

NATURAL RESOURCES

Asset Profile: Habitats & Wildlife

Marin County is known and treasured for its beaches, estuaries, wetlands, marshes, creeks, national and state park lands, and wildlife preserves. Several natural resource assets on the Marin shoreline could be vulnerable to sea level rise and storms, however; it is important to note that a significant portion of the shoreline is developed or bordered by development in some way. This development and human activity has reduced the natural resilience of the baylands by constricting habitat, fragmenting habitat, altering sediment supply, and cutting off wildlife corridors.⁸¹ Simultaneously, urbanization stresses wildlife with pollution, invasive species, food web disturbances, and close proximity to people and pets.⁸² Natural habitats tend to be resilient to storms, however, some storms may be strong enough to cause large changes in landscape and worse, permanent inundation could shift habitats from one type to another in the same location, for example marsh to mudflats.⁸³

Sea-level rise would cause fundamental changes in the bay and bayland habitats.⁸⁴ The following are natural resources and wildlife habitat vulnerabilities to sea level rise:

- Where space exists, sea level rise may push shoreline beaches and marshes inland, and shift existing tidal areas to standing water and/or flood inland areas with saltwater.
- Roads, rail, storm drains, and development greatly restrict habitats from migrating landward, and could completely eliminate them.
- Increases in salinity in freshwater and brackish water habitats can impact habitat suitability for existing species.
- Endangered species and special habitats are especially vulnerable.
- Ecosystem services, such as water filtration and existing levels of flood protection, may be compromised.

⁸¹ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 27

⁸² Ibid.

⁸³ Ibid. Pg. 156, 158

⁸⁴ Ibid., Pg. 37

IMPACTS AT-A-GLANCE: SCENARIO 6

6,500 acres of wetlands	CA DFW USFWS State Lands Commission County of Marin Local municipalities Marin Audubon Society National Audubon Society Nature Conservancy
5,500 acres of marshland	
5+ Narrow Beaches	
568+ acres of Eelgrass	
Ridgeway's rail Soft salty bird's-beak White-rayed pentachaeta Salt-marsh harvest mouse Tidewater goby And more...	



Corte Madera Ecological Reserve bordering Greenbrae Boardwalk, looking on to San Quentin. Credit: BVB Consulting LLC

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Figure 5. Shoreline Habitat Zones

Insert natural resources graphic

A majority of the natural resource areas are managed by government agencies for public use. Major examples include: Golden Gate National Recreation Area, Bothin Marsh, China Camp State Park, and San Pablo Bay National Wildlife Refuge. In addition, natural resource lands are also held by non-profit organizations such as the Nature Conservancy or Audubon Society, and some habitats are privately owned.

Beaches

Sea level rise can inundate beaches and increase rates of shoreline erosion. This could potentially force beach inland.⁸⁵ However, in most cases along the urbanized shoreline, development, roads, or steep slopes, limit landward migration, causing beaches to shrink or disappear.⁸⁶ Several of the beaches along the shore are narrow and short and could be completely lost. This shift could affect many species, including pinnipeds (seals and sea lions), snails, and tidal and freshwater plants. In addition, shifts and losses in beach ecological zones could degrade the food web⁸⁷ and ecosystem.⁸⁸

Bluff erosion can be exacerbated by sea level rise along the shoreline and can have varying impacts on beach habitats. Eroding bluffs can be a major source of sediment or rock, allowing beaches to evolve.⁸⁹ Alternatively, beach loss due to a major bluff collapse can negatively impact sand crabs, wrack consumers, and species that depend on beach habitats for breeding and nesting.⁹⁰ Beaches known to provide habitat include:

- Brick Kiln Park, Larkspur,
- Brick Yard Cove Beach, Strawberry,
- China Camp State Park Beaches,
- ESR Shoreline Park,
- Remillard Pond Beach,
- Marin Rod & Gun Club, San Rafael,
- McInnis Park,
- McNears Beach, Pt. San Pedro,
- Paradise Beach, Unincorporated Tiburon,
- Richardson Bay Center and Sanctuary beach, Tiburon,
- Private Beaches in Unincorporated Tiburon,
- San Pedro Cove Open Space, and
- Schoonmaker Beach, Sausalito.

⁸⁵ Feagin, R.A., D.J. Sherman, and W.E. Grant. 2005. *Coastal erosion, global sea-level rise, and the loss of sand dune plant habitats*. *Frontiers in Ecology and the Environment* 7:359-364.

⁸⁶ Largier, J.L., B.S. Cheng, and K.D. Higgason, editors. 2010. *Climate Change Impacts: Gulf of the Farallones and Cordell Bank National Marine Sanctuaries*. Report of a Joint Working Group of the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries Advisory Councils.

⁸⁷ Dugan, J.E., D.M. Hubbard, I. F. Rodil, D. L. Revell and S. Schroeter. 2008. *Ecological effects of coastal armoring on sandy beaches*. *Marine Ecology* 29: 160-170.

⁸⁸ Feagin, R.A., D.J. Sherman, and W.E. Grant. 2005. *Coastal erosion, global sea-level rise, and the loss of sand dune plant habitats*. *Frontiers in Ecology and the Environment* 7:359-364.

⁸⁹ Baye, P. R., 2014. Memorandum: Bolinas Lagoon Restoration Project Design Review Group (DRG) Meeting San Francisco Bay Joint Venture Meeting Summary and Synthesis Draft.

⁹⁰ Largier, J.L., B.S. Cheng, and K.D. Higgason, editors. 2010. *Climate Change Impacts: Gulf of the Farallones and Cordell Bank National Marine Sanctuaries*. Report of a Joint Working Group of the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries Advisory Councils.

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Mc Nears Beach. April 2016. Credit: BVB Consulting LLC



China Camp State Park, San Rafael. Credit: Marin County CDA

Tidal Estuaries, Wetlands, & Marshes

An estuary is a partially enclosed shoreline body of brackish water, or a mixture of fresh and saltwater, with one or more rivers or streams flowing into it that mix with and transition to open ocean. Additionally, timing and extent of the rise and fall of the tide may be altered in estuaries and tidal rivers.⁹¹

Many estuaries feature marine wetlands and marshes. Wetlands and marshes also occur in other locations along the shoreline. Overlaying the BayWAVE scenarios on habitat data layers reveals that approximately, 6,500 acres of wetlands and 15,500 acres of marshlands along Richardson's Bay, San Francisco Bay, San Pablo Bay, and up the Petaluma River and several creeks could be impacted to varying degrees across all of the scenarios. Key sensitivities include drowning, erosion, and increased salinity.⁹²

Data examined in the Bayland Habitat Goals Update (2015) indicate that tidal marshes in San Francisco Bay can withstand current 2-3 mm/year increase in sea level, as long as sediment availability is relatively high.⁹³ Without a comparable increase in land elevation from sediment delivery from erosion, and slowing subsidence, these intertidal habitats will be unable to adjust and thus, flood more frequently.^{94,95} Much like beaches, these areas can be prevented from moving landward when backed by development, shoreline armoring, or cliffs.

