

Adapting to Rising Tides Program: Preserving Shoreline Parks in the Face of Climate Change

SEPTEMBER 2015

1. Introduction

The Bay Conservation and Development Commission’s (BCDC) Adapting to Rising Tides (ART) Program began in 2011 as a multi-jurisdictional, multi-asset climate adaptation planning effort along a portion of the shoreline in Alameda County. The ART Program recognized the importance of the region’s shoreline park and recreation areas early, determining that our shoreline open spaces and trails are critically important in defining the Bay Area and its communities. Based on this recognition, the ART Program focused the work of its NOAA Coastal Fellow on the climate resilience of the region’s shoreline parks and recreation areas by working with the East Bay Regional Park District (EBRPD), the San Francisco Bay Trail Program and city and county park departments. The following report is one of the results of this sea level rise vulnerability and risk assessment.

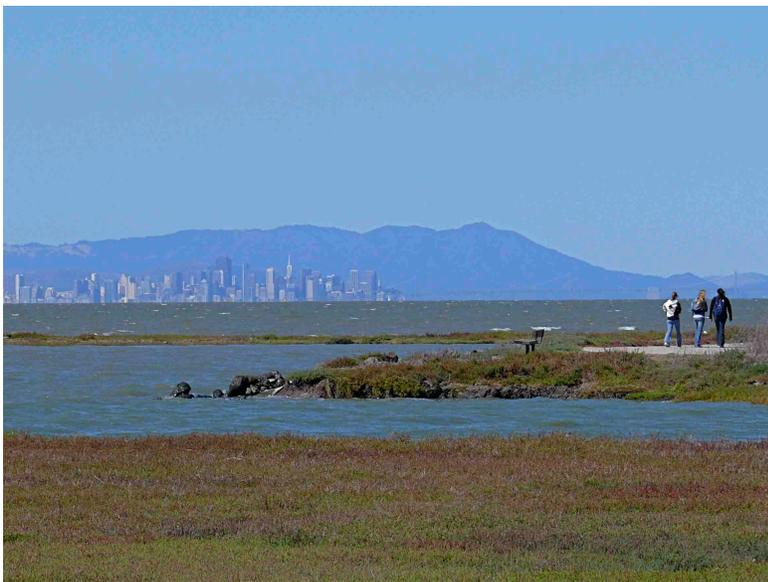


FIGURE 1.1. Hayward Regional Shoreline. Photo Credit: Ingrid Taylor

The San Francisco Bay area has more than one million acres of open space including regional, local and state parks. However, only 30,000 acres of this open space is along the shoreline (Bay Area Open Space Council). These shoreline open spaces share the shoreline with seaports, residential development, airports, interstate highways, business parks and many other uses. The high density of development along the shoreline leaves few opportunities for developing new major shoreline parks, so current and future demand for shoreline recreation will likely need to be met by current parklands. However, as sea level rises and storm events

begin to cause more extensive and longer duration flooding, park and recreation assets along the shoreline will become more costly to maintain, have services disrupted and compromised and some may disappear entirely. This will diminish the important regional role that shoreline parks and recreation serve in providing ecosystem and community services, and in defining, improving and maintaining the Bay Area’s quality of life.

Shoreline parks in the Bay Area are often comprised of marsh habitat, wetlands, bluffs and other natural areas that bring communities in direct contact with the Bay and its natural resources. The Bay Area's shoreline parks are most often used for walking, nature-viewing, and picnic areas but also provide shoreline-specific recreational opportunities such as kayaking launches, beach access, and fishing piers. These shoreline parks provide a variety of benefits, including, critical wildlife habitat for aquatic, terrestrial, and avian species, reduced flood risks to inland communities, and improved public health. These valuable services may be lost however as these natural shorelines face increased wave and tidal energy, and in some locations, longer duration periods of flooding or permanent flooding as sea level rises.

Shoreline parks serve as de facto coastal flood protection for much of Alameda and Contra Costa counties, de facto because the areas were developed and are managed to be park and recreation areas, not coastal flood protection for inland areas. In some parks this protection consists of structural shoreline components like levees and riprap shoreline; others provide natural shoreline protection through wetlands and coastal bluffs. Shoreline parks can buffer Bay Area communities from flooding events in three ways. The first is by detaining stormwater in wetlands and permeable surfaces. The second is by reducing the height and strength of waves across wetlands, which reduces the need for expensive shoreline protection like levees and seawalls. The third is by serving as a setback from the Bay, separating denser and more sensitive development from storms and sea level rise. Sea level rise will increase the importance of the role of shoreline parks and natural areas in these critical flood and stormwater management services.

Another important benefit of park and recreation areas is the economic benefit provided to communities and regions that have functional open space systems. EBRPD analyzed the economic benefits of all its 111,000 parkland acres, including shoreline parks, and found that the park system in Contra Costa and Alameda counties provides \$200 million in direct, regional economic benefits (EBRPD 2013). The Trust for Public Land has observed that strong park systems increase property values by 5-15% in cities across the country, therefore contributing to the tax revenue within cities that have strong park systems¹.

Taken together, the economic, environmental and community benefits of shoreline parks prove that planning for sea level rise resilience must be a priority for the entire region and not just park supervisors and decision-makers. The importance of park and recreation areas to the Bay Area economy, environment and to its communities is the reason that the issue of parks and recreation areas was highlighted by the ART Program and the reason for this sector specific assessment, conducted as part of the ART Program.

In addition to the valuable role park and recreation areas already play in the region, the ART Program identified early on that shoreline park and recreation areas could play a central role in educating people about the effects of climate change. Shoreline parks and recreation areas are not only geographically at the front lines in the Bay Area, they are also places that people visit and care about. An important component of the assessment is also to explore the role parks and recreation areas can play in educating communities on the issue of climate change vulnerabilities and adaptation strategies and the role that such spaces can play as laboratories and classrooms for climate resilience. This can help communities understand and experience climate adaptation to sea level rise that may start in their parks, but move on to the entire community.

¹ <http://cloud.tpl.org/pubs/ccpe-econvalueparks-rpt.pdf>

Recommended Adaptation Strategies for EBRPD

- Incorporate sea level rise and climate adaptation into existing public education and outreach programs and expand these programs to new audiences and areas.
- Preserve and enhance shoreline habitat and wetlands on EBRPD property in conjunction with regional agencies and in accordance with the Baylands Ecosystem Habitat Goals Update.
- Coordinate with permitting and regulatory agencies to facilitate efficient adaptation through programmatic EIRs and pilot projects such as the Bruener Marsh Restoration and Mitigation Bank.
- Identify hotspots where flooding and erosion cause problems now and there is limited space for adaptation, e.g., Bay Trail in Martin Luther King Jr. Regional Shoreline.
- Find new funding sources for adaptation by integrating parks planning and improvements with water quality, wetland habitat, flood control, and urban development projects.
- See chapters five and six for more detailed adaptation responses and recommendations.



FIGURE 1.2. San Leandro Marina. Photo Credit: Ingrid Taylor

2. Why Study Shoreline Parks Vulnerability and Risk?

Shoreline Parks Provide Significant Regional Benefits

Parks, trails and public shorelines along the San Francisco Bay provide environmental, economic, public health and recreation benefits to the region. Decades of work by park districts, cities, non-profits, and other



FIGURE 2.1. King Tide at Crown Memorial State Beach. Photo Credit: EBRPD

agencies, such as National and State Parks, the San Francisco Bay Conservation and Development Commission (BCDC), the California Coastal Conservancy, and the Association of Bay Area Government's Bay Trail Program, to preserve open space along the waterfront and provide accessible recreation to citizens has resulted in more than 300 miles of Bay Trail, extensive regional park networks, and preserved and restored natural areas. Even with all of

this work, the number of acres dedicated to shoreline parks is comparatively small. There are more than one million acres of public open space in the Bay Area but only 30,000 acres along the shoreline (Bay Area Open Space Council 2012). This parkland serves the seven million residents of the Bay area, as well as tourists. BCDC has noted the unique value of the Bay and its shoreline as open space in the Bay Area in its *San Francisco Bay Plan* and in the laws and policies that encourage the creation and preservation of parkland along the Bay shoreline (Bay Plan 2006).

This report focuses on work conducted with EBRPD and was developed within the ART Program, using the processes, findings and tools developed as part of the ART Program. The intent of focusing on EBRPD was to develop findings and adaptation responses that could not only make EBRPD more resilient, but to provide information to build upon to increase the climate resilience of all of the park and recreation areas along the Bay shoreline. For more information about the other components of the ART Program, including further findings and materials related to park and recreation assets and other community, transportation and utility assets, please find these materials and background information at adaptingtorisingtides.org

Bay Area residents visit shoreline parks for water and shoreline recreational activities such as kayaking, swimming, running, walking, dog walking, fishing, team sports, bird watching, youth and community education and passive recreation in picnic areas and community centers. Although there are upland parks that provide some similar opportunities, unique shoreline recreational benefits include water access, wildlife

watching, Bay views, and open space appreciation. In addition, the Bay Area is highly developed, and if shoreline parks degrade or disappear due to storm events and sea level rise, communities cannot easily replace these recreational functions elsewhere; there are not sufficient alternative shoreline or inland areas to develop as open space. In fact, in the more urban areas of the region, the shoreline park and recreation areas provide critical services to the cities, providing them with much needed park areas.

