO

CAROL BACH, PORT OF SAN FRANCISCO
ROANA TIRADO, LANDSCAPE DESIGNER/PLANNER, PATRI FELLOW 2013
EMILY FRYER, ECO CENTER
DANIEL PROSTAK, UC BERKELEY, MASTER OF LANDSCAPE ARCHITECTURE 2014
LADDIE FLOCK AND NIKKI ARELLANO, FLOATING ISLANDS WEST

FOR ADDITIONAL COPIES OF THIS HANDBOOK, PLEASE SEE SPUR'S WEBSITE FOR A DOWNLOADABLE, PRINT-YOUR-OWN PDF (www.spur.org/spur-program/community-planning/piero-n-patri-fellowship)

Book set in Mission Gothic font, created by James T. Edmondson and inspired by hand painted signs of the Mission District

APPENDIX

REFERENCES & MORE INFORMATION

PAGE 3-4 All images from foundsf.org except last image of Hunter's Point Power Plant, by Lance Tyson for The Chronicle

PAGE 6 For more information on the progress of the Blue Greenway, see http://sfport.com/index.aspx?page=1433

PAGE 7-8 Bird enthusiasts interested in learning more about San Francisco's local species can download *A Field Guide to 100 Birds of Heron's Head* from http://sfport.org/index.aspx?page=221

PAGE 11-12 Manufacturers of floating wetland products: Floating Islands International, west coast territory office is Floating Wetlands West (866-798-7086, floatingislandswest.com). Beemats (386-428-8578, beemats@gmail.com, beemats.com). Both manufactures websites include additional multiple case studies, installation information specific to their products and scientific reports. Tidal range as measured at Hunter's Point is 9.9', before installing a project, measurements should be taken at selected site, local bathymetry may mean tidal range differs from station measurements

PAGE 13 Martin's Ecosystems, Baton Rouge, LA have installed and overseen the coastal Louisiana Projects, martinecosystems.com. See wetlandsbaltimore.com for status updates on future expansion of Baltimore's floating wetlands.

PAGE 15-16 Water depths based on NOAA soundings map, available at nauticalcharts.noaa.gov, shallow water definition of under 20' also based on NOAA's guidelines

PAGE 21-22 For more information about the programs at the EcoCenter see ecocenterhhp.org. Sea level rise projections based on National Research Council's Upper Limit predictions for sea level rise and mapping tools at climatecentral.org

PAGE 25 The longest standard size for sea kayaks is 19'

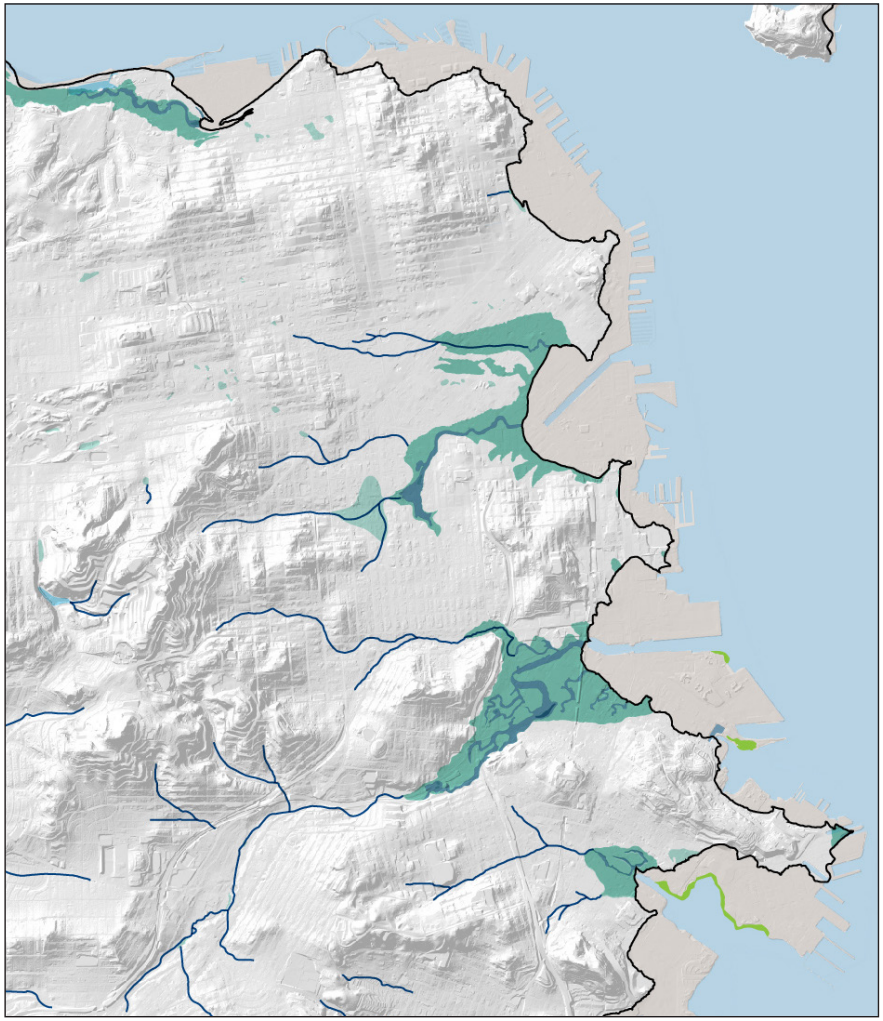
PAGE 31 For instructions and helpful guidelines for filling out JARPA permitting paperwork, see http://www.sfestuary.org/wp-content/uploads/2012/12/JARPA-Instructions-final-1106_1.pdf

For submission to Army Corp of Engineers be aware that prior to completing permit application, the party overseeing project or their representative must attend one of the bi-monthly pre-application meetings (also via teleconference) conducted by the District, a District staff person will assign the proposed activity an identification number to be used on permit application. Once complete application is submitted, typically 15 days for review

CONTENTS

HISTORY OF THE SOUTHEAST WATERFRONT
the evolution of a landscape

San Francisco's waterfront looked very different 250 years ago. Prior to European settlement, there were abundant creeks, tributaries, and marsh lands. By 1950, 137,000 acres of waterfront marsh had been filled and developed and 90% of the wetlands were gone. Today, there are only about 40 acres of restored wetland along the southeast waterfront and the many creeks are all mostly culverted and buried.



HISTORIC MARSH
FILLED LAND
RESTORED MARSH

ESTABLISHMENT PERIOD

As with the installation of any plants, an establishment period of higher vulnerability must be planned for. The first three weeks should be considered the establishment period where closer monitoring of plant health should be done. Daily visual assessment should be sufficient for determining whether plant roots are successfully reaching the water level.

With some existing products, coconut fiber or peat based potting mix is put in pre-cut planting holes. After one watering from above at installation, no other watering is necessary as the potting mix wicks water upward to the plant roots. Other systems may vary and testing should be conducted to ensure the best possible rate of plant success before embarking on a large project.

MAINTENANCE

A maintenance plan should be a part of any floating wetland design before installation is even begun. Depending on water depth, maintenance personal need to access all above, and below the water line floating wetland elements in waders, via boat and/or by diving. The following should be planned for:

PERIODIC INSPECTION TO CONFIRM INTEGRITY OF ALL SUBMERGED HARDWARE AND ANCHOR OR ABOVE WATER TETHERING

HEALTH OF PLANTS AND REPLANTING WHERE NECESSARY

REMOVAL OF DEBRIS BOTH MAN-MADE AND NATURAL

PERIODIC INSPECTION FOR SIGNS OF DEGRADATION OF BASE MATERIAL, MECHANICAL (TEARING) OR UV DAMAGE (DISCOLORATION)

POTENTIAL PROJECT PARTNERS

Some of the potential organizations project leaders could explore a partnership with:

SAVE THE BAY
SF BAY RESTORATION AUTHORITY
SF ESTUARY INSTITUTE
SF PORT AUTHORITY
SF DEPT OF PUBLIC WORKS
BAY KEEPERS
BAY ACCESS
GOLDEN GATE AUDUBON SOCIETY
USGS
US FISH & WILDLIFE SERVICE
SAN FRANCISCO RECREATION & PARKS DEPT.
KAYAKS UNLIMITED
CITY KAYAK
BAY INSTITUTE/THE ECOCENTER
BAYVIEW NEIGHBORHOOD ASSOC.
BAYVIEW BOAT CLUB
LITERACY FOR ENVIRONMENTAL JUSTICE

7 COST, CARE, & MAINTENANCE

COST

Total project costs will, of course, vary widely depending on the size and complexity of a floating wetland project. Costs for design, planning, permitting and installation labor will also vary widely and estimates of hard costs are only given below. Decking and integrated docks are also not included.