Increased storm severity could have significant implications for erosion. Increased storm surge severity could also increase salinity of shoreline

⁹¹ Largier, J.L., B.S. Cheng, and K.D. Higgason, editors. 2010. *Climate Change Impacts: Gulf of the Farallones and Cordell Bank National Marine Sanctuaries*. Report of a Joint Working Group of the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries Advisory Councils.

⁹² Knowles, N. and D.R. Cayan. 2002. *Potential effects of global warming on the Sacramento/San Joaquin watershed and the San Francisco estuary*. *Geophysical Research Letters* 29:1891.

⁹³ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 24

⁹⁴ Largier, J.L., B.S. Cheng, and K.D. Higgason, editors. 2010. *Climate Change Impacts: Gulf of the Farallones and Cordell Bank National Marine Sanctuaries*. Report of a Joint Working Group of the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries Advisory Councils.

⁹⁵ Ackerly, D. D., R. A. Ryals, W. K. Cornwell, S. R. Loarie, S. Veloz, K. D. Higgason, W. L. Silver, and T. E. Dawson. 2012. *Potential Impacts of Climate Change on Biodiversity and Ecosystem Services in the San Francisco Bay Area*. California Energy Commission. Publication number: CEC-500-2012- 037.

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wetlands and marshes further upland until freshwater inputs can balance out salinity. Studies on the effect of salinity extremes indicate that, when combined with temperature stress, salinity can negatively impact intertidal invertebrates through increased embryonic mortality^{96,97} and decreased adult aerobic performance.⁹⁸ In addition, projected increases in storm activity can remove larger intertidal organisms.⁹⁹ If tides do not retreat as far as they currently do with sea level rise, these areas could shift from intertidal to underwater habitats.

In general, vegetation occurs from just above mean sea level (MSL) to just above mean higher high water. Cordgrass is found at lower elevations, and pickleweed is typically at the MHHW limit with a number of other species depending on local elevation, drainage, soils, site history and other factors. As sea level rises, these plants will need to migrate to higher lands land if sediment accretion does not maintain marsh elevation in relation to water level. The following are examples of vulnerable locations featuring estuarine, tidal wetland, and marsh habitats:

- Aramburu Wildlife Preserve, Strawberry
- Bahia/Rush Creek Marshes, Novato
- Bothin Marsh, Almonte
- Cal Park Hill wetlands
- Canalways Marsh, San Rafael
- China Camp State Park,
- Diked baylands, Novato
- Gallinas Creek, San Rafael
- Hamilton Wetlands, Novato
- Island Park,
- Madera Gardens Lagoons, Corte Madera
- Marin Audubon Society Lands,
- Marin Conservation League Lands,
- McInnis Marsh, San Rafael

- McNears Beach Park,
- Corte Madera Ecological Reserve,
- Triangle Marsh, Corte Madera
- National Audubon Society Lands,
- Nature Conservancy Lands,
- Paradise Beach Park, Unincorporated Tiburon
- Pt. Tiburon Marsh,
- San Pablo Bay National Wildlife Refuge, St. Vincent's
- Santa Margarita Island, Santa Venetia
- Santa Venetia Marsh,
- Scottsdale Marsh, Mill Valley
- Shorebird Marsh, Strawberry
- Spinnaker Point Marsh, San Rafael
- Strawberry Point Tidal Area, and
- Tiscornia Marsh, San Rafael.

Bay

Eelgrass is also a critical tidal habitat, typically in slightly deeper, saltier waters, associated with rocky ground. These habitats can be found in Richardson's Bay in Sausalito, Belvedere, and Tiburon. Eelgrass is a vascular, perennial marine plant that typically occurs in shallow waters from 0 to 6 feet below mean low tide.¹⁰⁰ Eelgrass beds trap suspended materials, take up nutrients and other dissolved substances, help to prevent erosion, increase water clarity and quality, produce organic matter, and export dying plant materials. Eelgrass beds also provide food and feeding grounds for several marine food chains.¹⁰¹ As mean low tide rises closer to shore, these essential plants could be flooded out and denied adequate sunlight to survive and maintain this valued habitat.

Eelgrass beds are recognized by both federal and state agencies as sensitive and highly valuable habitat for a suite of species. They are regulated under the Magnuson-Stevens Fishery Conservation and Management Act. Eelgrass beds are listed as a Habitat Area of Particular Concern because they are susceptible to degradation, especially ecologically important, and/or located in an environmentally stressed area. National Oceanic and Atmospheric Association's fisheries policy recommends no net loss of eelgrass habitat function in California.¹⁰² The policy establishes protocols for mitigating adverse

⁹⁶ Przeslawski, R., Davis, A. R. and Benkendorff, K. (2005), *Synergistic effects associated with climate change and the development of rocky shore mollusks*. *Global Change Biology*, 11: 515–522. doi: 10.1111/j.1365-2486.2005.00918.x

⁹⁷ Deschaseaux, E.S.M, A.M. Taylor, W.A. Maher, A.R. Davis. 2009. Cellular responses of encapsulated gastropod embryos to multiple stressors associated with climate change. *JEMBE* 383(2):130-136.

⁹⁸ Vajed Samiei, J., Novio Liñares, J.A., Abtahi, B. 2011. *The Antagonistic Effect of Raised Salinity on the Aerobic Performance of a Rocky Intertidal Gastropod Nassarius deshayesianus* (Issel, 1866) Exposed to Raised Water Temperature. *Journal of the Persian Gulf* 2(6): 29-36.

⁹⁹ Largier, J.L., B.S. Cheng, and K.D. Higgason, editors. 2010. *Climate Change Impacts: Gulf of the Farallones and Cordell Bank National Marine Sanctuaries*. Report of a Joint Working Group of the Gulf of the Farallones and Cordell Bank National Marine Sanctuaries Advisory Councils.