The coastal habitat preserved and maintained within many shoreline parks also provides educational value through birdwatching, nature hikes, and environmental education programs around the Bay. San Francisco Bay hosts millions of migratory birds each year and most feed in the ponds, mudflats and marshes at the water's edge. Fish species like Delta Smelt and herring spawn in the eelgrass beds along the shoreline and endangered species like the Salt Marsh Harvest Mouse live entirely in tidal wetlands. These species and the habitat they rely on are the subject of environmental education and interpretation programs that are critical to maintaining public support and engagement in protecting the Bay.

Parks and trail systems provide public health benefits in multiple ways; they provide space for free and low cost physical activity, they improve air quality and mitigate heat island effects, and studies have shown that communities with parks are healthier than those without (Urban Parks Alliance 2014). Because of these health-related benefits, health care for residents with access to parks can cost \$250-500 less per capita

(Trust for Public Land 2009) compared to costs for residents without access to nearby parks. This has significant economic benefits, but more importantly, these cost savings reflect real improvements in residents' health and quality of life. These benefits are vulnerable to sea level rise and storm impacts. Current and future flooding will result in increased erosion, longer duration and more extreme flooding, flooding in new areas, habitat degradation, and the loss of park area or entire park systems due to these impacts. Fortunately, the region and its park managers can prepare for storm events and sea level rise through proactive land use planning, capital improvement planning, and making changes to ongoing management and operations practices.



FIGURE 2.2. Sea Level Rise exhibits at Crissy Field. Photo credit: National Park Service

Shoreline Parks Can Demonstrate and Communicate Adaptation

Park districts around the Bay are beginning to use their shoreline habitats, interpretive staff, and park supervisors to educate the Bay Area community on sea level rise vulnerability, possible consequences and adaptation options. This education and awareness is important for two reasons. The first is because park and recreation areas are valued by community members for all of the benefits that these spaces provide to them. The second is that many of the region's shoreline parks are vulnerable to sea level rise and storm events relatively early. These two factors – the importance to the community/region and the early vulnerability – make shoreline parks a perfect place to communicate with

community members about risks from sea level rise and storms. Shoreline parks can serve as laboratories for sea level rise adaptation and platforms for public outreach and education for issues related to climate change around the Bay.

Elsewhere in the country, parks are prioritizing climate resilience and adaptation. Assateague Island National Seashore in Maryland is a barrier island that has experienced significant hurricane and storm damage and expects three to nine inches of sea level rise by 2040. Park staff there has moved quickly to adapt park infrastructure, including installing portable restrooms that can be moved to the mainland before large storm events. Additionally, they have invested in education and interpretation about expected effects of sea level rise and storm events. Their education staff created a sea level rise and storm event curriculum that teaches high school students how to survey barrier islands before and after storm events to monitor elevation changes and the position of the island. In response to sea level rise and storm events, natural resource managers have restored marshes that were originally channelized for mosquito control and included these adaptations in the park master plan. Assateague Island has become a national leader within the National Park Service and for other park supervisors and recreation providers for addressing sea level rise and storm impacts in a transparent, visitor-inclusive way².

Within San Francisco Bay, the Golden Gate National Recreation Area, managed by the National Park Service has installed multiple sea level rise exhibits at Crissy Field, including symbols marking projected sea level elevations along walkways. Park rangers and education staff include sea level rise vulnerability and risk in their “Spreading the Word on Climate Change” programs with students from across the Bay Area³. National Park Service staff also conducts research and monitoring of climate change within the park, including sea level rise. These actions enable thousands of visitors each year to learn about sea level rise while standing at the edge of the Bay where tide levels have been measured for 161 years, the longest consecutive record in North America.

In Alameda County, the Hayward Area Recreation and Park District (HARD) has incorporated sea level rise into its management, planning, and education programs. HARD staff participated in the ART Program Alameda County Project and used the vulnerability and risk assessment from ART Alameda County to begin including adaptation planning within the different aspects of their agency. The Hayward Shoreline Interpretive Center, which educates 9,000 visitors a year about marsh and tidal habitat in San Francisco Bay, has added sea level rise curriculum to its school programs and adult environmental education. The Center has also hosted sea level rise art exhibits, including glacier photography and paintings with 55” horizons to symbolize future water levels. In 2013, summer camp students were asked to build hypothetical cities along a rising Bay using toys and a stream table. Students envisioned floating homes, new wetland areas, and boat accessible businesses along the shoreline. HARD’s investments in the San Lorenzo Community Park to make that park more climate resilient, also demonstrate their understanding of sea level rise and storm event impacts and their commitment to adaptation. They have planned the park renovation to address flood risks by building a slough and natural pond in addition to improving athletic fields and building a new community center. HARD staff was able to incorporate sea level rise and storm event adaptation into their core mission of providing high quality recreation to Hayward residents.

² <http://www.nps.gov/articles/assateaguelandscape.htm>

³ <http://www.nps.gov/goga/learn/nature/sea-level-rise-exhibits.htm>



FIGURE 2.3. Sea level rise art exhibition at the Hayward Shoreline Interpretive Center. Photo credit Ronald Horii.

EBRPD has its own interpretive center at Crab Cove where education staff is working to develop sea level rise curriculum appropriate for their resources. Sea level rise will also shape the long-term vision for management and recreation at Crown Memorial State Beach and many other parks. Park and recreation managers can learn from local, regional and national examples to incorporate visitors into adaptation planning, implementation, and communication and share with each other what has been engaging and effective in communicating and educating about this important issue to the public.

3. Existing Conditions for East Bay Regional Park District

Upon completion of the ART Program’s Alameda County project, which assessed vulnerability and risk of a portion of Alameda County, several issues and geographic areas that needed further assessment were identified, including: the geographic areas in Hayward, Bay Farm Island and Oakland and sector specific projects focused on community housing, regional passenger rail and shoreline parks. The sector specific issues were identified due to either early vulnerability or high consequences or both. Additionally, the role that park and recreation areas could play in education and outreach was another factor that led to a focus on these assets. EBRPD had participated in ART’s Alameda County project as a working group member and participant in the project’s communications subcommittee, which assisted more closely with project design and the development of project communication material. The shoreline parks unit was interested in extending the vulnerability and risk assessments conducted in the ART Program to shoreline parks in Contra Costa County and developing park-specific and agency-wide adaptation responses. BCDC staff secured funding and selected a NOAA Coastal Management Fellow to complete the parks and recreation risk assessment and adaptation-planning project between August 2012 and August 2014.

EBRPD manages 65 parks in Alameda and Contra Costa counties including trails, environmental education centers, upland open space and shoreline parks. EBRPD, formed in 1934, is a special district, which owns, manages, and funds regional parks that serve 2.6 million residents. The parks are located throughout both counties, from more urban areas along the Alameda County shoreline to more rural areas in the inland portions of both Alameda and Contra Costa Counties. EBRPD accommodates 25 million visitors each year, including hikers, bird watchers, bicyclists, picnickers and participants in educational and recreation programs. The EBRPD employs over 700 people, including 44 within the shoreline parks. EBRPD staff are organized into six departments: 1) the land division, which acquires land, plans its development, seeks permits, and builds parks and trails, 2) management services, which supports program staff through office services and grants, 3) operations, which includes park supervisors and staff, interpretive and recreation services, and skilled trades maintenance staff, 4) planning/stewardship, which manages biological resources and restoration projects as well as design and construction of capital improvements, 5) public affairs, which communicates with the community at large and designs and distributes outreach material, and 6) public safety, which houses EBRPD fire and police departments. In 2013, EBRPD updated their Master Plan to include the need to address climate impacts in the park district and reiterated its mission to “preserve a rich heritage of natural and cultural resources and provide open space, parks, trails, safe and healthful recreation and environmental education.”

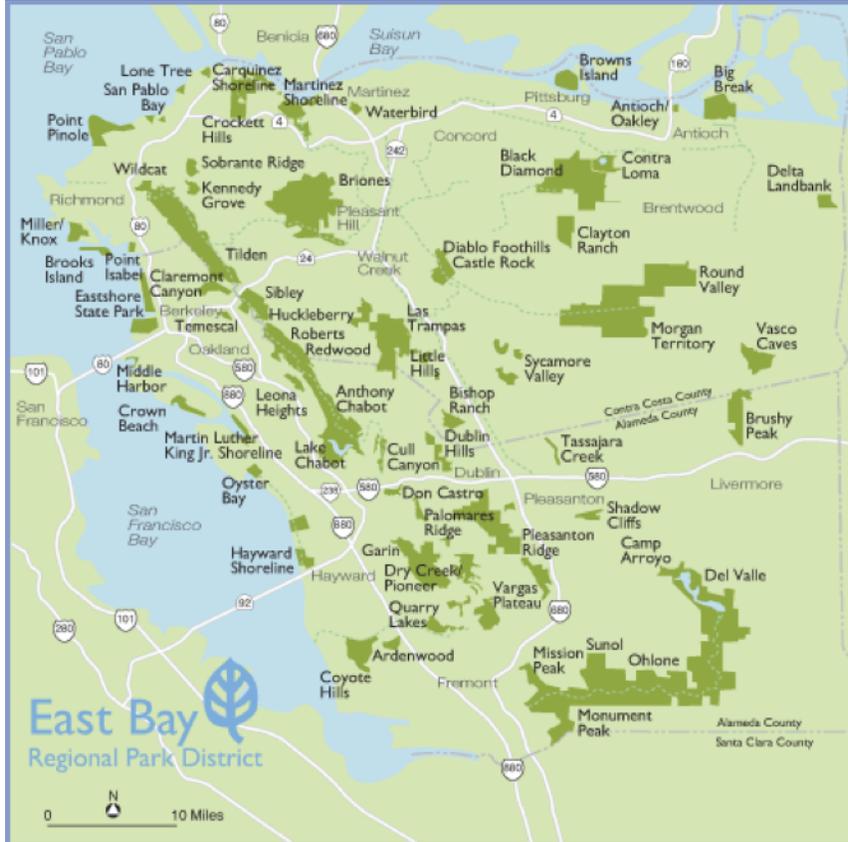


FIGURE 3.1. East Bay Regional Park District map.