FLOATING WETLAND BASE MATERIAL	$4-$32 per square foot, depending on supplier
ATTACHMENT HARDWARE/ANCHORS	included in base price by some manufacturers, otherwise, estimated at $5 per sq ft
PLANTS	approx. $5 per sq ft
SOIL/PLANTING MEDIUM	less than $1 per sq ft
TOTAL ESTIMATED RANGE	$15-38 per sq ft

INSTALLATION

Installation requirements will also vary widely given the size, complexity, water depth, location, and anchoring type. Some considerations for each condition type:

CHANNELIZED CREEKS: small human powered boats should be sufficient to tow out wetlands, divers may be necessary for installing anchors

SHALLOW WATER: if installed during low tide, only waders would likely be necessary for bringing wetland islands into place and for securing anchors

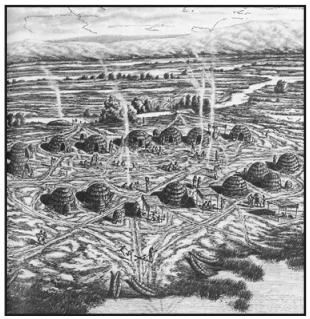
DEEP WATER: a larger, motorized boats would be required to tow wetlands into place and to support divers and equipment for heavy duty anchoring

UNUSED DOCKS: depending on depth and anchoring vs tethering, divers may or may not be needed, wetland islands would likely be towed by small craft and secured to docks from them

"Almost the entire bay is fringed with a belt of tide-land, salicornia marsh, which attains a width of from three to five miles at the extremities and is absent only in the constricted central portion."

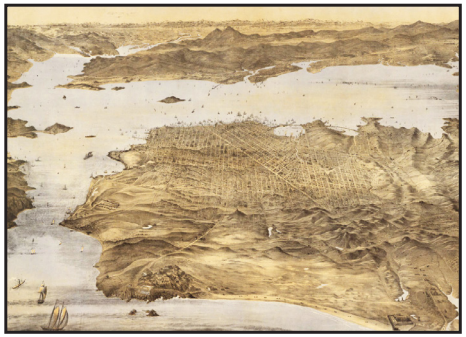
--N.C. Nelson, 1909
University of California
Archaeologist

CHANGES TO THE SOUTHEAST WATERFRONT 1700-PRESENT



pre-1700's

Prior to European settlement, the Yelamu people are believed to have had seasonal fishing and hunting settlements along the waterfront, particularly in wetlands near Mission and Islais Creeks where the birds and sea life were abundant



1848

The population explosion caused by the Gold Rush meant huge increases in commerce, building, and shipping infrastructure along the waterfront

1869

Hundreds of acres of marsh lands were filled for new housing development to accommodate the rapidly increasing population, 'waterlots' were sold before they had even been filled in the land rush

1910

Islais Creek, among other fresh water creeks, provided irrigation for crops but eventually became polluted by sewage and were culverted and buried

SIMPLIFYING THE PROCESS

The current permitting process considers wetland restoration projects, and floating wetlands, to be 'fill' in the Bay. The legacy of land fill for the sake of development that damaged ecosystems has led to a permitting process that is irrelevant for projects whose primary purpose is restoration. A reassessment of this process, could encourage the completion of more projects. A more streamlined and approachable process would also encourage community groups to take the lead on future restoration projects.

PILOT PROJECT

An important step that would need to be undertaken before any sizable floating wetland project can be implemented in San Francisco Bay is a pilot project. To date, there have not been any salt water projects in the San Francisco area (that the author is aware of). San Francisco's unique climate and the additional complexity of salt water points to the need for a pilot project to test plant species that could successfully be used for floating wetlands.

Plant species that should be tested in a pilot project include:

+++*SARCOCORNIA PACIFICA*
COMMON PICKLEWEED

++*JAUMEA CARNOSA*
FLESHY JAUMEA

++*DISTICHLIS SPICATA*
SALT GRASS

++*FRANKENIA SALINA*
ALKALI HEATH

+*GRINDELIA STRICTA*
MARSH GUMPLANT

+*TRIGLOCHIN MARITIMA*
SEASIDE ARROW GRASS

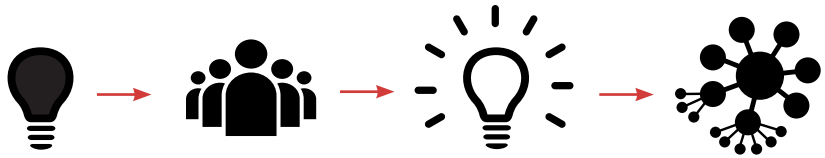
+*SUAEDA CALIFORNICA*
CALIFORNIA SEABLITE
(critically imperiled species)

+++HIGHLY RECOMMENDED
++RECOMMENDED
+QUESTIONABLE BUT SHOULD BE TESTED

6 IMPLEMENTATION

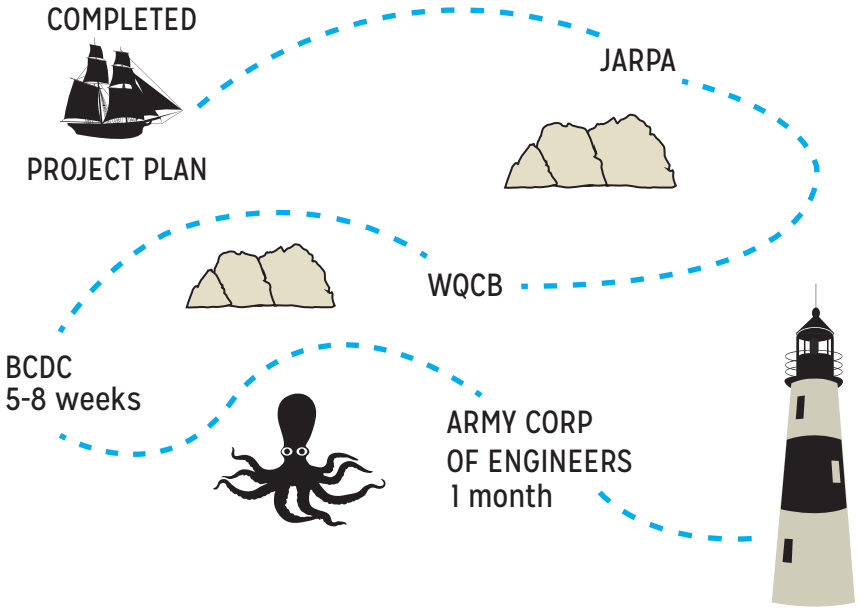
MAKING AN EQUITABLE & SUCCESSSFUL PLAN

Existing floating wetland projects have predominantly come about through partnerships between government agencies and non-profits, sometimes with funding from private companies. Community input should also be an integral part of the design process for public assets like waterfronts. Communities can engage with a floating wetland project during the design phase, as volunteer maintenance staff/citizen scientist and through educational programs.



NAVIGATING THE REGULATIONS

In order to protect the Bay from over development there is a permitting process in place to review the impact of all projects. Any floating wetland project in the Bay currently must be approved by the Bay Conservation and Development Commission (BCDC) and the Water Quality Control Board (WQCB). Any project in navigable waterways must be approved by the U.S. Army Corp of Engineers, In most cases a floating wetland project would fall under multiple jurisdictions and the Joint Aquatic Resource Permit Application (JARPA) was developed for this purpose.



1940

Originally a commercial shipyard, Hunter's Point was expanded to 638 acres and purchased by the Navy for shipbuilding and repairs beginning in 1940

1960

A drastic plan proposed in 1960 to fill most of the Bay inspired activists to take action and protect the open water and estuaries from further filling and development. The movement lead to the creation of the Bay Conservation & Development Commission and legislation to protect the Bay

1994

Hunter's Point Naval Base closed in 1994 after having been declared a Superfund site in 1989

2006

Hunter's Point Power Plant permanently closes after years of protest and complaints of air pollution by adjacent neighborhood residents