NOAA Fisheries West Coast Region. 2014. The Importance of Eelgrass. Updated fall 2014.

http://www.westcoast.fisheries.noaa.gov/stories/2014/04_1107_2014_eelgrass_mitigation.html. Accessed 1/18/17

¹⁰¹ Ibid

¹⁰² Ibid

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impacts on eelgrass, restoration, monitoring, and evaluation

Freshwater Resources

Freshwater habitats are also likely to be subject to flooding impacts from sea level rise and storm surges. Changes in salinity and water levels could cause habitat shifts, especially when these influences are regular and not seasonal. In scenario 6, with 60 inches of sea level rise and 100-year storm surge, saltwater can travel miles inland, totaling 211 miles of creeks that could be impacted by higher levels of saltwater. San Antonio Creek in North Novato could fill with saltwater up to ten miles upstream in the long-term. Similarly, the Corte Madera channel could fill with saltwater nearly eight miles inland. On average, up to one half of a mile upstream could be under tidal influence. This could shift existing freshwater habitat to brackish habitat. Creeks that could be affected by rising bay waters include:

- Armory Creek
- Arroyo Corte Madera del Presidio,
- Arroyo de San Jose,
- Baccaglio Basin Drainage,
- Basalt Creek,
- Beach Marsh Channel,
- Black John Slough,
- Castro Ditch,
- Cheda Creek,
- Corte Madera Channel,
- Corte Madera Creek,
- Corte Madera Outfall Channel,
- Coyote Creek,
- Deer Island Channel,
- East Creek,
- Estancia Ditch,
- Gallinas Creek,
- Glen Creek,
- Glenwood Creek,
- Greenbrae Creek,
- High Canal/Irwin Creek,
- King Mountain Creek (Brixon Creek),
- Larkspur Creek,
- Leveroni Ditch,
- Low Canal,
- Lynwood Slough,
- Mabry Ditch,
- Mahon Creek,
- McAllister Creek,
- Meadow Sweet Creek,

- Miller Creek,
- Murphy Creek,
- Novato Creek,
- Novato Ditch System,
- Nyhan Creek,
- Pacheco Creek,
- Peacock Gap Creek,
- Petaluma River,
- Reed Creek,
- Rush Creek,
- Ryan Creek,
- Salt Works Canal,
- San Antonio Creek,
- San Clemente Creek,
- San Rafael Airport Ditch,
- San Rafael Creek
- Simmons Slough,
- Strawberry Ditch,
- Strawberry Marsh,
- Sunny Oaks Drainage,
- Tamalpais Creek,
- West Creek,
- Willow Creek, and
- Wolfe Grade Creek.

In addition, freshwater ponds and vernal pools within the Petaluma Marsh System in North Novato, large freshwater emergent marshes along the western side of Novato Creek north of Highway 37, and Pacheco Pond could experience increased salinity and water level impacts, and therefore, habitat impacts, in the long-term.

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Bothin Marsh bordering Richardson's Bay. Credit: MarinMap



Saltworks Canal, Strawberry. Credit: DPW

Wildlife & Endangered Species

The most vulnerable species are those that use the vulnerable habitats. Vulnerable habitats are beaches, tidal marshes, freshwater streams and ponds, eel grass beds in the intertidal zone. These habitats offer feeding and breeding ground for several mammal, birds, and insects, and host several rare and valued plants along Marin's eastern shoreline. Several species, and/or their habitats, are protected under federal, state, or regional regulations. Meeting existing habitat goals and

needs may prove challenging as tides rise. Species potentially located within the geographic extent of scenario 5, when significant habitat changes could occur, are listed in [Table 41](#).

Mammals

According to the Department of Fish and Wildlife, the following are recorded locations marine mammals inhabit (does not include federal park locations):

- Sausalito Basin 3,
- Strawberry Spit,
- Corte Madera Ecological Reserve,
- Angel Island, and
- Castro Rocks.

The Pacific Harbor Seal and Southern, or California, Sea Otter are known to use the San Francisco Bay. San Francisco Bay Pacific harbor seals have spotted coats, and many are fully or partially reddish in color. They reach six feet in length and weigh up to 300 pounds. Harbor seals are the third most common patient at The Marine Mammal Center. In general, Harbor seal colonies in the Bay Area are vulnerable to human disturbance, climate change and human-produced pollutants.¹⁰³

The Southern Sea Otter is among the smallest of marine mammals and may live for 15-20 years in the wild. Sea otters occupy marine habitats from the littoral zone to depths of less than 330 feet, including protected bays. Sea otters in California are a threatened species due to past over hunting for their fur. Although they are protected from hunting, sea otters are still vulnerable, especially to habitat loss and oil spills.¹⁰⁴

Mammal species are already vulnerable, typically due to habitat destruction. Sea level rise would likely exacerbate the fragility of these habitats and the threatened and endangered species in them.

Another vulnerable mammal in the study area is the Salt marsh harvest mouse. Salt marsh harvest mice are endangered because of habitat loss,

¹⁰³ The Marin Mammal Center Website. Harbor Seal. Accessed Jan. 18, /2017. Last updated: Jan. 2017
<http://www.marinmammalcenter.org/education/marine-mammal-information/pinnipeds/pacific-harbor-seal/> accessed.

¹⁰⁴ The Marin Mammal Center Website. Sea Otter. Accessed Jan. 18, 2017. Last updated: Jan. 2017
<http://www.marinmammalcenter.org/education/marine-mammal-information/sea-otter.html>.

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fragmentation, and alteration.¹⁰⁵ These mice are only found in the marshes of Corte Madera; the Marin Peninsula and San Pablo Bay, typically in the upper half of tidal salt marshes and the adjacent uplands during high tides.¹⁰⁶ Sea level rise would greatly impact this species, especially if the mouse's habitat is trapped by development. If high inundation rates occur in areas without upland habitat then reproduction could be reduced or eliminated. This is more likely an issue in the narrow valley outlets of southern portion of the study area, than the larger basins of the northern study area. Other potential impacts of sea level rise include changes and shifts in vegetation composition and the overtopping of all intertidal vegetation by higher storm surges. Such severe inundation could increase predation¹⁰⁷ and decrease reproductive success by flooding nests.¹⁰⁸

Fish

The two listed fish off the shores of the study are the tide water goby and the longfin smelt. The tidewater goby is listed as Endangered at state and federal levels. Tidewater gobies are about two inches in length, translucent with gray, green, and brown. The tidewater goby's ideal habitat is a brackish estuary or marsh with shallow water, a sandy bottom, and cool temperatures. Tidewater gobies are vulnerable to the introduction of non-native species and sudden increases in salinity levels.¹⁰⁹ As brackish waters push further and further up narrow valleys during storms or the highest tides, and existing habitats increase in salinity, the amount of suitable habitat could decrease significantly. The longfin smelt is listed as threatened on the California list and a candidate on

the federal list. The largest longfin smelt population occurs in the San Francisco Estuary and Sacramento-San Joaquin Delta. This species occupies bay waters throughout summer and moves into lower reaches of rivers in fall to spawn.¹¹⁰



Harbor Seal. Credit: Bay Nature

Table 41. Example Vulnerable Species

Federal: Endangered	<ul style="list-style-type: none"> • Ridgeway rail • Soft salty bird's-beak • White-rayed pentachaeta • Salt-marsh harvest mouse • Tidewater goby • Chinook Salmon
Federal: Threatened	<ul style="list-style-type: none"> • Western snowy plover • California red-legged frog
Federal: Candidate	<ul style="list-style-type: none"> • Longfin smelt
Others	<ul style="list-style-type: none"> • Salt Marsh Yellowthroat • Southern sea otter • Delta smelt • Green Sturgeon • Pacific Herring • Steelhead • Monarch Butterfly

Source: California Natural Diversity Database

¹⁰⁵ Shell hammer, H. 2000. Salt Marsh Harvest Mouse. Pp. 219 – 228 in Goals Project. 2000. Baylands Ecosystem Species and Community Profiles: Life history and environmental requirements of key plants, fish and wildlife. Prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. P. R. Olson, editor. San Francisco Bay Regional Water Quality Control Board, Oakland, California.