As a regional park district, EBRPD provides open space and recreation to local residents as well as the entire Bay Area and visitors from outside the region. While EBRPD includes both inland and shoreline parks, it has been able to acquire and maintain large and diverse parcels of shoreline land, including regional shorelines, Bay Trail segments, and extensive marshes, beaches, and other shoreline natural areas. EBRPD’s regional shorelines provide wildlife viewing, small boat launches, fishing piers, and other recreation benefits generally not present at community parks. EBRPD also manages parkland owned by cities, counties and the state to help ensure that all East Bay residents have access to recreational opportunities.

EBRPD has the financial and organizational resources to purchase and retain open space for future recreation uses, conduct long term planning for trails and restoration projects, and invest in parklands to provide high quality recreation.

EBRPD’s service area is majority non-white, with more than 25 percent of residents foreign-born. Alameda and Contra Costa county residents are also young, with 25 percent under age 18 and only 12 percent over 65. These characteristics shape the services EBRPD provides as well as how it conducts community outreach and planning efforts. EBRPD reaches out to community members directly through education and interpretation programs. EBRPD also works indirectly with the community through local governments including cities, flood control districts, and water management agencies. Understanding the social, economic, and cultural background of the populations within the service area helps EBRPD make responsible and effective decisions about maintaining, replacing and expanding shoreline parks. For example, park staff has developed larger group picnic and camping areas to accommodate changes in what services and facilities people in the region would like to see provided by the district. EBRPD has also added shorter trail loops to help elderly and limited mobility visitors experience the EBRPD trail system. Alameda and Contra Costa residents engage with the EBRPD through volunteering, attending programs, commenting at public meetings and voting on bond issues for EBRPD.

EBRPD makes funding and planning decisions through a board with representatives from the seven wards in the district. Board members are elected to four-year terms. The board holds bi-monthly public meetings where they hear updates from EBRPD departments and approve contracts, funding and major purchases and acquisitions. The board determines whether to support or oppose state and federal legislation affecting the District. EBRPD also has a 21 member Park Advisory Committee (PAC) that meets monthly. Board members and other local authorities nominate PAC members for two-year terms. PAC members provide comments and input on park decisions about expansions, capital investments, program changes and other matters. The board also has subcommittees (executive, legislative, operations, finance, workforce diversity, and natural/cultural resources), which meet as needed to discuss specific issues before the EBRPD. Shoreline park staff must receive the approval of the board to acquire land, begin, amend, and complete park specific land use plans, accept grants, and conduct planning. The Board must approve the park district-wide Master Plan (last updated in 2013) as well as site-specific plans such as restoration plans, land use plans, and capital improvement projects.

EAST BAY REGIONAL PARK DISTRICT

Organizational Chart

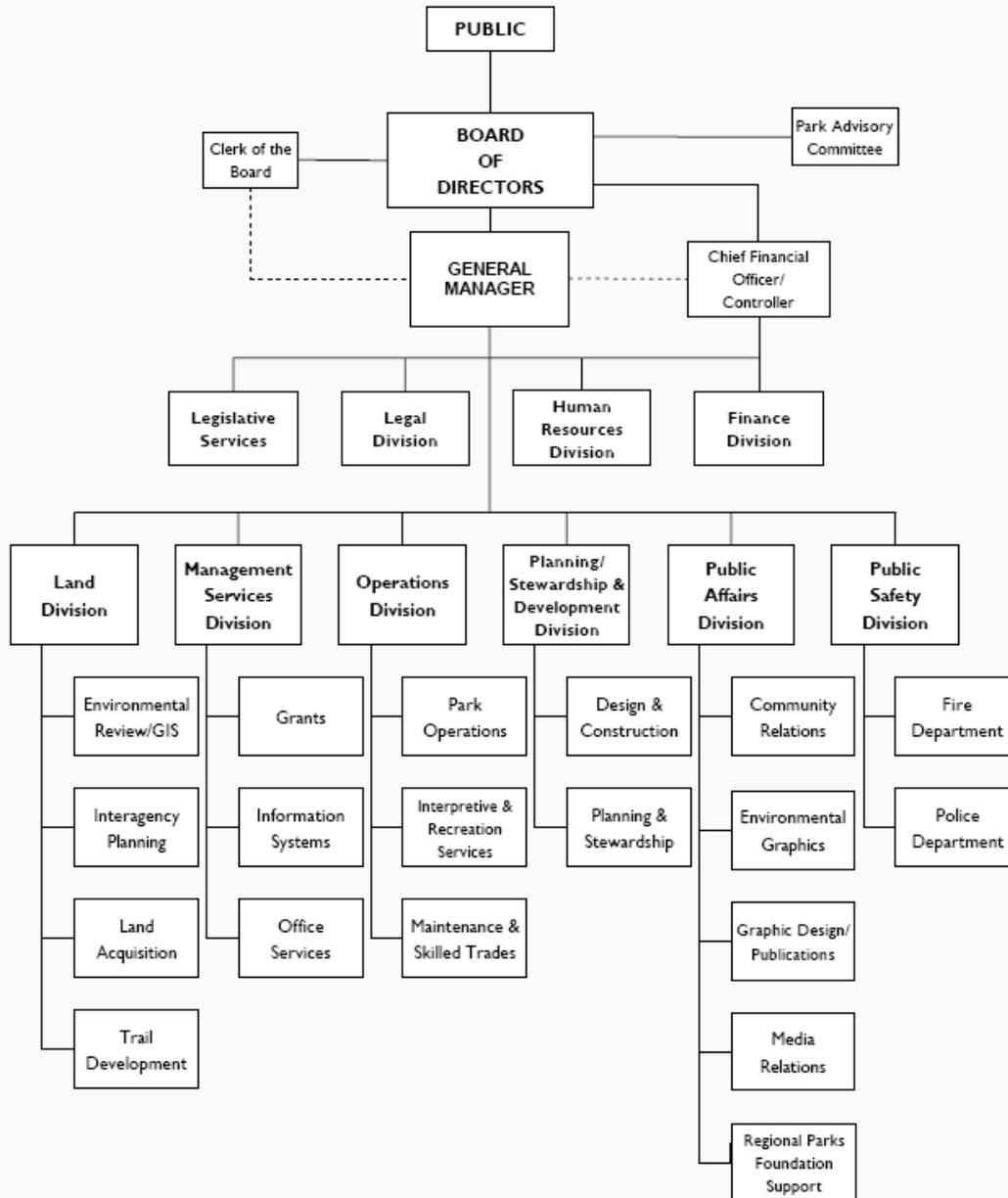


FIGURE 3.2. East Bay Regional Park District organizational chart. Shoreline park management sits within the Operations Division.

EBRPD has an annual budget of \$171 Million (2013). It is funded primarily through taxes and bonds in Alameda and Contra Costa counties (84 percent) and fees/leases (13 percent). The remainder of the budget comes from interagency agreements, investments, and miscellaneous sources. Residents in Alameda and Contra Costa counties approved Measure WW in 2008, which provided a \$500 million expansion to Measure AA from 1988. These funds have been used by EBRPD and partner agencies to acquire new parkland, make overdue infrastructure improvements, and provide recreation opportunities for a growing population. Overall, the EBRPD spends approximately 50 percent of its budget on personnel, 17 percent on debt service, 16 percent on supplies and services, 5 percent on capital outlay and the remainder on interagency agreements and intra-agency costs. Shoreline parks received \$5.7 million in 2013, including \$5.3 million for operations and \$400,000 for projects. The majority (77 percent) of the shoreline park budget goes to personnel costs for the 44 employees in the shoreline unit. Large projects within the shoreline parks such as beach replenishment at Crown Memorial State Beach are funded through a district-wide projects budget and grants. Regular operations and repairs are funded through the shoreline budget.