CHANGES TO THE SOUTHEAST WATERFRONT TODAY & INTO THE FUTURE

MISSION BAY REDEVELOPMENT PROJECT

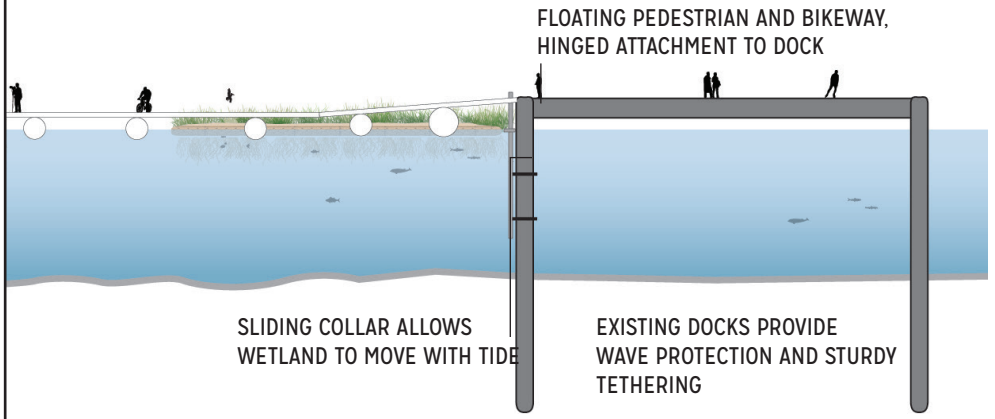
PHOTO: SKYSCRAPERCITY.COM

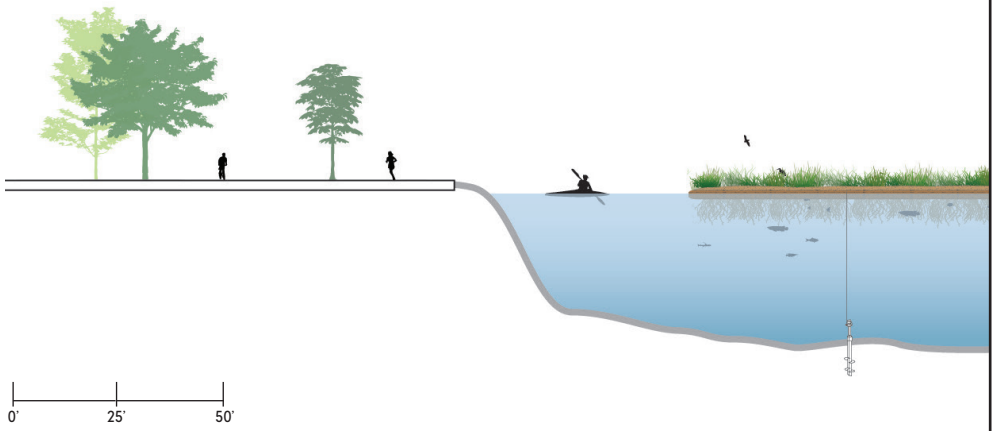
Since it's designation in 1998 as a neighborhood for redevelopment, this former rail yard dominated area has become the site of massive investment in primarily residential building. Mission Creek has gained new green spaces along its banks and new condos are advertised for their waterfront views.

FUTURE PLANS FOR HUNTER'S POINT AND CANDLESTICK PARK

IMAGE: TRANSPARENT HOUSE, FROM DEXINGER.COM

The former Naval Shipyard will be radically transformed into housing, office space, and commercial development. Ultimately expected to generate more than 12,000 permanent jobs, 10,500 residential units and 320 acres of parks and open space.





THE BLUE GREENWAY

IMAGE: PORT OF SAN FRANCISCO

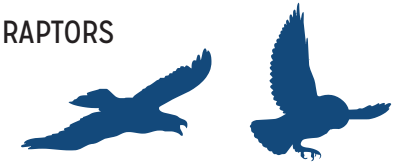
The Blue Greenway is a long term plan that will ultimately create a continuous pedestrian, bike, and boat trail along the southeast waterfront and is a part of the larger 500 mile Bay Trail around the entire San Francisco Bay. The Blue Greenway will take another 25 years to complete with the southern end in Hunter's Point being the last to be connected.

2 THE IMPORTANCE OF WETLANDS

biodiversity and ecosystems services

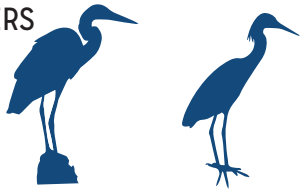
Wetlands are some of the most biodiverse ecosystems on earth. In tidal salt marshes, where fresh water and salt water mix, a wide gradient of ecological conditions exist. As tidal waters come in, sea creatures are brought in and as the tide goes out, some remain on mudflats and provide food for birds and small mammals. The shallow water provides protected habitat for countless species to feed and reproduce. Below are just a few of the species that benefit from wetland habitat.

RAPTORS



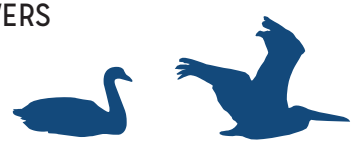
Hawks, falcons, eagles, and owls find food like rodents, amphibians, fish and small birds in shoreline grasses and shallow water

WADERS



Herons and egrets feed by standing in shallow water and waiting for prey like fish, crabs, and amphibians, many species worldwide are threatened by a lack of available wetland habitat

DIVERS

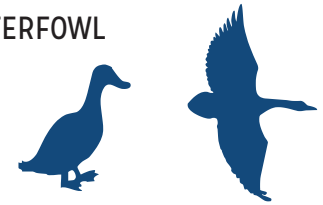


Grebes, loons, and pelicans dive from the air or water's surface for food like small fish, crustaceans, and insects

SHOREBIRDS

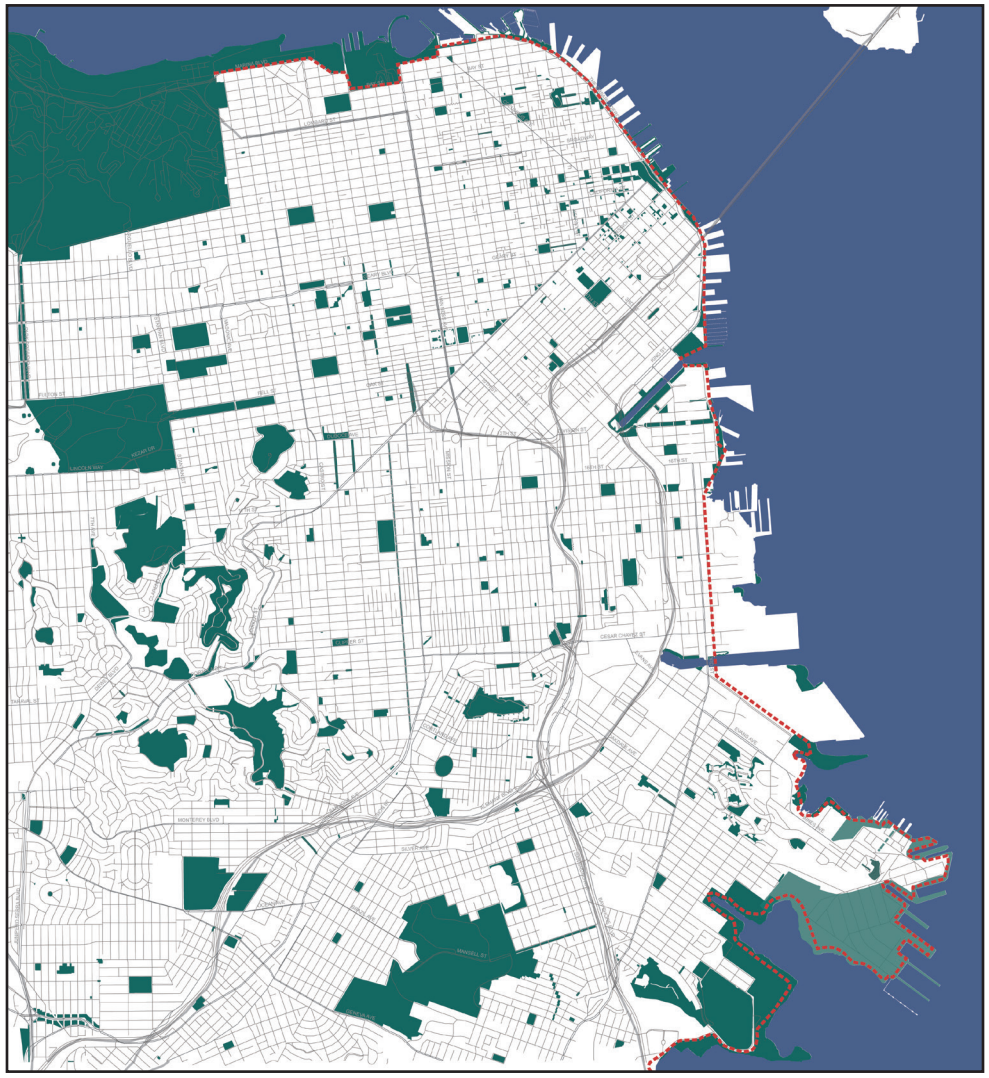
Sandpipers, plovers, and curlew belong to this large group of birds that generally feed along the water's edge or on mudflats and have highly specialized beaks for their niche food source

WATERFOWL



Ducks, geese, and swans all have webbed feet and spend much of their time swimming on water. Most rely on underwater food sources such as aquatic insects, fish, and vegetation