¹⁰⁶ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Appendix 5.1 Salt Marsh Harvest Mouse. Ecosystem Baylands Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA.

¹⁰⁷ Johnston, R. F. 1957. Adaptation of salt marsh mammals to high tides. *Journal of Mammalogy*, 38:529-531.

¹⁰⁸ Hardaway, H. C. and J. R. Newman. 1971. Differential responses of five species of salt marsh mammals to inundation. *Journal of Mammalogy*, 52:818-820.

¹⁰⁹ Farallones Marin Sanctuary Association Website. Endangered Spotlight: Tidewater Gobi Updated 2005. http://www.farallones.org/e_newsletter/2008-02/TidewaterGoby.htm Accessed Jan. 18, 2017.

¹¹⁰Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Appendix 3.9 Longfin smelt. Ecosystem Habitat Goals Science Update 2015 Baylands prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA.

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Other important fish species that are sensitive changes in environmental conditions that could occur in the San Francisco, San Pablo, and/or Richardson's Bays are:

- Chinook salmon: These fish spend time in the ocean and migrate into freshwater rivers to spawn.
- Delta smelt: Delta smelt are endemic to the Sacramento-San Joaquin River Delta, occupies saltwater habitats, and spawns in freshwater.
- Green sturgeon: These large and long living fish spend time in the ocean and migrate into freshwater rivers to spawn every three to five years and can be found traveling through the bay to breeding grounds in the Sacramento River.
- Pacific herring: The Pacific herring is typically found in large schools. Adults breed in estuaries in shallow areas along shorelines. Eggs are laid on kelp and eelgrass November through April. Richardson's Bay is considered a critical spot for spawning.
- Steelhead: Adults spend time in the ocean and migrate into freshwater rivers to spawn, after spending two to three years in the ocean. San Francisco Bay is within the range of two runs of steelhead.



Ridgway's Rail at High Tide. Credit: Chris Cochems

Birds

Shoreline wetlands, marshes, mudflats, and ponds provide valuable bird habitat. One of the largest protected habitats is the San Pablo Bay National Wildlife Refuge (SPBNWR) managed by United States Fish and Wildlife Service (USFWS), which connects to the Petaluma Marsh Wildlife Area managed by California Department of Fish and Wildlife (CDFW), another extensive area of habitat to the northeast. Both of these areas, and smaller marsh lands further south, are major winter-migration stopovers along the Pacific Flyway for waterfowl. Smaller shoreline habitats in southern Marin are also known to support vulnerable and valuable bird species.

Vulnerable bird species that could be found in or moving through the eastern Marin shoreline include the Ridgway's rail, the Western snowy plover, and salt marsh yellowthroat. The Ridgway's rail is one of the largest rails in North America, very secretive, and primarily lives in salt and brackish marshes. The following locations are known to support Ridgway's rail populations:

- Richardson's Bay is known to support a small number of Ridgway's rails.
- Bothin Marsh Preserve, Mill Valley.¹¹¹
- The marsh at the mouth of Gallinas Creek, including China Camp, supports what appears to be the largest population of Ridgway's rails in the North Bay.¹¹²
- The Corte Madera Ecological Reserve supports one of the densest populations of Ridgway's rails in the northern San Francisco Bay.¹¹³

The Western snowy plover is a small shorebird that occurs along the Pacific Coast. They forage for small invertebrates in beach sand, kelp, and low-growing dune vegetation. A small population nests on and near the shores of the San Francisco Bay and may forage in Richardson's Bay. The San Francisco common (salt marsh) yellowthroat is

¹¹¹ Distribution and population trends for the Endangered California Clapper Rail. State of the Estuary Conference, 26 October 2013, Oakland, CA.

¹¹² Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 156

¹¹³ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 168

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a subspecies of the common yellowthroat and is endemic to the San Francisco Bay region in wetland and riparian habitats. Other unique and valuable bird species common in the study area are:

- California brown pelican: The California brown pelican, the smallest species of pelican, forages within Richardson's Bay and may be present in the study area.
- California least tern: The California least tern is the smallest of North American terns, has nesting colonies in the San Francisco Bay, and may forage within Richardson's Bay.
- Double-crested cormorant: Double-crested cormorant are large seabirds that live year-round in the San Francisco Bay. Cormorants forage within Richardson's Bay. The Richmond-San Rafael is a nesting site.
- San Pablo (Samuels) song sparrow: This subspecies lives in tidal marshes throughout the San Pablo Bay, San Francisco, and Richardson's Bays year-round. They are primarily associated with high marsh habitats dominated by pickleweed.

Additional migratory birds were reported in study area are Allen's hummingbird, marbled godwit, Nuttall's woodpecker, and the eastern grebe. Most migratory bird species, with a few specific exceptions, are protected under the federal Migratory Bird Treaty Act and California Fish and Game Code.

Insects

Insects could also suffer from impacts to their habitats. The Monarch butterfly, an orange and black milkweed butterfly with a wingspan of 3.5 to 4 inches, could suffer from impacts to milkweed habitat along the coast. Populations of monarch butterfly are found in the San Francisco Bay region especially during the winter months. The Mission blue butterfly has a small wingspan of 1 to 1.5 inches. They occur in coastal chaparral and grassland habits and depend on lupine plants for the egg, larvae, and pupae life phases. The butterfly was documented at Fort Baker, though it was not detected in the 1984 and 1985 during last survey.

Plants

Numerous special status plants with habitats that are expected to be vulnerable to sea level rise are:

- Franciscan thistle,
- Hairless popcornflower,
- Marin western flax,
- Oregon polemonium,
- Point Reyes salty bird's beak,
- Tiburon buckwheat,
- Tiburon paintbrush, and
- White-rayed pentachaeta.¹¹⁴

Salt marshes are host a variety of unique and valuable plants, such as pickleweed and cordgrass, in Novato, San Rafael, St. Vincent's, Tiburon, Strawberry, Tamalpais Valley, and Mill Valley. Patches in Novato, St. Vincent's, Mature wide salt marsh habitat has regenerated near the mouth of Coyote Creek, supporting regionally rare plant populations, including some of the largest colonies of northern salt marsh bird's beak in San Francisco Bay.¹¹⁵

In addition, eelgrass beds off the shores of Sausalito, Tiburon, and Belvedere previously discussed under Tidal Estuaries, Wetlands, and Marshes, are also vulnerable to sea level rise.