EBRPD provides unique shoreline recreation opportunities in Alameda and Contra Costa counties. For example, at Crown Memorial State Beach, EBRPD's Crab Cove Visitor Center Naturalists use an accessible tide ramp to introduce visitors to tidal species. EBRPD boat launches accommodate kayaks, stand up paddleboards, rowing shells, and large boats. Public boat launches are rare in the Bay; there are only eight designated water trail launch sites in the entire region, two of which are managed by EBRPD. Crown Memorial State Beach and Miller Knox Regional Shoreline, both managed by EBRPD, contain the only sandy beaches in the East Bay for swimming and wading. Their shoreline parks also accommodate large picnic areas and community centers that could not be replaced in local or upland parks due to limited capacity and high demand. Although many private landowners allow public access to the Bay, EBRPD provides much of the improved access that occurs in Alameda and Contra Costa counties, with interpretive staff, active management, and facilities that enhance the shoreline experience.

EBRPD is responsible for providing recreation and open space in a highly developed and growing area. Since the EBRPD's creation in 1934, the East Bay population has increased from 550,000 to 2.6 million and growing. Like many public agencies, EBRPD struggles to find funding for staff, maintenance, and capital improvements. The EBRPD's role has expanded over the years to include a greater range of management objectives on the parklands it owns and operates, including natural area restoration, community engagement, and new partnerships with neighboring landowners. Climate change will stress EBRPD management even further. EBRPD can expect climate change impacts including increase risks from those hazards and issues that already affect their resources, such as wildfire, heat events, drought, invasive species, changes in habitats, flooding and earthquakes. Sea level rise and future flooding will also affect neighboring and inland land uses in places EBRPD provides the official or de facto shoreline protection. EBRPD will need to work with these neighbors, including Union Pacific Railroad, cities, and private landowners, to protect not only their park and recreation areas but also the inland development that it protects. As the EBRPD plans and prepares for the impacts of climate change and a growing population, the shoreline park unit worked with the ART Program to build upon the work conducted in the ART Alameda County project and to develop a detailed sea level rise and storm event vulnerability and risk assessments and responses that can lead to improved resilience of the district's shoreline parks.

4. EBRPD Shoreline Parks Sea Level Rise Vulnerability and Risk Assessment

As an extension of the ART Alameda County project, ART Program staff worked with EBRPD staff to assess the vulnerability and risk for all EBRPD shoreline parks, extending the project area to Contra Costa County. In order to conduct this assessment, ART staff conducted desktop research, used existing ART resources, and site visits and interviews with park staff to create the following vulnerability and risk assessment. The ART Program defines **vulnerability** as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including inundation and storm event flooding.

Approach to Understanding Sea Level Rise Vulnerability and Risk in Shoreline Parks

For all park and recreation resources, including natural areas and built infrastructure like trails, interpretive centers, and picnic areas, understanding the potential exposure to future climate impacts is the first step in determining vulnerability and risk. However, to understand the vulnerability of shoreline parks, managers must consider how sensitive the assets may be to projected storms and sea level rise and the ability of the agency and the asset to adapt to the changes brought on by these impacts. Marshes, managed ponds and seasonal wetlands are supposed to be inundated for parts of the day or the year, so temporary flooding may not damage them. At the other extreme, some parks house community centers and education facilities, some of which would be severely damaged by short duration flooding or destroyed by permanent inundation. Park structures like boat ramps and playgrounds may be less sensitive; they could have moderate sensitivity to temporary and limited duration flooding, but may quickly recover and reopen when the flooding event is over.

ART Program staff and EBRPD park supervisors completed surveys and site visits to determine the sensitivity of park resources to both temporary and permanent flooding. Research and interviews also helped BCDP staff understand the informational, governance, functional and physical vulnerabilities of EBRPD resources, individual parks and resource types. Information about EBRPD budgets, grants, permits and planning processes helped park supervisors and ART Program staff understand current management issues and information gaps that may increase sea level rise vulnerability in shoreline parks and therefore represent opportunities for adaptation responses that would build resilience.

Some of the physical characteristics that make shoreline parks vulnerable include shorelines that are prone to erosion and those with low elevation habitats. For example, Crown Memorial State Beach requires regular sand nourishment to maintain its recreational and flood protection benefits. Storm events and sea level rise will lead to increased maintenance needs, increased costs and/or the eventual loss of the beach. Point Pinole and Miller Knox Regional Shoreline have bluffs and natural shorelines that are subject to major erosion and collapse during storm events. Martin Luther King Jr. Regional Shoreline, Hayward Regional Shoreline, and other parks with extensive riprap require more frequent maintenance and will need improvements to increase the protection provided to trails, park and other assets from sea level rise and storm impacts. In addition, almost all tidal marshes within the EBRPD area are vulnerable to sea level rise. The marshes may be degraded and eventually drown because they are too low and do not have enough sediment supply to keep

up with sea level rise or the inland areas necessary to allow them to migrate naturally to higher land. If the marshes transition entirely to mudflat or Bay, their flood protection, wildlife, educational, and recreational values will be diminished or lost.



FIGURE 4.1. Point Isabel Regional Shoreline dog walkers. Photo Credit: Point Richmond Voice

In addition to being physically vulnerable, shoreline parks are functionally vulnerable because of the services they rely on and functions provided by park and recreation assets and services. Parks rely on transportation services to provide visitors access, so transportation vulnerabilities can affect park use. Oyster Bay Regional Shoreline is relatively high in elevation due to its construction on a closed landfill, so no flooding is expected within most of the park. However, the access road to Oyster Bay is very low-lying. During flood events the park may be undamaged but inaccessible and therefore not available to the public. Similarly, parks with restrooms, visitor's

centers like Crab Cove Interpretive Center, or the Point Isabel dog concessionaire require electricity, water supply, and wastewater utilities to be functional for the park to operate at full capacity. Vulnerabilities in the utility network that serve shoreline parks that result in service outages or disruptions that are widespread and long lasting could significantly affect park function.

EBRPD faces information gaps and governance challenges when managing its parks for current flood events and future sea level rise and storm impacts. The lack of certainty about exactly when and how or when sea level rise will begin affecting marshes and other natural areas means that levee and structural shoreline maintenance is put off until significant damage occurs. Even when the District takes up a project, the project is challenging due to budget limitations and extensive permitting requirements. EBRPD also manages many parks that they do not own. Their cooperative management agreements with California State Parks, local park districts and cities complicate long term management of the parks and restrict managers' park infrastructure investment decisions. Park supervisors must also work around infrastructure owned by others, such as utility pipelines, or flood control channels that run through shoreline parks. Adjacent land uses, including railroads, bridges, and industrial facilities can make parks more vulnerable to sea level rise and storm impacts because of hazardous material use or contamination, uncoordinated improvements to railroad alignments, and right-of-way requirements for transportation corridors. Park planners, managers and the region will need to work proactively and cooperatively to protect park and recreation resources and access to parks, while considering the relationship of these resources to neighboring land uses.

Special consideration needs to be given regarding the vulnerabilities of park and recreation assets that serve communities with characteristics that make them more vulnerable to climate change and hazard disruptions. EBRPD serves 2.6 million Alameda and Contra Costa county residents as well as other Bay Area residents and visitors. Alameda and Contra Costa counties are very diverse, with more than 50 percent of resident's non-white or Hispanic. Both counties have around 10 percent of households living below the poverty line (2010 US Census). Almost a quarter of residents are foreign-born. In studies conducted by the Pacific Institute, which assessed the relationship between climate change vulnerability and population characteristics in California, Alameda and Contra Costa Counties contained a number of census blocks near EBRPD shoreline parks with these characteristics, including poverty, linguistically isolated households, and a lack of access to green space⁴.