HUNTER'S POINT PARK FITS INTO A CITY WIDE NETWORK CONNECTED BY THE BLUE GREENWAY TRAIL



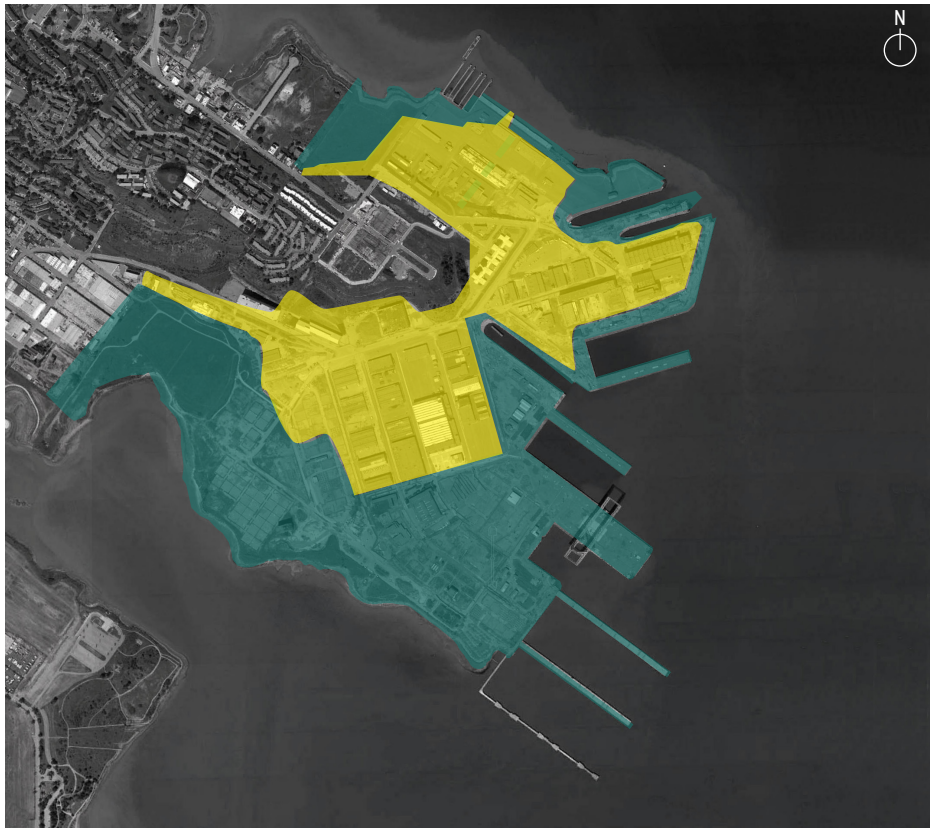
EXISTING GREEN SPACE

PLANNED GREEN SPACE

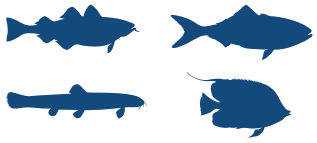
BLUE GREENWAY

Hunter's Point Docks

Hunter's Point is in the midst of a transformation from abandoned shipyard to complex of residential, commercial, and park land development. The plans put forth include extensive green spaces along the waterfront that will make the completion of the southern end of the Blue Greenway possible. The docks that will remain provide a unique opportunity for pedestrians and bikers to explore deeper water areas. Floating wetlands and connecting boardwalks could further expand the Blue Greenway by attaching to the docks and also circumvent any problem areas.



FIN FISH



Thousands of species of fin fish take advantage of the shallow, protected waters of wetlands to live, spawn, or feed. Estuaries are considered the nursery of the sea and 75% of the commercial fish stocks in the US depend on estuaries for survival

INVERTEBRATES

Invertebrates include popular human food sources like crabs, oysters, clams and mussels that thrive in shallow tidal waters. Thousands of other insects, snails, sea urchins, and worms provide food to birds, fish, and mammals

PALO ALTO BAYLANDS PARK (PHOTO: PANORAMIO USER DAVIDCMC58)

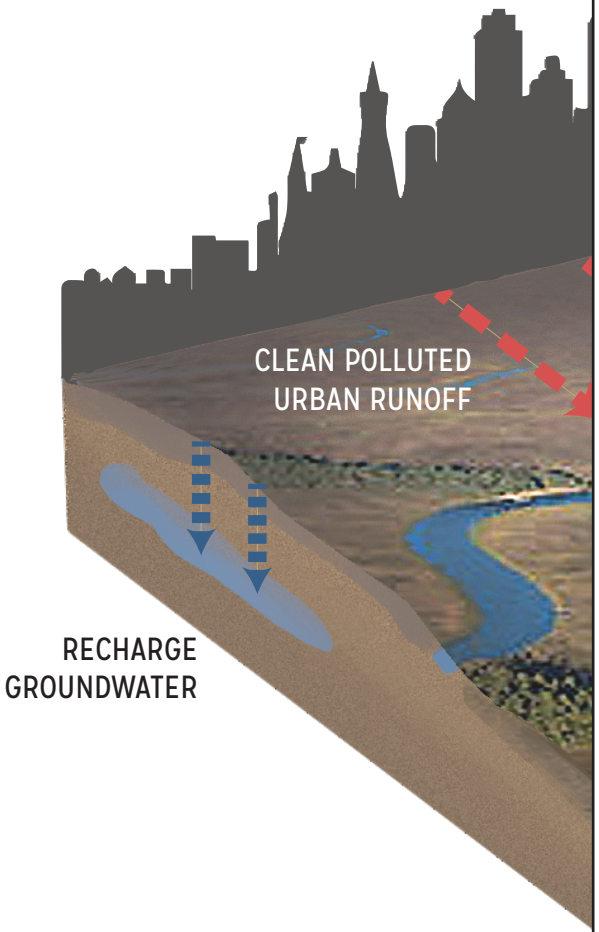
In addition to the habitat provided for so many species, wetlands also provide valuable ecosystem services.

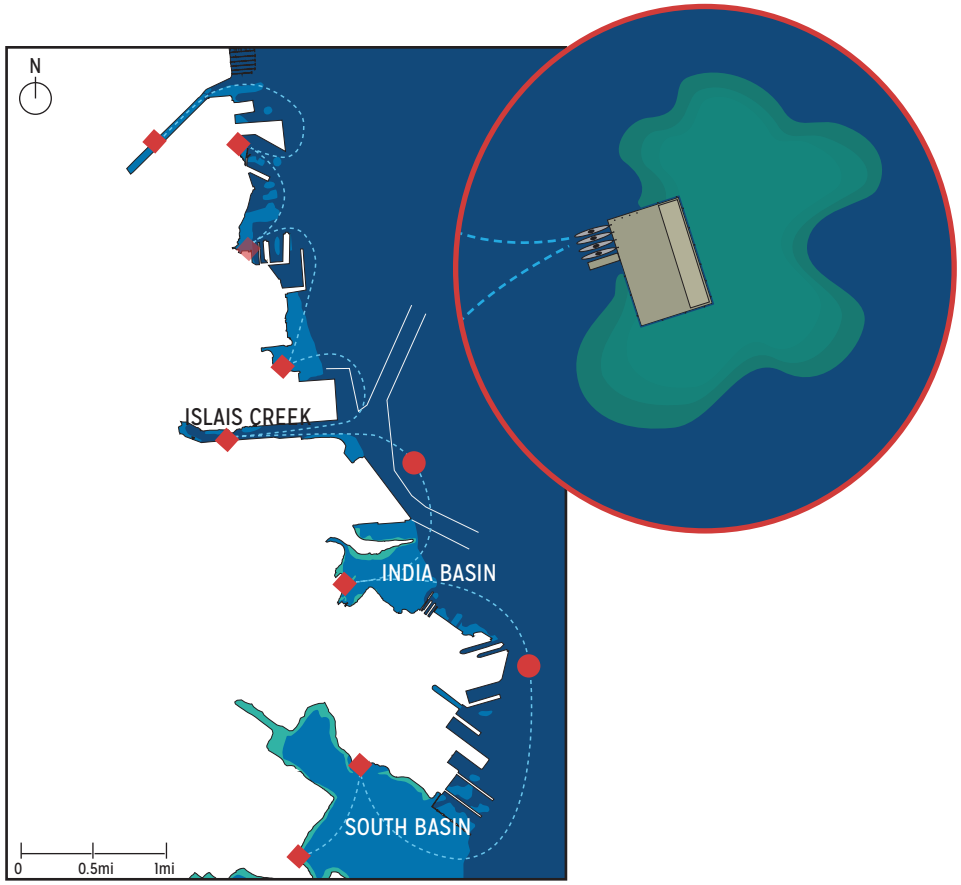
During storms, water that runs off hardscaped surfaces, carrying pollutants can first be intercepted by wetlands. The plants prevent particles from making it to the ocean by settling or by uptake in their roots. Excess nitrogen and phosphorous from fertilizers can be used by the plants and prevent algae blooms.