¹¹⁴ Prunuske Chatham, Inc. March 2016. Draft Biological Resources Assessment: Dunphy Park Improvement Project Sausalito, Marin County.

¹¹⁵ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 168

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Table 42. Example Vulnerable Natural Resource Assets Ranked by Onset and Flooding at MHHW

Location	Asset	Near-term	Medium-term	Long-term
		Scenario 1	Scenario 3	Scenario 5
Sausalito	Swedes Beach	Floods at existing high tides		
Novato	Scottsdale Marsh	Floods at existing high tides		
Unincorporated Tiburon	Paradise Beach Park	Floods at existing high tides		
Mill Valley	Bothin Marsh	Floods at existing high tides		
Corte Madera	Corte Madera Ecological Reserve	Floods at existing high tides		
Corte Madera	Triangle Marsh	Floods at existing high tides		
San Rafael	Tiscornia Marsh	Floods at existing high tides		
Novato	Bahia marshes	Floods at existing high tides		
State Park	Angel Island State Park	14'1"	14'10"	17'9"
San Rafael	Shoreline Open Space	10'3"	11'1"	25'4"
Tiburon	Pt. Tiburon Shoreline Park	8'	8'8"	11'6"
Pt. San Pedro	China Camp State Park	7'6"	8'1"	18'4"
San Rafael	John F. Mc Innis Park	7'6"	8'6"	10'6"
Larkspur	Piper Park	7'2"	7'11"	10'8"
Santa Venetia	Santa Venetia Marsh	7'	7'10"	9'11"
San Pablo Bay	Wildlife Refuge	6'9"	7'2"	19'
Santa Venetia	Santa Margarita Island	5'8"	6'8"	8'8"
Sausalito	Arques Shipyard & Marina	5'7"	8'6"	21'9"
Sausalito	Marina Plaza Harbor	5'7"	8'6"	21'9"
San Rafael	Jean & John Starkweather Shoreline Park	5'4"	6'	16'3"
Bel Marin Keys	Del Oro Park	5'2"	5'8"	8'9"
Sausalito	Dunphy Park	5'1"	5'8"	13'8"
Bel Marin Keys	Cavalia Cay Park	5'1"	5'8"	8'9"
San Rafael	Pickleweed Park	5'	5'8"	8'9"
Larkspur	Cal Park wetlands at Corte Madera Creek	4'10"	5'3"	8'2"
Waldo Point	Richardson Bay Marina	4'5"	7'4"	18'7"
Larkspur	Bon Air Landing Park	4'4"	5'	8'6"
Pt. San Pedro	McNears Beach Park	4'4"	5'9"	8'
Belvedere	Corinthian Yacht Club	4'	4'3"	11'
Tiburon	Mc Kegney Green	3'1"	5'7"	15'3"
Tiburon	Richardson Bay Lineal Park	0-3'	1"-3'7"	1"-15'
Larkspur	Remillard Park beach	2'11"	3'6"	6'2"
Belvedere	San Francisco Yacht Club	2'2"	3'6"	8'10"
Tiburon	Blackie's Pasture	0-9"	5'4"	12'9"
Tiburon	The Cypress Garden Park	7"	1'4"	4'4"
Sausalito	Sausalito Yacht Harbor	4"	1'	3'
Paradise Cay	Paradise Cay Yacht Harbor	2"	1'6"	3'10"

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Location	Asset	Near-term	Medium-term	Long-term
		Scenario 1	Scenario 3	Scenario 5
San Rafael	Lowrie Yacht Harbor	2"	9"	3'7"
San Rafael	Marin Yacht Club	1"	1'6"	3'9"
Sausalito	Pelican Yacht Harbor	No data	No data	No data
Strawberry	Aramburu Wildlife Preserve	No data	No data	No data
San Rafael	San Rafael Yacht Harbor	No data	No data	No data
San Rafael	Beach Park		8'11"	11'10"
Mill Valley	Bayfront Park		8'3"	4'-11'6"
Sausalito	Schoonmaker Beach		7'2"	10'1"
Strawberry	Brickyard Cove		6'11"	9'11"
Corte Madera	Hal Brown Park		6'3"	9'2"
Strawberry	Strawberry Point Tidal Area		5'1"	8'1"
Strawberry	Seminary Marsh		4'4"	8'1"
Corte Madera	Shorebird Marsh		5'3"	10'9"
Strawberry	Strawberry Point Park		4'10"	9'2"
San Rafael	Loch Lomond Marina		3'7"	9'7"
Sausalito	Clipper Yacht Harbor		2'5"	6'3"
San Rafael	San Rafael Yacht Club		2'2"	5'7"
Bel Marin Keys	Montego Park		2'	5'4"
Sausalito	Cass Gidley Marina		2'	3'2"
Larkspur	Hamilton Park		10"	3'9"
Mill Valley	Shelter Bay		2"-9"	6"-1'10"
Novato	South Hamilton Park			11'6"
Novato	Deer Island Baylands			10'10"
Corte Madera	Madera Gardens Lagoons			10'4"
CA Fish & Wildlife	Gallinas Creek			10'2"
Corte Madera	Town Park			9'10"
Novato	Rush Creek			8'10"
Mill Valley	Sycamore Park			8'6"
Novato	Slade Park			8'
Bel Marin Keys	Caribe Isle Park			7'6"
Sausalito	Tiffany Beach			7'4"
Santa Venetia	Castro Park			7'
Santa Venetia	Adrian Rosal Park			6'3"
San Rafael	Shoreline Pathway			5'10"
Santa Venetia	Pueblo Park			5'1"
Tiburon	Zelinsky Park			4'11"
Tiburon	Pt. Tiburon Marsh			4'10"
San Rafael	Schoen Park			4'4"
Mill Valley	Freeman Park			4'2"
Strawberry	Greenwood Cove			4'1"
Corte Madera	Ring Mountain			3'6"
Mill Valley	Hauke Park			3'6"
Corte Madera	Skunk Hollow Park			3'4"

NATURAL RESOURCES

Location	Asset	Near-term	Medium-term	Long-term
		Scenario 1	Scenario 3	Scenario 5
Tiburon	Bel Aire Park			3'
Larkspur	Bon Air Landing Park			2'4"
Corte Madera	San Clemente Park		No data	No data
Bayside Acres	Marin Islands Ecological Reserve		No data	No data
North Novato	Petaluma Marsh Ponds			No data
Mill Valley	Arroyo Corte Madera del Presidio	Water resource		
Larkspur	High Canal	Water resource		
Larkspur	Larkspur Creek	Water resource		
Larkspur	Low Canal	Water resource		
Novato	Novato Creek	Water resource		
Novato	Petaluma River	Water resource		
Strawberry	Salt Works Canal	Water resource		
San Rafael	San Rafael Canal	Water resource		