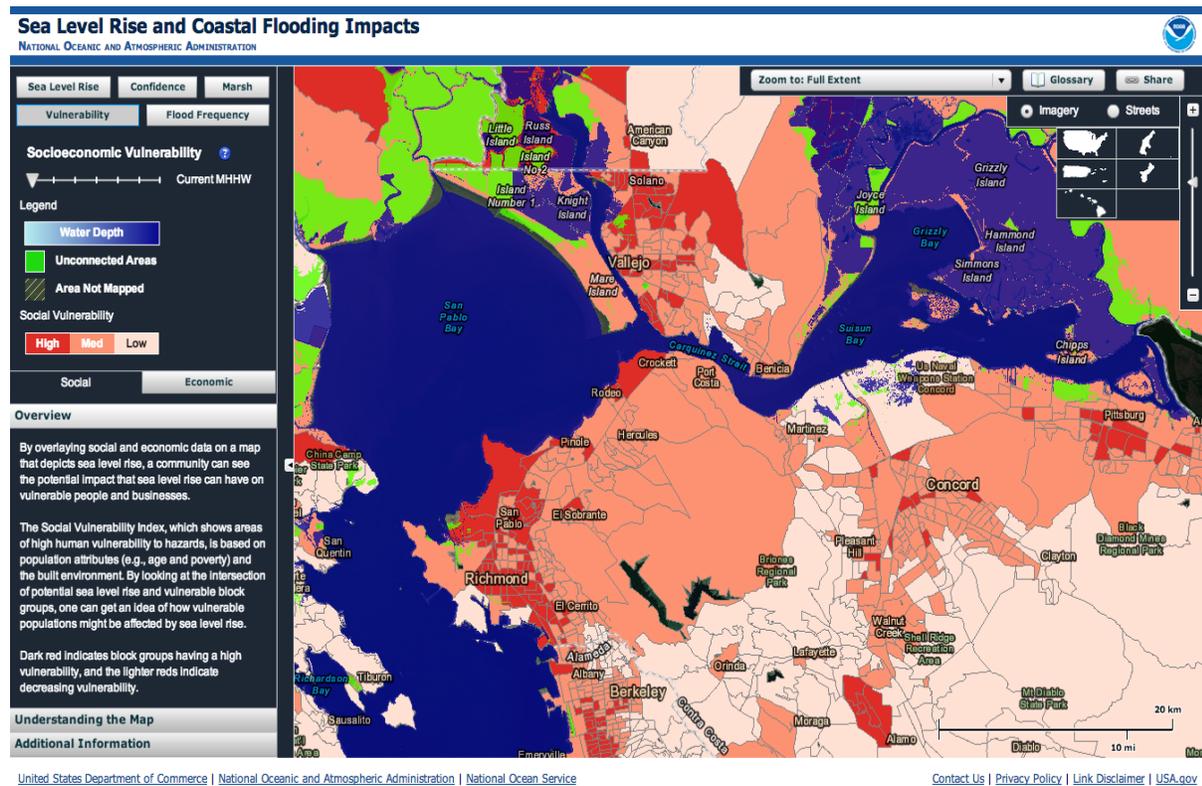


FIGURE 4.2. Socio-economic vulnerability index for Contra Costa County. Higher vulnerability areas are shown in red including much of Pinole, Richmond and San Pablo.

These community characteristics make the services and system provided by EBRPD more vulnerable to climate change impacts due to reduced ability to raise funds, a lack of alternative or redundant open spaces and challenges to accommodate closures or maintenance. Additionally, because the areas near the EBRPD shoreline parks are projected to grow, adding new households and residents, and because there is a lack of other open spaces near these parks, particularly in cities like Oakland and Richmond, the EBRPD will need to accommodate more visitors and address sea level rise and storm impacts at the same time.

⁴ <http://coast.noaa.gov/slr/>

High Level Exposure Analysis

In conjunction with desktop research and park staff interviews to understand vulnerability and consequences, the ART Program conducted an exposure analysis of the EBRPD shoreline parks. Overlaying park maps with future sea level rise scenarios can provide a better understanding of how and when to prepare for future sea level rise and flood impacts. For EBRPD, BCDC staff used the NOAA CSC Sea Level Rise Viewer⁵ to map potential impacts with 1, 2, 3, 4, 5, 6ft of sea level on top of the daily high tide, or mean higher high water (MHHW). Inundation maps show managers and decision makers areas, which may be temporarily flooded during storm events or permanently inundated due to sea level rise. For shoreline parks, many areas are already partially or totally within the daily tidal range or are seasonally flooded during extreme high tides. The response of these dynamic nearshore systems to changes in sea level will depend on a number of factors including mineral sediment supply and organic matter accumulation. The NOAA CSC Sea Level Rise Viewer maps used to evaluate park exposure do not account for the nearshore dynamic processes that are likely to occur within natural areas and therefore provide a very conservative estimate of the potential impact to these areas.

Park Name	Total Acres	0'	1' SLR	2' SLR	3' SLR	4' SLR	5' SLR	6' SLR
Martinez Shoreline	158	0	45%	56%	62%	66%	74%	78%
Point Pinole	594	0	13%	18%	19%	21%	22%	23%
Miller Knox Regional Shoreline	209	0	1%	2%	2%	2%	2%	7%
Brooks Island/Point Isabel	68	0	14%	22%	27%	30%	32%	33%
Eastshore State Park	317	0	27%	30%	33%	37%	53%	59%
Crown Memorial State Beach	80	0	1%	4%	11%	30%	48%	65%
MLK Regional Shoreline	217	0	42%	45%	53%	65%	82%	89%
Oyster Bay Regional Shoreline	187	0	2%	2%	2%	3%	3%	4%
Hayward Regional Shoreline	149	0	86%	91%	97%	98%	99%	100%

Table 4.1. Park area and percentage inundated at present and for six future water levels.

⁵<http://coast.noaa.gov/digitalcoast/tools/slr>

The exposure analysis provided the ART Program staff with a useful screening process to highlight at-risk areas and resources and was refined by interviewing people with expertise about the shoreline areas and through field visits. For future projects and site-specific management decisions, further investigation will be needed to fully understand local shoreline elevations, condition, and overtopping potential, similar to the work and analysis conducted within the ART Program for the Hayward Regional Shoreline.

Exposure analysis and the vulnerability and risk assessments were conducted for nine parks and regional shorelines managed by EBRPD for water levels between current MHHW and MHHW+6 feet.

All of the parks are exposed to at least some flooding with six feet of sea level rise. Low-lying parks consisting mostly of wetlands, like Hayward Regional Shoreline, are nearly fully inundated with this amount of sea level rise, while higher elevation parks like Oyster Bay Regional Shoreline will experience only limited flooding. Six feet of sea level rise is a reasonable proxy for a year 2100 storm event, given the National Research Council has predicted three feet as the most likely sea level rise scenario for San Francisco Bay and the current 100-yr storm event is approximately three feet above MHHW.

The Define Step: Understanding Key Vulnerabilities and Planning Issues

Instead of a numerical scoring or ranking system to prioritize adaptation actions, the ART Program developed an approach to classify vulnerabilities and risks into actionable categories that would help asset managers and decision-makers understand the defining characteristics of an issue (e.g., its timing, scale, responsibility for management, consequence, etc.). This approach better supports informed discussions and decisions – both internal to the agencies participating in the ART Program and in coordination with other interested parties and stakeholders – about priorities and potential adaptation responses. Additionally, defining key issues and planning priorities in terms of actions to be taken rather than numerical risk rankings makes the results of the assessment more transparent and actionable to decision-makers and asset managers. The ART Program and EBRPD staff used three classifications, governance, functional, and physical, to identify types of key vulnerabilities for the entire shoreline and individual parks. Governance vulnerabilities stem from challenges with management, regulatory authority or funding options that create barriers to adaptation. Physical vulnerabilities occur when conditions or design aspects of an asset make it highly sensitive to sea level rise impacts. Functional vulnerabilities arise when an asset cannot provide its core service, even if it has not been physically damaged, e.g., when a park is inaccessible due to a flooded roadway, it cannot provide recreation even if the park itself is intact.

The vulnerability classifications make it easier to identify specific and appropriate actions, the potential agencies and other actors to be involved, and the processes and scales at which the actions could be implemented. Understanding the type of vulnerability can more quickly lead to a targeted and appropriate response to resolve the real issues faced, avoiding potentially costly and unnecessary actions. The vulnerability assessment also identified potential consequences to society and equity, the economy, and the environment due to specific vulnerabilities.

EBRPD Key Vulnerabilities

The shoreline parks staff selected five key vulnerabilities with help from ART Program staff. These vulnerabilities were originally identified in the ART Alameda County Project and refined to be EBRPD-specific. EBRPD's key vulnerabilities, listed below, are present across the shoreline parks and affect the function of EBRPD as a whole.

GOVERNANCE Structural shorelines that (a) lack dedicated funding and permit authorizations for maintenance and improvements, and (b) are not included in long-range capital improvement planning, are more vulnerable because shoreline managers cannot easily maintain or make repairs to address sea level rise and storm event impacts.

GOVERNANCE Planning and implementing improvements or use changes at shoreline parks is complex because parks are often managed by one agency while the land is owned by another. Some parks have multiple managers and owners, adding complexity to funding and decision-making.

PHYSICAL Depending on the type and design, structural shorelines have varying sensitivity to tidal action and wave energy (e.g., daily tides can cause wear and tear, while overtopping during larger storm events can cause destabilization and failure).

PHYSICAL Many Bay Trail segments are vulnerable because they are situated on shoreline levees, cannot be used when flooded, and are surfaced with materials that are not erosion-resistant. Because of the interconnected nature of the Bay Trail, disruption of one can segment can affect the function of the entire Bay Trail in connecting the region's shoreline.

FUNCTIONAL Birds and wildlife that rely on tidal marshes will be displaced by more frequent flooding and permanent inundation that lead to habitat changes, e.g., downshifting or drowning. These changes will force them to forage and nest closer to people and infrastructure, such as roads and highways, and will reduce the amount of available high tide refugia.

Park Assessments

Park supervisors and ART Program staff developed vulnerability and risk information and key vulnerabilities at the park and district level. Park specific information, gathered through field visits and interviews with park supervisors, follows. Each park has a short description of existing conditions and stressors and classified vulnerabilities and consequences. Some vulnerabilities are present at the park and district level while others apply in only one or a few parks. Consequences vary for parks depending on resources within the park, surrounding land uses, and user groups in different locations. The parks are organized from north to south.