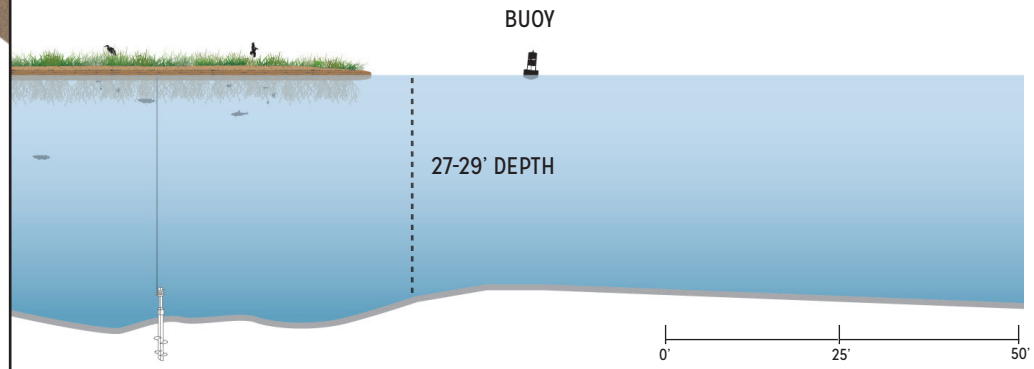
By slowing the runoff of water, wetlands can also help groundwater recharge, rather than running unimpeded into bays and oceans.

Wetland plants help protect coastlines from storm surges and erosion by interrupting the wave energy and by stabilizing shorelines with their root systems.

Wetlands absorb more CO2 from the atmosphere than an equivalent area of forested land.

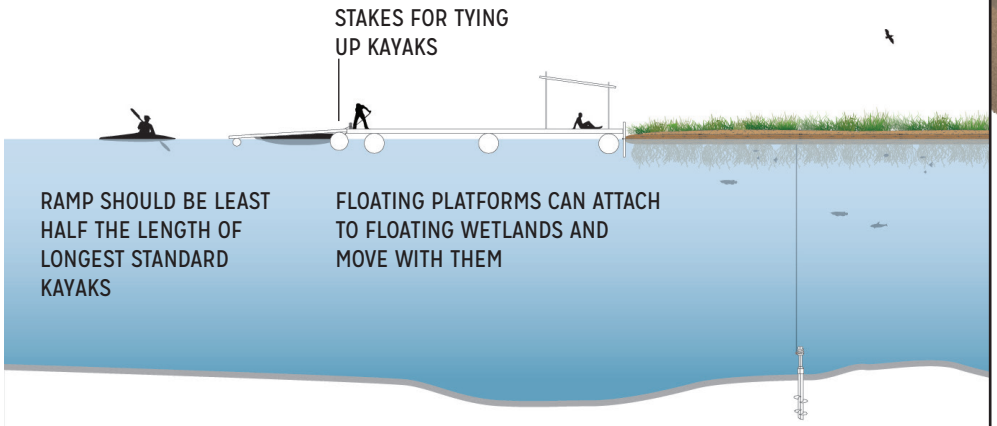


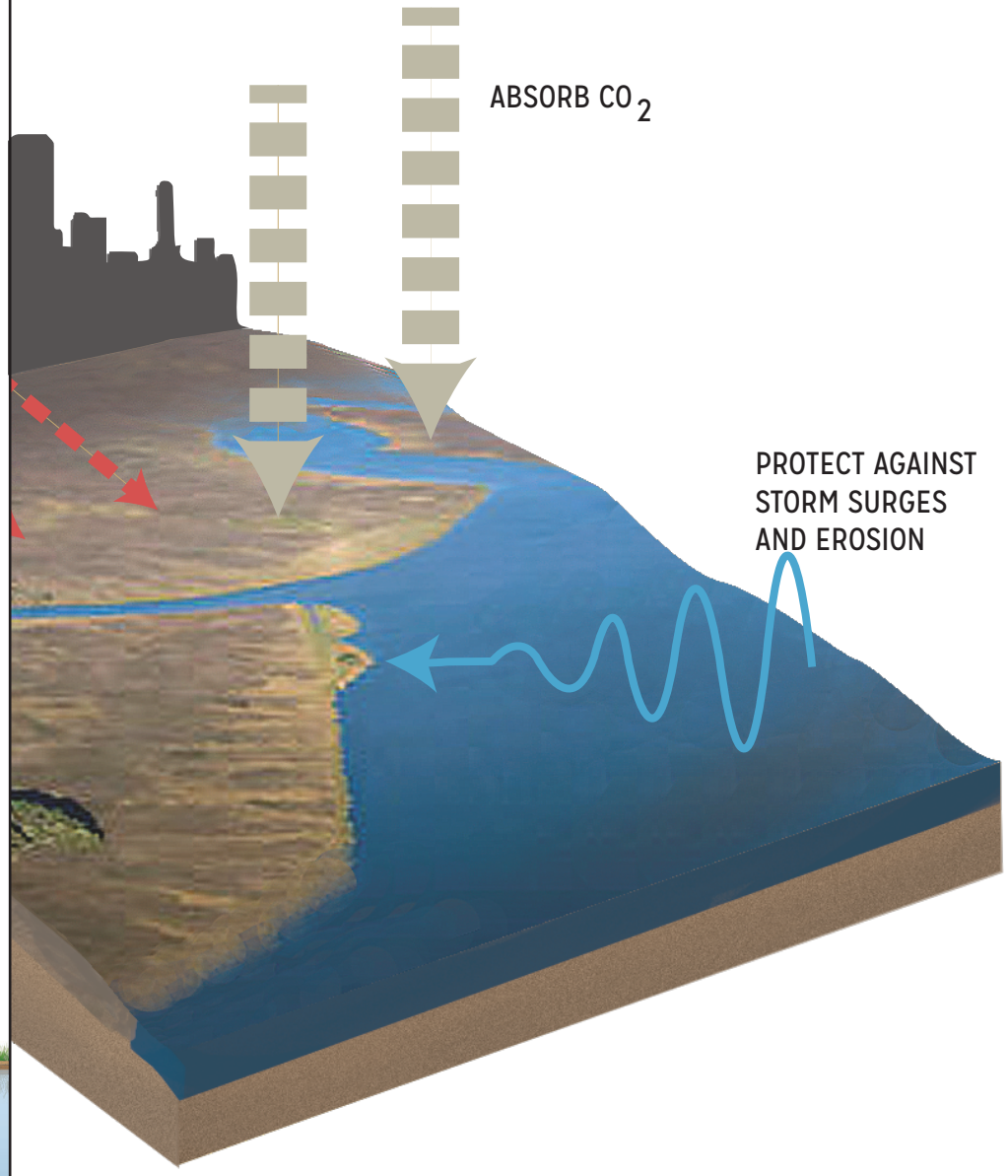




Kayak Rest Stop

As part of the Blue Greenway Plan, 7 kayak launches are already in place with an 8th one planned as part of Crane Cove Park. The stretch between the Islais Creek launch and India Basin, and then India Basin to South Basin are the longest and floating wetland kayak rest stops could provide habitat and a unique place to rest on a long journey. A stop sited near Pier 96, with active industrial activity, would need to be located out of the way of the navigation channel, be marked by buoys and be added to navigational maps.





3 FLOATING WETLANDS EXPLAINED

what are they and how do they work?

Several manufacturers currently produce off-the-shelf floating wetlands products. There are three basic elements needed for any variety of pre-made or custom system: a base, anchor, and the plant material. The base should be made of a material that is proven to be non-toxic to sea life and able to withstand being submerged in salt water for the life of the project. It must, of course, also be buoyant.

Depending on the intensity of wave action for a given site, the anchor type may vary. A helical (screw-like) anchor works well for higher wave areas. Stainless steel cords and attachment hardware are recommended for salt water.

A floating wetland can either be anchored to the floor of the water body or tethered to an existing stationary object such as a pier, pile, or on-shore object. Enough slack must be provided in the attachment to allow for tidal variation. The use of salt marsh plants allows for occassional inundation of islands without damage to the plants.