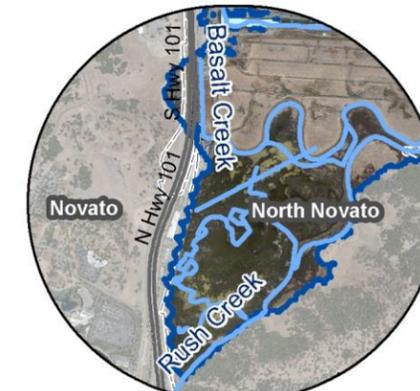
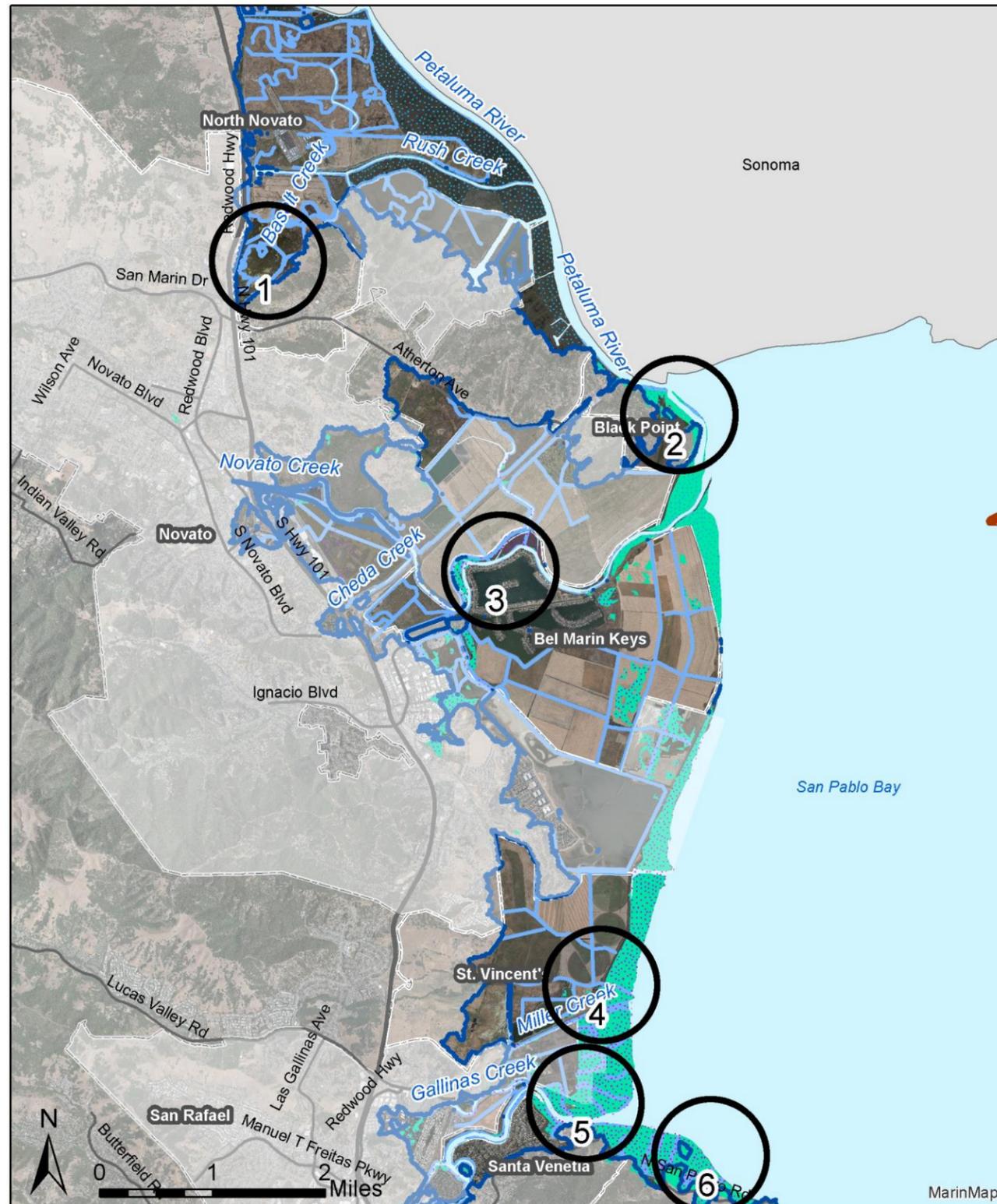
Source: MarinMap, CoSMoS

NATURAL RESOURCES

Map 36. Northern Study Area Vulnerable Natural Resources

Vulnerable Assets

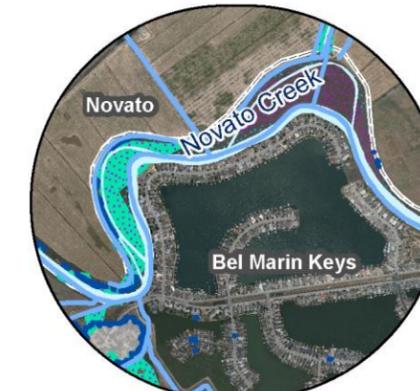
-  Mammal Haulouts
 -  Streams
 -  Marsh
 -  Estuary
 -  Wetland
- ## Location Indicators
-  Unincorporated
 -  Municipality
 -  Road
 -  Bay
 -  Inland Extent: Sea Level @ 60"+100-year Storm