Martinez Regional Shoreline

Martinez Regional Shoreline is a 342-acre park with shoreline trails, marshes, fishing, picnic areas and separate recreation areas managed by the City of Martinez, including a marina and athletic fields. Park infrastructure is over 35 years old. Shorelines are rapidly eroding and erosion has forced the closure of over 300 feet of trail in past years. Outer turf areas are experiencing increasing salt-water intrusion and planted trees are showing increasing signs of exposure to salt water. Interior marshes were designed to alleviate flooding in downtown Martinez through a joint agency project with the City of Martinez, which was completed in 2004. These marshes have been functioning well in wet weather events.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Rising sea level will exacerbate shoreline erosion.	Physical	Recreation opportunities will be lost as EBRPD closes or reroutes trails and shoreline access points.
	Functional	Natural shorelines such as beaches, cliffs and marshes provide habitat that may be lost due to erosion.
The service road along the shoreline could be compromised by shoreline erosion and overtopping.	Functional	EBRPD cannot access the shoreline and historic buildings to maintain and manage the park without an open service road.
Saltwater intrusion is damaging turf areas and killing trees in the passive recreation area.	Physical	EBRPD must clear out dead trees and may eventually convert the turf to different land cover. This would degrade the passive recreation opportunities at Martinez Regional Shoreline.

Miller-Knox Regional Shoreline

Miller-Knox Regional Shoreline is a 307-acre shoreline park that includes trails, a swimming area at Keller Beach, picnic facilities, the Golden State Model Railroad Museum, a fishing pier and a lagoon. The park is built at the site of a historic ferry terminal that no longer provides ferry service. Several historic structures are located on the property. The structures are vacant and are vandalized frequently. The park contains seven miles of Bay Trail with views of the Bay and historic sites. The park contains an unused railroad right-of-way that is now owned by EBRPD but still contains railroad bed and tracks.

EBRPD is preparing a Land Use Plan Amendment (LUPA) for Miller-Knox. This process may include breaching the lagoon to tidal action, removing historical structures, and adding Bay Trail segments to complete the trail to the park. Sea level rise will be taken into consideration during this planning process. The lagoon has current management problems in terms of water quality that may be addressed through tidal action. The LUPA process will assess the feasibility of breaching the lagoon.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Rising sea level will exacerbate shoreline erosion.	Physical	Recreation opportunities will be lost as EBRPD closes or reroutes trails and shoreline access points.
	Functional	Natural shorelines such as beaches, cliffs and marshes provide habitat that may be lost due to erosion.
The service road along the shoreline could be compromised by shoreline erosion and overtopping.	Functional	EBRPD cannot access the shoreline and historic buildings to maintain and manage the park without an open service road.
Riprap along the shoreline is not properly stacked, keyed, and engineered.	Physical	EBRPD could not continue maintenance and operations without incurring greater costs or loss of recreation services.
Keller Beach may be subject to increased erosion due to storm events and sea level rise.	Physical	Sandy beach swimming opportunities could be lost.

Point Isabel Regional Shoreline

Point Isabel Regional Shoreline covers 23 acres, and includes Bay Trail, grass areas, Hoffman Channel and Hoffman Marsh, and riprap shoreline segments. The park also contains a dog grooming business and cafe as a concessionaire as well as restrooms and a parking lot for visitors. Despite its small size, it is a very popular location for off-leash dog walking and serves 1.4 Million visitors each year. EBRPD has worked to minimize erosion in Hoffman Channel through fencing to keep dogs out and bank stabilization. Dogs and humans are not allowed in Hoffman Marsh to protect its habitat value.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Portions of the park and its levees may be overtopped or flooded by higher tides and more severe storms in the future.	Physical	Flood control maintains community services and protects private and public property. Without proper management, flooding will affect the surrounding community and reduce access to the recreation opportunities of the trails.
The park's trails are part of the Bay Trail system, and if closed, would prevent recreation and reduce access to the shoreline.	Functional	These trails are within an underserved community, and negative impacts would affect the community directly.
Marsh habitat may be submerged and lost due to sea level rise.	Physical	Marsh habitat would be lost or degraded affecting wildlife populations and recreation.

Wildcat Creek Trail and Wildcat Marsh Trail

Wildcat Creek Trail is an eight-foot wide asphalt trail, which extends from Wildcat Marsh to east of Giarmita Street, plus a parking lot, restroom, and a grassy meadow. The portion of the trail system that is located under the Richmond Parkway has been closed for over 10 years due to overtopping of Wildcat Creek onto the trail, flooding the trail and failure of the flood control district’s pumping system. Budget constraints will determine whether the tunnel is repaired or a bridge overcrossing is to be built. Wildcat Marsh Trail is on the edge of the marsh, so sea level rise and major storm events will affect this trail in the future. This section of trail was built in 2012 and constructed to be resilient to future flooding and sea level rise up to MHHW+36” through increased trail elevation and the use of erosion-resistant materials. Wildcat Creek Trail is owned entirely by Contra Costa Flood Control District, and Wildcat Marsh Trail is the property of West County Wastewater District. Since both trails are integral to their missions, it is very likely that both agencies will keep these trails useable.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
The entire area is within a 100-year flood zone, and the surrounding levees may be overtopped by higher tides and more severe storms in the future.	Physical	Flood control maintains community services and protects private and public property. Without proper management, flooding will affect the surrounding community and reduce access to the recreation opportunities of the trails.
These trails are part of the Bay Trail system, and if closed, would prevent recreation and reduce access to the creek and the marsh.	Functional	These trails are within an underserved community, and negative impacts would affect the community directly.
Marsh habitat may be submerged and lost due to sea level rise.	Physical	Marsh habitat would be lost or degraded affecting wildlife populations and recreation.

San Pablo Bay Shoreline

San Pablo Bay Shoreline is currently a series of disconnected multi-use trail segments and adjacent parklands, extending along the southeastern shore of San Pablo Bay from west of Pinole Shores Drive in San Pablo to the town of Rodeo. When completed, this trail will connect Point Pinole Regional Shoreline with the shorelines in the cities of San Pablo, Pinole, Hercules, and Rodeo, and eventually to regional trails further east. Budget and political constraints have delayed the completion of the trail due to the necessity of constructing bridges across the railroad tracks at two locations. Completion of the trail is planned but not funded. Hercules, Pinole, and Rodeo are highly socioeconomically vulnerable as shown in Figure 1, because their residents are disproportionately elderly and low income. Many users of the trail are elderly or disabled, therefore maintaining their access to the trail is critical. Lone Tree Beach, a popular recreation site along the San Pablo Bay Trail, has suffered severe erosion due to strong tidal action and poor shore stabilization. The cliffs are being undermined and are somewhat unstable. Lone Tree Beach is adjacent to derelict private property that has drawn graffiti and crime to the area and made management of the park difficult. The land is under new ownership but it is unclear what the site will become due to soil contamination and other issues.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Rising sea level will exacerbate shoreline erosion.	Physical	Recreation opportunities will be lost as EBRPD closes or reroutes trails and shoreline access points.
	Functional	Natural shorelines such as beaches, cliffs and marshes provide habitat that may be lost due to erosion.
Lone Tree Beach is highly erodible and erosion will increase with storm events and sea level rise.	Physical	Sandy beaches are rare and heavily used. The loss of this beach cannot be replaced within Rodeo for users.
Trail flooding and rerouting may cause temporary or permanent disconnection.	Functional	Bay Trail depends on connected segments—even small closures can disrupt the function of the trail. Rerouting and detours need to be considered in the context of the Bay Trail system.
Marshes may not be able to persist with rising sea level due to their low elevation, low sediment supply, and lack of landward space.	Physical	Marsh habitat may be lost or degraded.
Railroad easements along the trail are vulnerable to sea level rise. Railroad actions to address their own vulnerabilities may negatively affect park assets.	Governance	Parkland may be lost or cut off from access if the railroad companies need to raise or rebuild their railroad beds.

Point Pinole Regional Shoreline

Point Pinole Regional Shoreline contains 2,315 acres of marsh, meadow and woodlands and provides fishing, walking, nature viewing and dog walking recreation opportunities. The park provides shuttle service seven days a week to bring visitors from the parking lot to the fishing pier and other attractions within the park. The park is heavily used as an off-leash dog area. The park has rerouted several foot trails to accommodate shoreline cliff erosion and collapse. So far, there has been sufficient space to reroute trails and maintain access to the shoreline. The fishing pier, the most significant built infrastructure at the park, is in good condition and sufficiently high to be resilient to future sea level rise impacts.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Rising sea level will exacerbate shoreline erosion.	Physical	Recreation opportunities will be lost as EBRPD closes or reroutes trails and shoreline access points.
	Functional	Natural shorelines such as beaches, cliffs and marshes provide habitat that may be lost due to erosion.
Trail flooding and rerouting may cause temporary or permanent disconnection.	Functional	Bay Trail depends on connected segments-even small closures can disrupt the function of the trail. Rerouting and detours need to be considered in the context of the Bay Trail system.
Marshes may not be able to persist with rising sea level due to their low elevation, low sediment supply, and lack of landward space.	Physical	Marsh habitat may be lost or degraded.
Railroad easements along the trail are vulnerable to sea level rise. Railroad actions to address their own vulnerabilities may negatively affect park assets.	Governance	Parkland may be lost or cut off from access if the railroad companies need to raise or rebuild their railroad beds.