BENEFITS

PLANTS

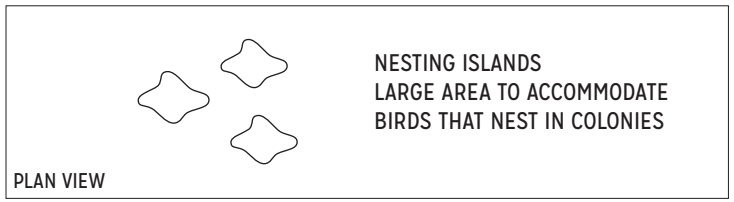
- ATTRACT INSECTS WHICH PROVIDE FOOD FOR BIRDS
- PROVIDE COVER FOR BIRDS TO NEST OR EVADE PREDATORS
- ABSORB POLLUTANTS LIKE EXCESS NITROGEN FERTILIZERS

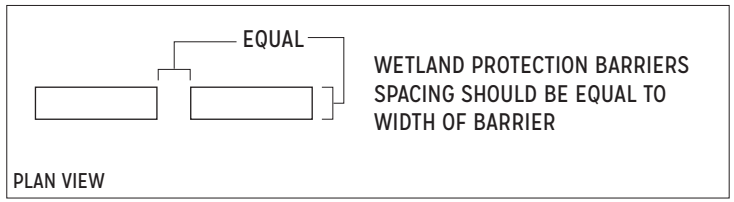
ROOTS

- PROVIDE SURFACE AREA FOR BENEFICIAL MICROBES THAT CLEAN WATER AND SUPPORT THE BASE OF THE FOOD CHAIN
- PROVIDE COVER FOR FISH
- HELP SEDIMENT DROP OUT MAKING CLEARER WATER

OTHER

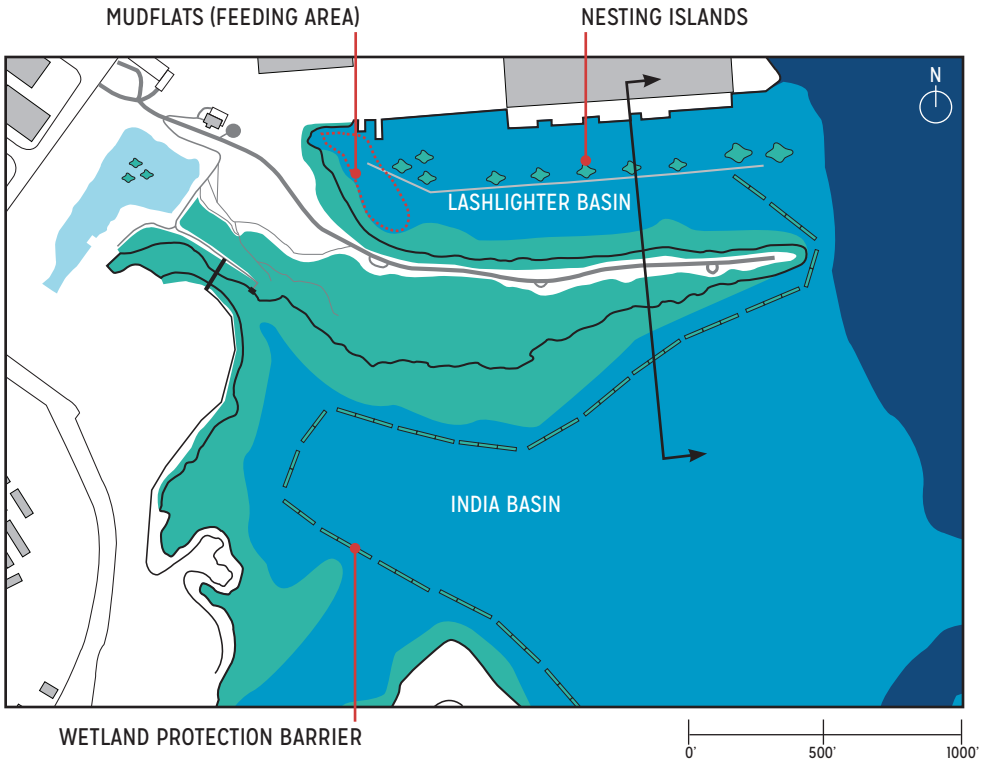
- FLOATING WETLANDS MOVE WITH THE TIDE AND CAN WITHSTAND SEA LEVEL RISE
- SHADE FROM ISLAND KEEPS WATER TEMPS COOLER
- FLOATING WETLANDS CAN PROTECT ON SHORE WETLANDS FROM EROSION AND BREAK STORM WAVES AND SURGES

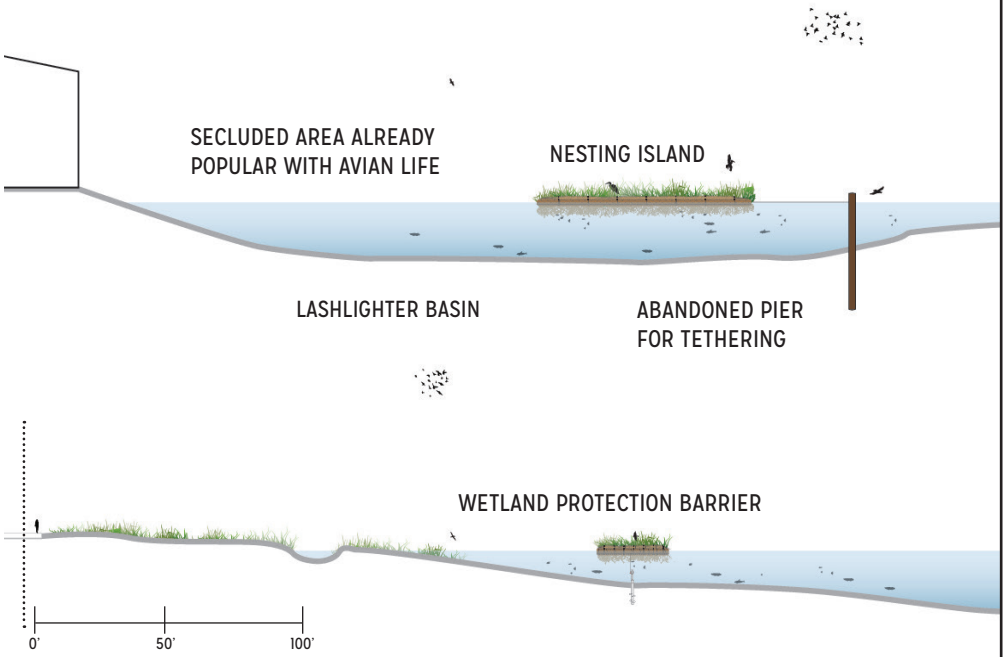


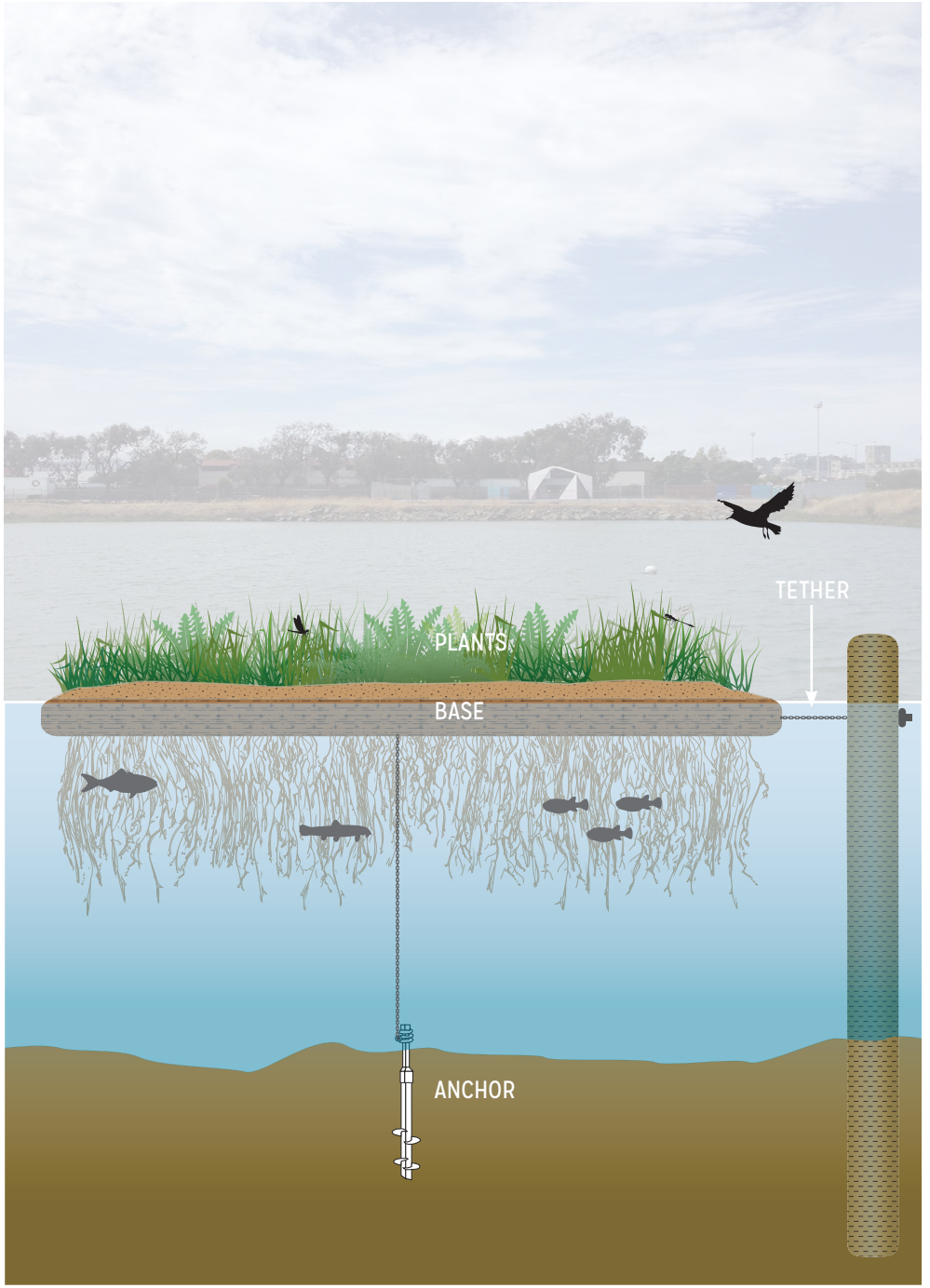


SHALLOW WATERS MAKE FOR EASIER INSTALLATION AND MAINTENANCE OF LARGE ARRAY

INDIA BASIN


MUDFLATS (FEEDING AREA)
NESTING ISLANDS
N
LASHLIGHTER BASIN
INDIA BASIN
WETLAND PROTECTION BARRIER
0'
500'
1000'