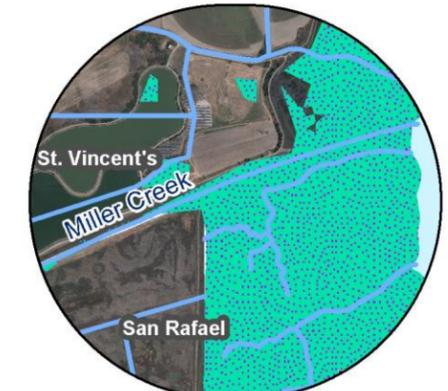
1: Rush Creek



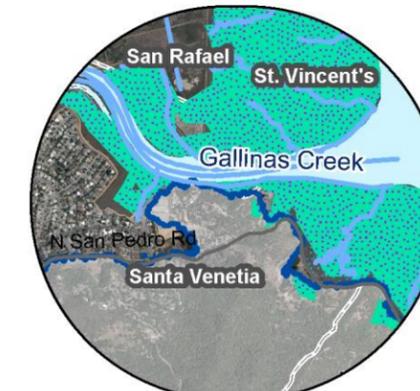
2: Black Point



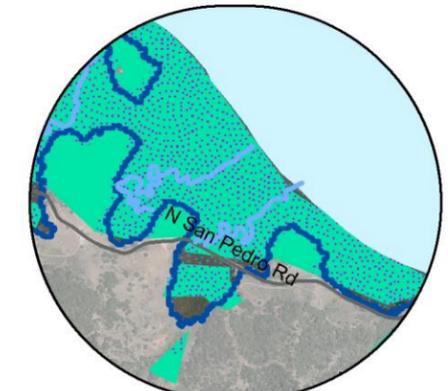
3: Upper Bel Marin Keys



4: Miller Creek

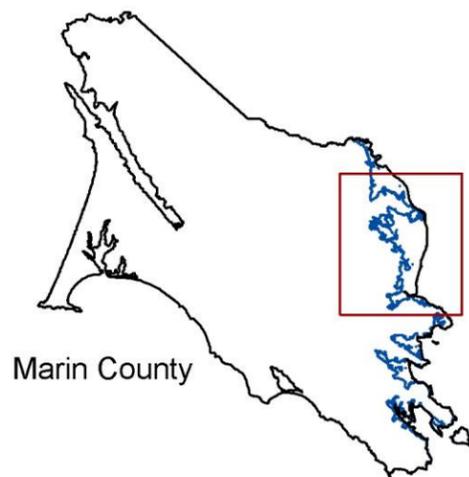


5: Santa Venetia Marsh



6: Gallinas Creek Estuary

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.



Date: 3/30/2017

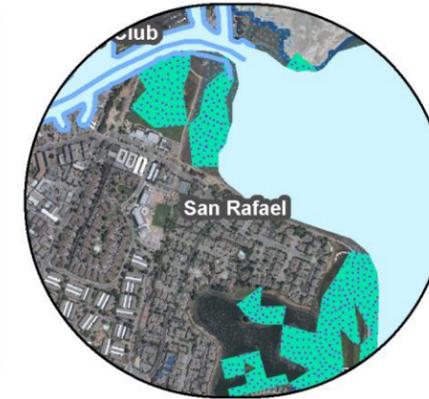
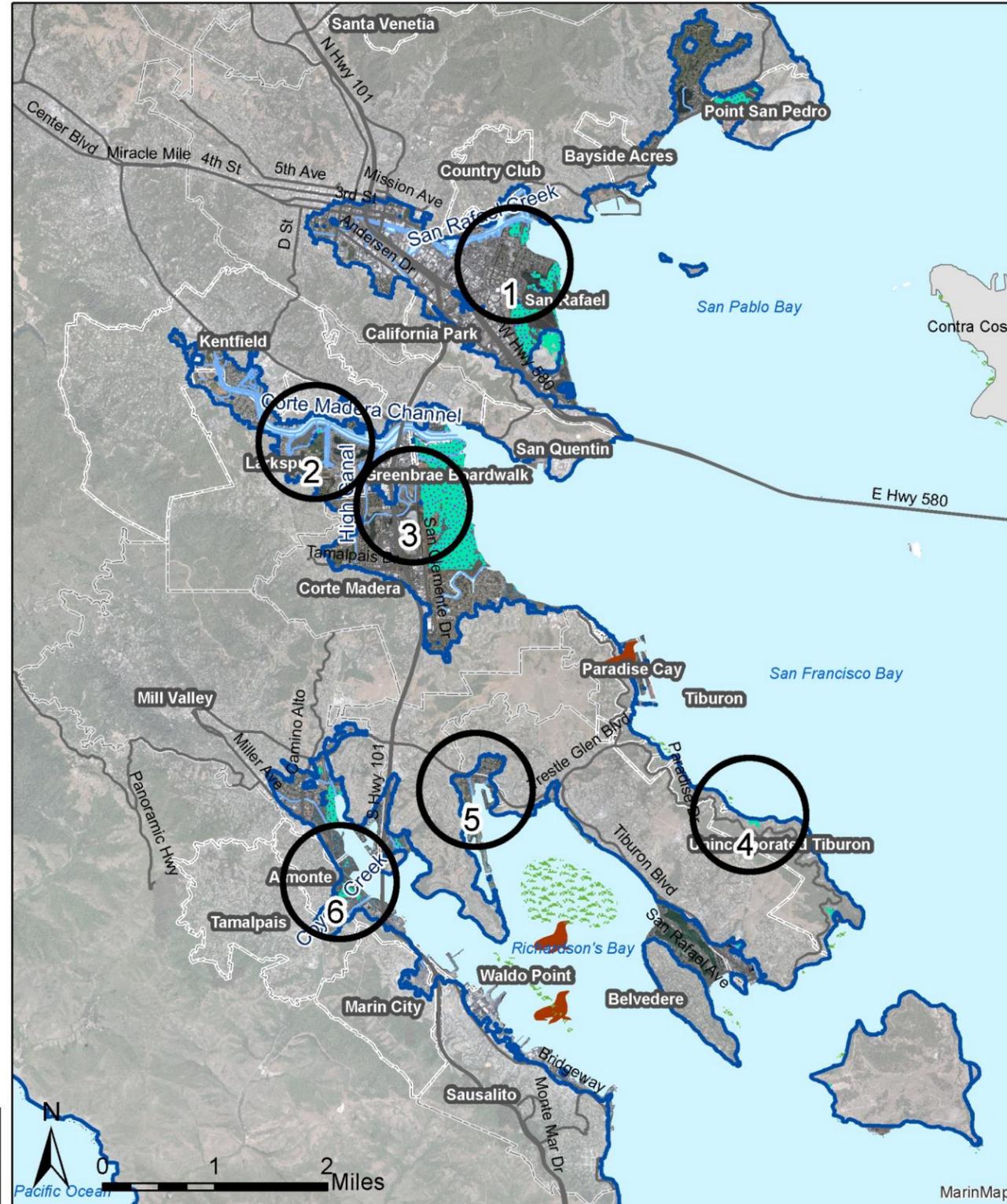
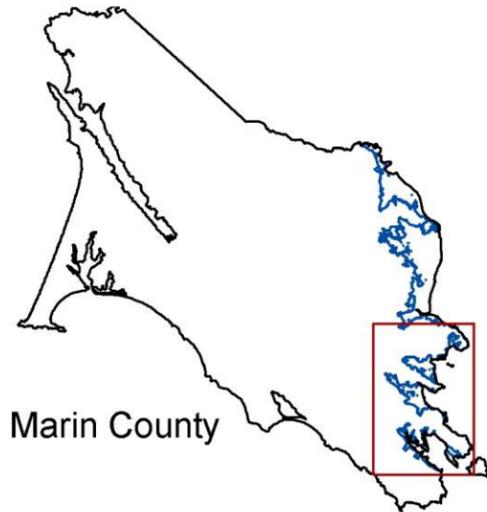