Crown Memorial State Beach

Crown Memorial State Beach in the City of Alameda is comprised of approximately 70 acres of sandy beach and 25 acres of landscaped areas. The northern portion of the park is owned by California State Parks and includes the Crab Cove Visitor Center. The long narrow southern part, including the beach and trail along Shoreline Drive, is owned by the City of Alameda. East Bay Regional Park District has operating agreements and manages both areas as one park. The State of California and the City of Alameda do not provide funding except for a shared cost with the city for annual beach maintenance. The park's long sandy beach – the largest contiguous beach on San Francisco Bay – is a popular recreational feature. Some flooding impacts are already evident at the park. The rocky point at the northern tip of the park is frequently overtopped with high tides and wind waves; and the lawn outside of the Crab Cove Visitor Center was flooded in January 2006 during an extreme high tide on New Year's Day.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Crab Cove education programs rely on a barrier-free tide ramp that is in poor condition and too low.	Physical	Educational opportunities will be lost, particularly for disabled visitors who need the tide ramp to access the shoreline.
A Windsurf and kiteboard concession at the park relies on sandy beach access.	Functional	Concessions bring in revenue for the park system and add recreation options for park visitors. Without sandy beach, this concession will leave the park.
Crown Beach is highly erodible and erosion will increase with storm events and sea level rise.	Physical	Sandy beaches are rare and heavily used. The loss of this beach cannot be replaced within Alameda and beach nourishment is costly.
The southern portion of the beach is a narrow strip with Alameda roads directly behind it. There is little room to modify park land and maintain the road.	Governance	Park land may be lost due to erosion or necessary road and shoreline protection improvements.

Martin Luther King Jr. Regional Shoreline

This popular, 217-acre park, located along the shoreline around San Leandro Bay, offers a diversity of recreation opportunities. Park facilities and activities include 3.7 miles of Bay Trail with six bridges, the Tidewater Boating Center with facilities and launches for rowing and kayaks, a boat launch ramp, the Shoreline Center (rental facility), 16 acres of grass turf, nine staging areas providing parking, picnic tables and restrooms, a staff office, the Arrowhead Marsh Overlook ramp and boardwalk, interpretive signage, wildlife viewing opportunities, and three marshes – Arrowhead, New, and Damon – which provide habitat for endangered species.

In the past, flooding has occurred on the grass turf and the Bay Trail during extreme weather events that coincided with high tides. High tides (greater than six feet NAVD 88) also flood the marshes regularly, and, when combined with storm events, can affect the Tidewater Boating Center. Currently, the park assets recover quickly or are not significantly impaired by this temporary flooding. For example, despite regular flooding, the three marshes are not subject to erosion due to the sheltered nature of San Leandro Bay. However, as sea level rises, the depth and duration of the flooding will increase, resulting in permanent, rather than temporary, flooding of these areas.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Rising sea level will exacerbate shoreline erosion along levees and natural shorelines.	Physical	Recreation opportunities will be lost as EBRPD closes or reroutes trails and shoreline access points.
Marshes may not be able to persist with rising sea level due to their low elevation, low sediment supply, and lack of landward space.	Physical	Natural shorelines such as beaches, cliffs and marshes provide habitat that may be lost due to erosion.
Endangered species habitat in healthy mid and high marsh may be lost if marshes downshift or drown.	Functional	Endangered species populations may not be locally viable given further reductions in habitat extent and quality.
Trails on failing levees may be flooded or damaged and be subject to temporary or permanent disconnection.	Functional	Bay Trail depends on connected segments—even small closures can disrupt the function of the trail. Rerouting and detours need to be considered in the context of the Bay Trail system.
MLK has a narrow footprint and borders extensive private property. Any adaptation measures would have to fit into the existing property arrangements.	Governance	Park land may be lost or cut off from access if agreements with the flood control district and private property owners cannot accommodate sea level rise.

Oyster Bay Regional Shoreline

This 190-acre park, located on a former landfill in the City of San Leandro that closed in the 1980s, is still under construction. Some park amenities are already open to the public, including a segment of the Bay Trail along the shore as well as upland trails, picnic tables, a restroom, and a four-acre grass area. To fully convert the landfill to a park over the next few years, EBRPD will be completing grading and landscaping and a new park entrance at Davis Street, with new parking located within the park. The Land Use Plan Amendment adopted for Oyster Bay Regional Shoreline includes the creation of a new entrance to the park, which builds resilience for the park, as it will no longer rely on a sole, vulnerable, access route.

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
More frequent and extensive inundation of the slough may reduce the quality of habitat and wildlife viewing at the park.	Functional	Wildlife viewing opportunities will be degraded.
	Physical	Habitat may be lost or degraded for marsh and slough species.
The park is constructed on a former landfill with leachate wells and uneven capping.	Governance	Any management measures need to maintain access for Waste Management and ensure the safety of the landfill cap and edges.
Surface streets that provide access to the park are exposed to sea level rise impacts.	Functional	Park land may be lost or cut off from access if city roads are not made more resilient.

Hayward Regional Shoreline

This large, 1,700-acre shoreline park features five miles of unpaved Bay Trail (along the park’s outboard levees) and other levee-top trails that connect the shoreline trail from the City of San Leandro to the Hayward Shoreline Interpretive Center (just north of Highway 92). The park is popular for walking, biking, running, bird watching, dog walking, fishing, and enjoying scenic views. It also provides opportunities to see three different marsh types. Oro Loma Marsh, near the northern end of the shoreline, is a tidal salt-water marsh at its western end, and a seasonal freshwater marsh fed by rainwater at the slightly higher elevations at its eastern end. Cogswell Marsh, near the southern end of the shoreline, was formerly a commercial salt pond that has been restored to tidal salt marsh habitat. Hayward Marsh is also a restored marsh, but it supports a different, more brackish mixture of vegetation because it receives treated freshwater from a nearby wastewater treatment plant (Bay Nature 2012).

VULNERABILITY AND CONSEQUENCES

Vulnerability	Classification	Consequence
Rising sea level will exacerbate structural shoreline erosion.	Physical	Recreation opportunities will be lost as EBRPD closes or reroutes trails and shoreline access points.
	Functional	Levees that are not high enough or properly maintained cannot adequately protect infrastructure behind them.
Trail flooding and rerouting may cause temporary or permanent disconnection.	Functional	Bay Trail depends on connected segments—even small closures can disrupt the function of the trail. Rerouting and detours need to be considered in the context of the Bay Trail system.
Marshes may not be able to persist with rising sea level due to their low elevation, low sediment supply, and lack of landward space. Managed ponds may be overtopped due to sea level rise and storm event impacts.	Physical	Marsh habitat may be lost or degraded.
	Functional	Managed marsh may lose its capacity to handle wastewater outflows.
	Functional	Hayward Shoreline Interpretive Center uses the marshes for environmental education and interpretation for all ages. Even if the center is protected, without marsh to interpret they cannot maintain their function.
Railroad and utility easements along the trail are vulnerable to sea level rise. Private property owners’ actions to address their own vulnerabilities may negatively affect park assets.	Governance	Depending on the actions or inaction of other property owners, recreation and habitat within the park may be degraded through new construction, the mobilization of contaminants, or other disruptions.

5. Adaptation Responses for EBRPD Shoreline Parks

In considering how to best address the vulnerabilities identified in the EBRPD shoreline parks, project staff quickly determined that a comprehensive approach that went beyond a list of actions or strategies was needed. The resulting adaptation responses, which are discussed in more detail below, connect actions directly to the findings of the vulnerability and risk assessment, and provide a path towards action implementation. ART Program staff developed adaptation responses for the five key vulnerabilities. See below for proposed actions for each key vulnerability as well as potential actors, funding sources, and implementation mechanisms. These five responses with full detail can be found in Appendix B.

GOVERNANCE Structural shorelines that (a) lack dedicated funding and permit authorizations for maintenance and improvements, and (b) are not included in long-range capital improvement planning, are more vulnerable because shoreline managers cannot easily maintain or make repairs to address sea level rise and storm event impacts. To address this issue, EBRPD will need to dedicate shoreline park resources to maintenance and repairs and work with planning and project design staff to improve the long term condition and function of its shorelines.

- Identify partnerships with neighboring landowners and other agencies that need to be developed or expanded to adapt to future water levels
- Prioritize the allocation of resources to vulnerable "at-risk" structural shorelines to ensure their regular and ongoing maintenance and any necessary upgrades or repairs
- Inspect and repair critical structural shorelines after storm events
- Advocate for a regional permit authorization program to expedite the ongoing maintenance, minor repair, or replacement of structural shorelines
- Identify and prioritize critical structural shorelines for inclusion in long-range capital improvement plans

PHYSICAL Depending on the type and design, structural shorelines have varying sensitivity to tidal action and wave energy (e.g., daily tides can cause wear and tear, while overtopping during larger storm events can cause destabilization and failure). EBRPD will need to work across its own departments as well as with neighboring landowners to fully understand the current condition of its structural shorelines and plan for repairs and improvements.

- Protect, enhance, or restore baylands outboard of structural shorelines to preserve wave attenuation benefits, thereby reducing wave erosion, the likelihood of overtopping, and maintenance needs of structures such as non-engineered berms and levees
- Increase the size or amount of armor on structural shorelines to reduce erosion and scour
- Enhance or reinforce non-engineered berms, e.g., armor to protect from erosion
- Increase the height of structural shorelines, if technically feasible and if physical and environmental constraints allow, to reduce potential overtopping

- Combine different types of structural shorelines, e.g., construct a flood wall on top of a levee
- Relocate or re-align structural shorelines to a landward location in conjunction with partner agencies and neighboring landowners

GOVERNANCE Planning and implementing improvements or use changes at shoreline parks is complicated because parks are often managed by one agency while the land is owned by another. Some parks have multiple managers and owners, adding complexity to funding and decision-making. EBRPD will need to maintain and improve its interagency relationships in order to adapt to sea level rise impacts.