SECLUDED AREA ALREADY
POPULAR WITH AVIAN LIFE
NESTING ISLAND
LASHLIGHTER BASIN
ABANDONED PIER
FOR TETHERING
WETLAND PROTECTION BARRIER
0'
50'
100'


TETHER
PLANTS
BASE
ANCHOR

EXISTING FLOATING WETLAND PROJECTS

LOUISIANA COASTLINE

PHOTOS: FLOATING ISLANDS INTERNATIONAL

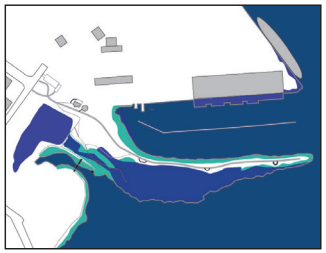
Louisiana loses 25,000 acres of coastal wetland per year. This loss is devastating for economic, ecological and aesthetic reasons. Projects spearheaded by the Coastal Conservation Association of Lousiana, along with public and private partners have installed over 3400 linear feet of floating wetland barriers in three locations. The oldest have been in place since 2009 and have withstood a storm that lasted 24 hours, had 90 mph winds, and a 5 foot storm surge. The plants are thriving and their wave breaking capability is clear in the image above, left.

BALTIMORE INNER HARBOR

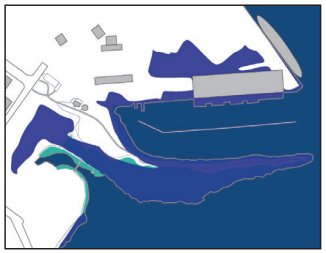
PHOTOS: HEALTHY HARBOR BALTIMORE

The Chesapeake Bay watershed is one of the largest in the U.S. and the resulting runoff from this vast area can be highly polluted with toxic chemicals and solid litter. To bring awareness to this issue, floating wetlands and a solar powered trash collecting water wheel have been installed in Baltimore's popular tourist attraction, the Inner Harbor. The Waterfront Partnership hopes to expand this pilot project to another location that will include boardwalks that bring visitors into the bay through a network of floating wetlands.

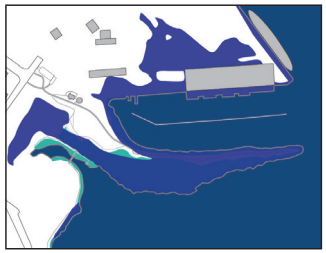
Although salt marshes are adapted to daily tidal inundation, marsh plant species are not able to withstand complete submergence. The unique San Francisco wetland habitat at Heron's Head is under threat from future projected sea level rise.



1 FOOT SEA LEVEL RISE, 2040



2 FEET SEA LEVEL RISE, 2060



3 FEET SEA LEVEL RISE, 2070

Floating wetlands can help in three ways:

1. Protect from erosion during storms by breaking waves

2. Slowing tidal water and trapping the sediment that help marsh grow higher

3. Replacing lost marsh permanently and/or provide temporary habitat until new marshes can be restored, floating wetlands can be moved as needed to protect areas that need protection most

*Biodegradable floating wetlands are also currently being developed that could be designed to root in permanently

Heron's Head Park

The area today known as Heron's Head Park was constructed in the early 1970's from landfill. Originally intended to be a shipping terminal and Pier 98, the plan was never completed and the area was left to the forces of nature. Marsh plants took root and numerous bird species began to make their home here. Clean up efforts were mounted to remove debris and litter, a petition was submitted by the Golden Gate Audubon Society, and in 1999, Heron's Head Park was officially born. In 2010, Literacy for Environmental Justice constructed the EcoCenter, a model of sustainable building powered by solar panels and processing all waste water on site. Educational programs are offered to school groups and the public, it is the only environmental education center for the southeast neighborhoods.

SENGKANG RIVER SINGAPORE

PHOTOS: NATIONAL PARKS, SINGAPORE

This network of docks and floating islands connects two public parks separated by the Sengkang River, making for a pedestrian friendly route between the parks that avoids the high traffic car bridges. Totaling over half an acre, this large wetland park is helping clean this river historically polluted by adjacent pig and poultry farms. Recreational, aesthetic, educational benefits are also enjoyed by Singapore's residents.

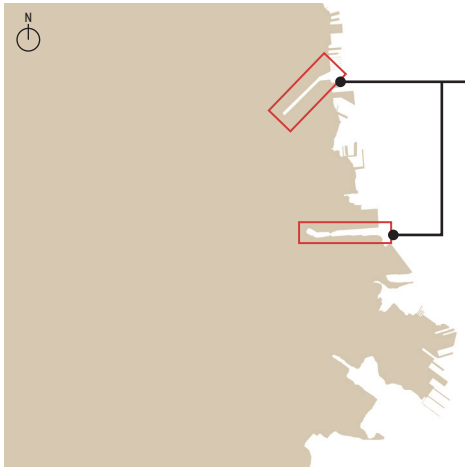
DUTCHY LAKE, OREGON

PHOTOS: FLOATING ISLANDS INTERNATIONAL

This one acre island was created to relocate the Caspian Tern who were over feeding several endangered salmon species in the Columbia River. The island was covered with a six inch thick mix of crushed stone, pumice and rhyolite that is lightweight yet mimics their natural rocky shoreline habitat. This island was developed jointly by the US Army Corp of Engineers, U.S. Fish and Wildlife Service, and NOAA Fisheries and has seen the successful nesting of the Caspian Tern.