NATURAL RESOURCES

Map 37. Southern Study Area Vulnerable Natural Resources

Vulnerable Assets

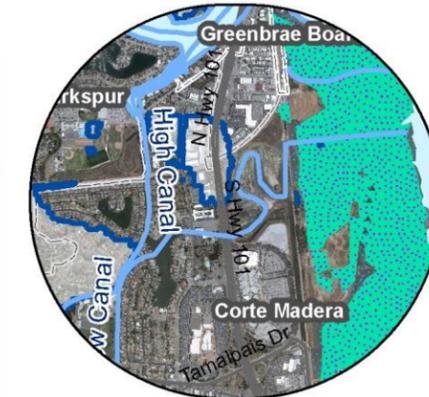
-  Mammal Haulouts
 -  Streams
 -  Eelgrass
 -  Marsh
 -  Estuary
 -  Wetland
- ## Location Indicators
-  Unincorporated
 -  Municipality
 -  Road
 -  Bay
 -  Inland Extent: Sea Level @ 60'+100-year Storm



1: Pickleweed & Tiscornia Marshes



2: Corte Madera Creek



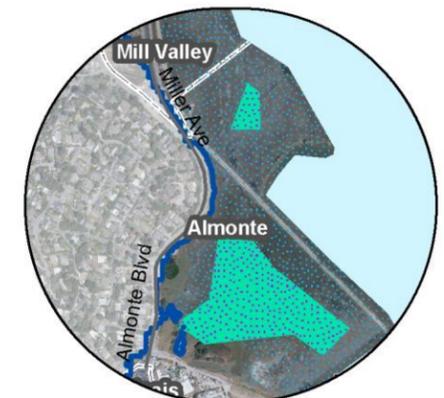
3: Corte Madera Ecological Reserve



4: Paradise Beach



5: Strawberry Point



6: Bothin Marsh

Disclaimer: Vulnerability Assessment maps, tables, etc. can be used as a resource to help identify potential hazardous areas and vulnerable assets. Marin County, and data providers here in, make no warranties of the accuracy or completeness of maps and data. Maps are representational and subject to future revision. Local site conditions must be examined. Commercial use is prohibited.

NATURAL RESOURCES

Other Considerations

Economic

Active and passive recreation on Marin's shoreline beaches, trails, and roads are major economic contributors to Marin (see the Recreation Profile for more information). Wildlife viewing is a major draw to the region and the inability to do so could significantly reduce tourism.

In addition, park maintenance costs could increase and substantial funding would be needed to relocate or improve infrastructure due to the high degree of scrutiny and environmental compliance required. These increased costs would be passed on to the tax payers and park users, creating potential disproportionate impacts across economic brackets.

Estuaries, beaches, bluffs, marine wetlands, and marshes also provide ecosystem services as buffers protecting development from waves and floods, filtration systems for pollutants, provide oxygen, and many others. Their loss could increase the cost of maintaining flood protection at the least.

Environmental

The complete or partial loss of tidal marshlands and other natural shoreline features could increase the reliance on structural shoreline protection to create a buffer from the rising waters, and would place shoreline residents at a greater risk of flooding. If compromised, multiple utility transmission lines and pipelines located in marsh areas or along waterways could cause fire, or other electrical hazards. Finally, efforts to protect vulnerable built assets with new shoreline armoring could have detrimental impacts on shoreline habitats by reducing their ability to adapt. Several studies have also shown that walls can increase erosion on neighboring land areas.¹¹⁶

According to the Bayland Habitat Goals Update (2015), other challenges to improving or restoring habitat in the northern study area are:

- Commercial and residential developments at Bel Marin Keys,
- Hamilton Field, and at several sites to the south;

¹¹⁶ California Coastal Commission Sea Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development. August 12, 2015. http://documents.coastal.ca.gov/assets/slr/guidance/August2015/0_Full_Adopted_Sea_Level_Rise_Policy_Guidance.pdf

- Diked golf course in Black Point;
- Low-lying segments of State Route 37 and US Highway 101, other roads,
- Northwestern Pacific railroad track, and
- Development between the railroad and the highway.¹¹⁷

In the southern portion of the study area, primary constraints would be:

- US Highway 101,
- An urbanized edge with roadways and infrastructure that currently flood (e.g., Miller Avenue, Manzanita parking areas, the Mill Valley sewer plant),
- Northwestern Pacific railroad tracks,
- Erosion from the Golden Gate Ferry in Larkspur,
- Exotic predators (e.g., rats and red fox),
- Invasive *Spartina*, and
- On-site contaminants.¹¹⁸

Social Equity

As preparations are made to protect existing areas, or create new public areas, costs could increase, entrance fees, or in some cases, require new fees. These added could make visiting county, federal, and state parks cost prohibitive for those of lesser means. Loss of any protected, publicly accessible lands would reduce the opportunities for visitors to these open spaces. These losses could disproportionately impact those who enjoy nearby public space along our shoreline as access becomes increasingly difficult, and in some cases access could be impeded entirely.

Management

Protecting natural resources and wildlife can be highly controversial. For example, protecting breeding areas may limit public access or economic activity. As tides rise, developable land area will be

¹¹⁷ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 159

¹¹⁸ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 172

reduced and, consequently, increase competition for resources. Limited financial resources could reduce priorities for wildlife protection, park maintenance, and investment. Park management would be affected because infrastructure within parks may become inaccessible or degraded due to flooding and saltwater exposure. Large amounts of funds would be needed to relocate or improve infrastructure due to the high degree of scrutiny and environmental compliance that would be necessary. Making improvements for public access or restoring habitats would also need to be sensitive to the multiple cultural sites relating to Coast Miwok habitation and early European and Asian settlements in the vulnerable portions of the study area.¹¹⁹

Developing and implementing large projects will require multiple agencies and private partners to coordinate and contribute financially. Moreover, natural resources often cross political borders and require intergovernmental collaboration. Any in many cases, especially in the northern study area, changes to or failures in flood protection in the baylands or managed land areas could impact development further inland, such as State Routes 101 and 37, SMART rail lines, and Gross Field. Planning would necessitate coordination amongst local municipalities, Marin County, California Department of Fish and Wildlife, and Caltrans.

The Marin Countywide Plan and local jurisdiction general plans guide protecting natural resources and sensitive habitats when land is developed, preserving public access to the coast, and maintaining and enhancing shoreline resources. Other regional, state, and federal regulators may also be involved, and commonly local plans reflect these goals and take advantage of any programs and funds at the higher levels of government.

¹¹⁹ Goals Project. 2015. *The Baylands and Climate Change: What We Can Do*. Baylands Ecosystem Habitat Goals Science Update 2015 prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. California State Coastal Conservancy, Oakland, CA. Pg. 159