- Develop agreements between park managers, landowners and other relevant agencies that articulate shared objectives, decision-making, and funding responsibilities for sea level rise adaptation planning and response
- Expand or form partnerships between agencies, organizations and community members to facilitate decision-making regarding park improvements and new investments in light of sea level rise

PHYSICAL Many Bay Trail segments are vulnerable because they are situated on shoreline levees, cannot be used when flooded, and are surfaced with materials that are not erosion-resistant. Because of the interconnected nature of the Bay Trail, disruption of one can segment can affect the function of the entire Bay Trail in connecting the region's shoreline. EBRPD will need to coordinate its park managers, planning staff, and Bay Trail staff to protect Bay Trail connections throughout the East Bay.

- Develop and keep current a Bay Trail asset management database that includes location, elevation, condition and management status
- Prioritize replacing vulnerable trail segments with erosion-resistant surfacing materials where possible
- Establish agreements among shoreline managers and others to maintain, repair and upgrade shoreline levees in a manner best preserving the Bay Trail and connected shoreline access

FUNCTIONAL Birds and wildlife that rely on tidal marshes will be displaced as more frequent flooding and permanent inundation lead to habitat changes, e.g., downshifting or drowning. These changes will force birds and wildlife to forage and nest closer to people and infrastructure, such as roads and highways, and will reduce the amount of available high tide refugia. EBRPD shoreline park managers and stewardship department staff will need to work together and with others to protect habitat and endangered species.

- Develop policies, guidance or incentives to encourage appropriate setbacks and buffers adjacent to tidal marshes that support sensitive bird and wildlife species
- Install "artificial" high tide refugia in habitats exposed to tidal inundation where natural refugia are limited
- Protect existing, or create new, corridors that facilitate the movement of birds and wildlife to viable nearby or adjacent habitats

6. Recommendations for Building Shoreline Park Resilience

EBRPD will need to change its internal approaches to maintaining, planning and funding shoreline parks as well as work with neighbors, partner agencies, and permitting agencies to prepare for sea level rise and storm impacts. EBRPD provides recreation and open space opportunities to a growing and diverse population. At the same time, EBRPD faces an uncertain financial future which does not include the necessary resources to address all of the current and future demands of the open space and recreation areas that the District currently manages, and climate change impacts to parks from increased wildfire, flood, habitat and species changes and drought risks will make this work more difficult.

To address these challenges and continue serving the region's communities effectively, EBRPD will need to maintain the parklands and facilities it has while preparing for major changes in land use, shorelines, and communities. This will stretch the financial and organizational capacity of the EBRPD. Increased maintenance costs due to sea level rise and storm event impacts will compete with capital improvement projects for funding.

Regardless of the availability of funding, some shoreline parks have limited options for physical and functional adaptation. Hardening shorelines through riprap or sea walls is not appropriate or permissible along the park district's natural shorelines. Some EBRPD shoreline parks have narrow footprints where retreat is not possible due to landward development. Some park facilities and uses such as community centers could be relocated and rebuilt if space can be found, but there is little undeveloped shoreline to replace lost shoreline access.

In the face of these challenges, it is important to communicate the need for sea level rise adaptation and preparation for storm events in order to ensure the persistence of parks and recreation resources. Due to the importance of parks to the environment, economy and social equity, the parks are an important place to start building community resilience. EBRPD should begin to develop and strengthen communication and outreach to the public on these issues and learn from successful efforts in the region, state and the country in developing an effective program for their agency's many assets and services.



FIGURE 6.1. East Bay Regional Park District Staff on a field trip with partner agency staff as part of the Adapting to Rising Tides Program

Governance vulnerabilities left unaddressed will severely limit EBRPD's response to sea level rise impacts. Presently, EBRPD staff struggle to complete levee and shoreline maintenance, even in response to current storm event damage, due to permitting requirements from BCDC, the Army Corps of Engineers, wildlife agencies, and the Regional Water Quality Control Board (RWQCB). Rigorous permitting requirements regarding fill, shoreline improvement, and any activities in sensitive marsh habitat make shoreline projects expensive and complicated. To date, EBRPD has taken up these maintenance and repair projects one at a time, often in short segments (150 feet or less of shoreline). This makes the permitting easier for the project itself, but does not solve district-wide deferred maintenance issues or build relationships with permitting agencies through proactive cooperative planning. EBRPD is currently working on a programmatic Environmental Impact Report (EIR) for Hayward Regional Shoreline to address this issue. By obtaining a programmatic EIR, EBRPD can complete needed repairs and maintenance on a much faster timeline through episodic approvals. Sea level rise and storm events will make policy approaches such as programmatic EIRs even more critical. EBRPD will need to do more repairs, more often, in more locations as well as start planning for long-term shoreline improvements and realignments. EBRPD should work more closely with partner agencies and permitting agencies to push for adaptive and resilient permitting along the shoreline.

EBRPD has a bigger budget and a larger and more specialized staff than local parks departments or other regional park systems, however sea level rise and storm event impacts will stress even a very successful agency like EBRPD. EBRPD currently spends the majority of its budget on personnel and capital improvements but climate change impacts will lead to increased maintenance costs across the entire EBRPD. How EBRPD's managers and board will need to make difficult choices given current budgets between preserving some parks and retreating from others. New funding through increased tax revenues or bonds could help preserve shoreline parks but these measures require public support and may still be insufficient for future challenges.

A growing Bay Area will have even more need for open space in a highly developed region, and increased maintenance and operations efforts and projects will burden budgets at every level of government. One way EBRPD can proactively adapt its financing and organization is to work with other shoreline agencies to share costs of projects whenever possible. As an example, the Hayward Resilience Study, a focus area study led by the ART Program with participation from EBRPD and local agencies in Hayward, has identified several possible landscape responses to improve coastal flooding protection. One of them could combine natural areas with storm water conveyance and wastewater discharge through a horizontal levee system. Cooperative solutions such as this bring together multiple agencies, which can expand available funding and political support for large projects.

Physical changes to shoreline parks will be part of EBRPD's response to sea level rise and storm events. Sand replacement at Crown Memorial State Beach in 2013 was a response to erosion and increased flood risk. The project was expensive and took almost 10 years to implement. Going forward, EBRPD will need to determine the value and sustainability of major projects like this. On a smaller scale, park supervisors are replacing bathrooms and beach mats with flood resilient alternatives. EBRPD could change project planning and design standards to include adaptive materials and construction methods where appropriate. One of the biggest and most difficult to resolve physical vulnerabilities of shoreline parks is in the marshes and other habitats along the shoreline. Depending on sedimentation, erosion, and sea level rise rates, some marshes may be able to adapt to sea level rise without human intervention in the near term. Post-2050, depending on local conditions, the region may lose extensive endangered species habitat and educational opportunities as marshes drown. EBRPD will need to follow and participate in regional efforts, like the Baylands Ecosystem Habitat Goals Update, to preserve shoreline natural areas through innovative measures like building coarse beaches, adding sediment, and constructed shallow transition zones.

In the long term, EBRPD, BCDC, Bay Trail, and other partners will need to reexamine possibilities for shoreline access in the Bay Area and work with others to redevelop the shoreline to achieve them. EBRPD parks may need to retreat where possible by moving trails, parking lots and other infrastructure inland and out of the flood zone. In other areas, retreat may lead to the complete loss of some park facilities and trails. EBRPD will need to work with local and regional partners to acquire land for upland migration, seek easements to allow for trail connectivity, and build additional shoreline recreation capacity wherever possible. This may require new types of permitting, new partnerships with landowners such as railroads and Caltrans, and new funding sources. It is unlikely that EBRPD shoreline parks will look exactly as they do now in 2100, but with proactive planning and cooperation, EBRPD can lead the region and continue to be a national model in preserving shoreline access and high quality recreation.

EBRPD cannot adapt to sea level rise on its own. Bay Area public agencies will need to adapt their policies to climate change in terms of permit requirements, project funding and regional planning and funding. The

region will have to find ways to support and assist agencies such as EBRPD to maintain and improve shoreline protection, habitat and ecosystem services, public open space, recreation and trails and the other services provided by the District's assets and programs. Regional shoreline planning will need to be adaptive, ready to accommodate changes in the landscape, in the human population, and in types of shoreline use. This will require new partnerships between regulatory agencies, state, regional and federal agencies, local jurisdictions, park supervisors, private property owners who provide trail access, and non-profit groups. The Bay Area can no longer look at water quality, wetland habitat, open space and urban development as separate issues or rely on park managers to maintain and improve significant amounts of shoreline protection and endangered species habitat on their own. As daunting as sea level rise and storm event impacts may be for the Bay Area, starting now and working together is the region's best hope for future shoreline recreation access and conservation.

Appendices:

A: SLR Maps for entire EBRPD and individual parks

B: Response cards for shoreline parks unit