4 FLOATING WETLANDS PLACEMENT

cataloging conditions along the southeast waterfront



CHANNELIZED CREEKS

MISSION CREEK

ISLAIS CREEK

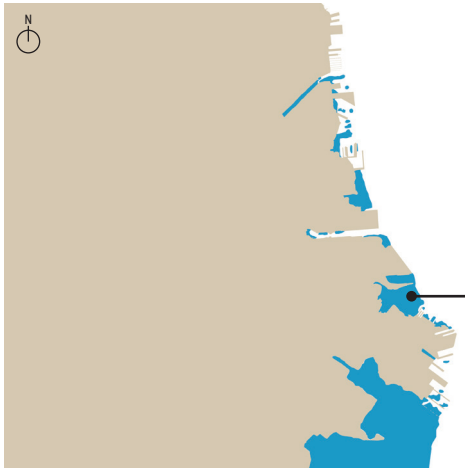
CONSIDERATIONS

Recreational and/or industrial boat traffic need room to maneuver

Sewer outfalls release water at high speed during storms

More enclosed, pollutants can become concentrated

Protected from strong bay waves



SHALLOW WATER

AREAS LESS THAN 20' DEEP

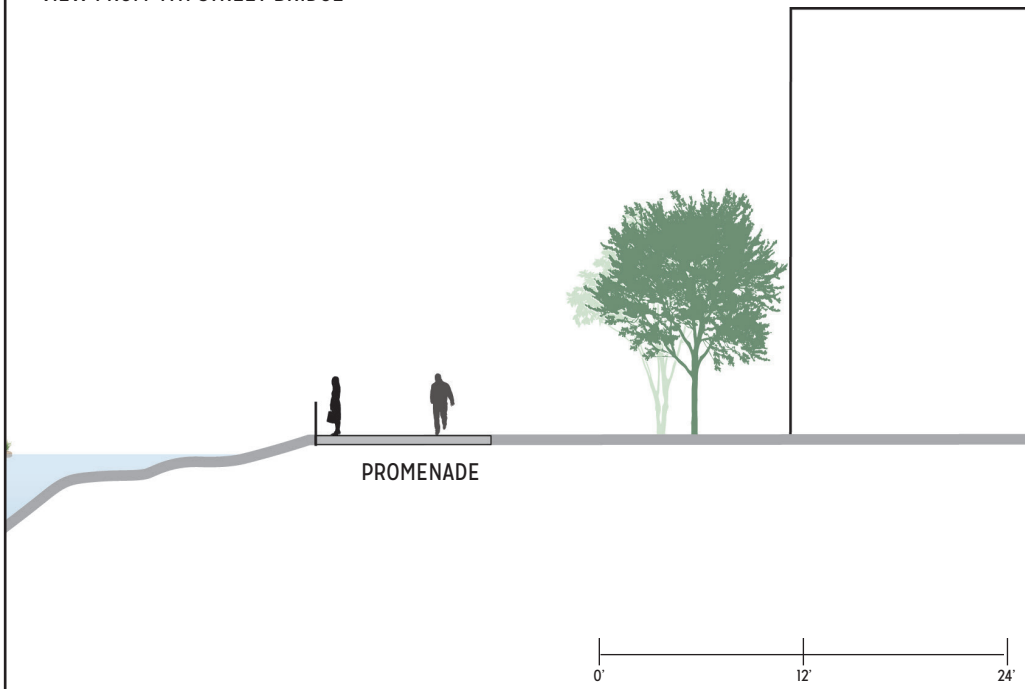
CONSIDERATIONS

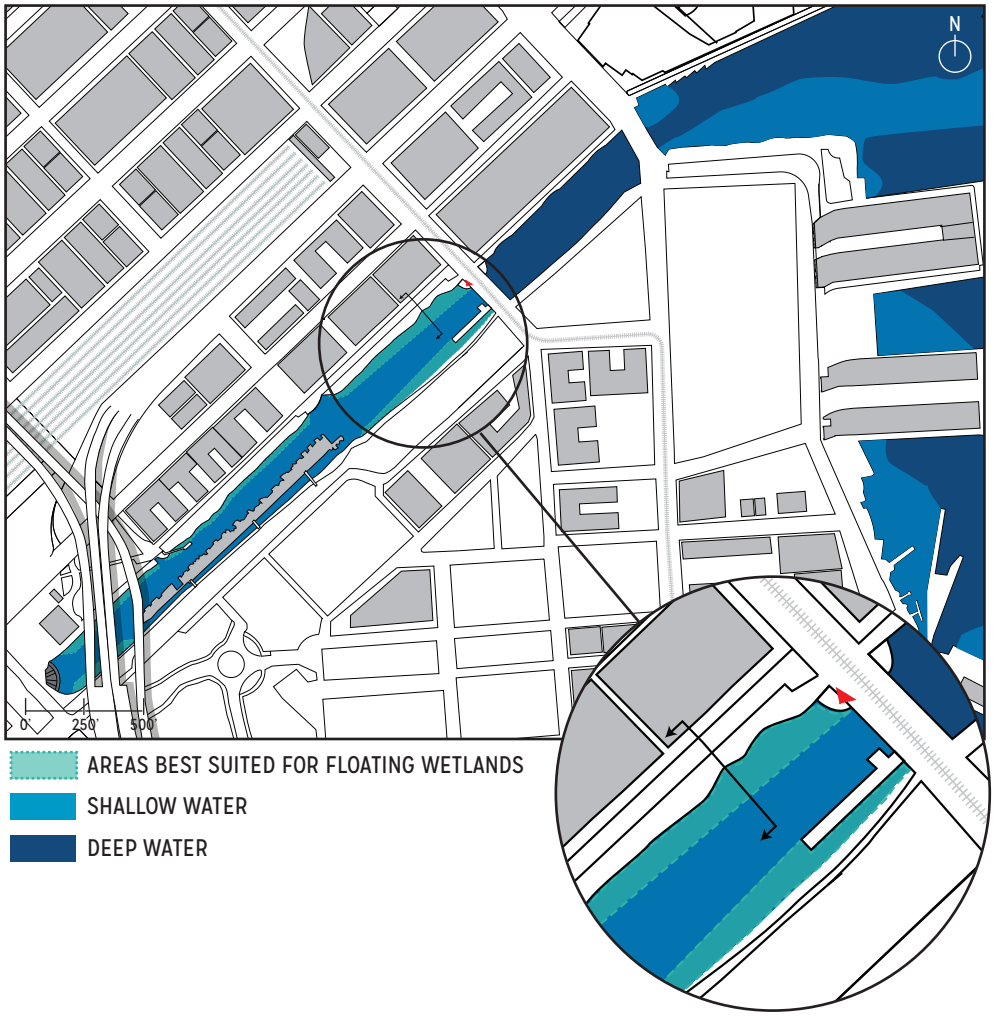
Areas tend to have richer existing biodiversity and more gradual shoreline slopes where wetlands can take hold

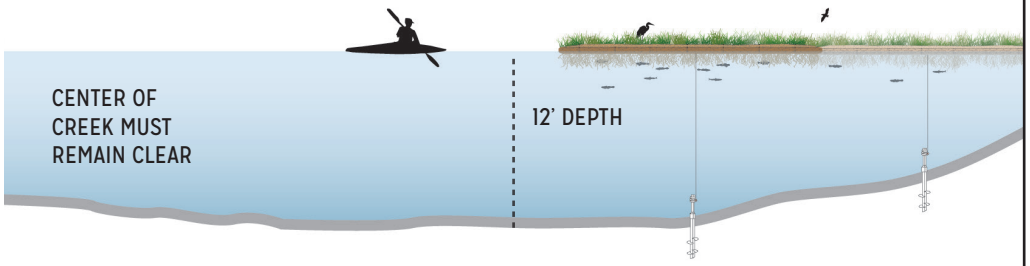
Better protected from strong waves

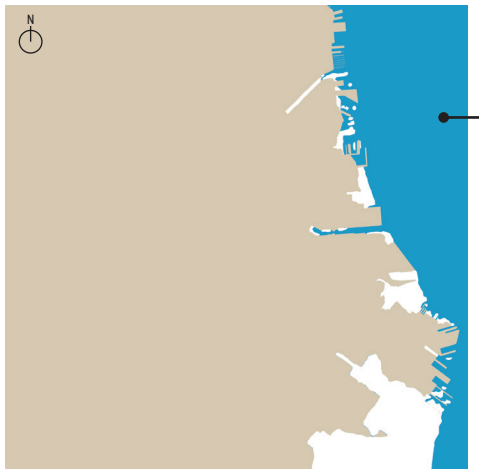
Shallow water is easier for installation and maintenance

VIEW FROM 4TH STREET BRIDGE





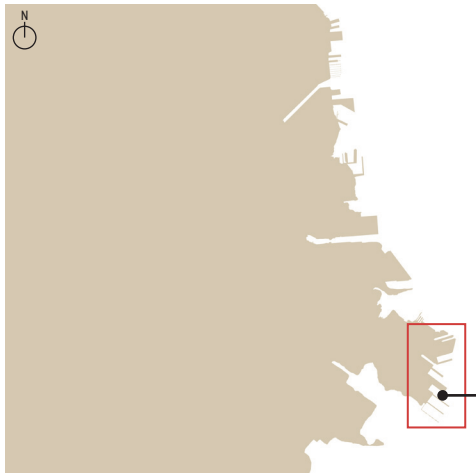


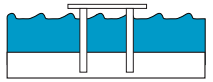


DEEP WATER
AREAS GREATER THAN 20' DEEP

CONSIDERATIONS
Opportunity to create habitats where they would not normally exist

Most challenging environment to install securely and maintain due to higher wave action





UNUSED DOCKS
HUNTER'S POINT

CONSIDERATIONS
Stable existing structures for secure tethering

Some protection from waves yet provide access for people to deeper water areas

DESIGN IDEAS: FOUR STUDIES

With a wide variety of conditions along the waterfront, local conditions need to be carefully considered. There are some common constraints that can be identified along with several potential benefits to positively impact waterfront areas with floating wetlands.

CONSTRAINTS

- RECREATIONAL BOAT TRAFFIC
- SEWER OUTFALLS
- INDUSTRIAL BOAT TRAFFIC
- STRONG WAVE ENERGY

BENEFITS

- WATER QUALITY IMPROVEMENT
- HABITAT CREATION
- AESTHETIC IMPROVEMENT
- SURGE & EROSION PROTECTION
- RECREATION ENHANCEMENT

Mission Creek

Mission Creek is crowded and bustling with activity. Boat traffic, two bridges, the 3rd Street T line, a popular kayak launch, full time houseboat residents, a water side promenade, a multitude of new building, and several sewer outfalls just to name some of the uses. Even with all this activity many birds and sea lions are known to frequent the creek. With all of these demands on this sliver of water, the challenge is to find balance in considering how floating wetlands could benefit people and ecology.