

Ref #	Approach	Strategic Management Action	Spatial or site-specific details	Timeframe	Stressor(s) addressed	Key Partners	Required Resources	Notes	Habitat(s)	Priority
1	Dynamic Management	Add or relocate sediment to areas that are sediment-starved in estuaries and wetlands to help keep pace with sea level rise.	Sediment-starved areas in estuaries, or where needed.	Near-term	sea level rise, sediment supply	Sanctuary in partnership with Army Corps of Engineers and other sediment suppliers.	May be able to use dredge materials. There must be a process to ensure quality sediment is used. Incorporate into a larger, watershed-specific sediment management strategy. CCC permit or federal consistency review.	Creates/maintains habitat area and function in the face of sea level rise. Potential issues with TMDLs.	estuaries	Priority
2	Dynamic Management	In areas dominated by grey infrastructure, identify potential demonstration sites for green infrastructure projects and/or other "active management" projects; implement and evaluate effectiveness to inform future efforts across the region. Potential project options include: - Use wastewater treatment plants to supply fully treated and advanced wastewater for estuaries where benefit can be demonstrated. - Build a horizontal levee in threatened part of sanctuary (e.g., estuary that is flood-prone or needs additional habitat) - Install bioswales near areas dominated by infrastructure/roads - Install rain gardens with soil layers engineered to help storm water infiltrate underlying layers of soil - Find ways to allow larger passage for high flow events	Site-specific: location and method/project will be determined by issues in each specific estuary Prioritize estuaries currently impacted by flooding/storms, and in locations where the project could have co-benefits for other systems or human communities	Near-term	precipitation, sea level rise, coastal erosion, wave action	Sanctuary and estuary managers (possibly Marin County Parks, State Parks, NPS, Sonoma County Parks) in partnership with universities.	Funding required for initial project implementation as well as monitoring after implementation - consider NSF and foundations. Monitoring framework. CCC permit or federal consistency review.	There are many unknowns in how to manage for estuaries; this action will test different strategies and help innovate management, with the goal of helping sustain estuary habitat. Could have negative impacts (e.g., loss of tidal mudflat habitat). Need to balance risks	estuaries	Priority
3	Dynamic Management	To the extent practicable, reduce or modify armoring that exacerbates erosion; replace or enhance with natural material to create sloped, transitional habitat (e.g., artificial reef or dune). If armoring can't be removed and replaced, implement living shoreline techniques in conjunction with new construction/repairs.	Potential locations: Bolinas Lagoon (on lagoon side of the spit), Sausalito Beach, Tomales Bay, Sonoma County along Hwy 1, Russian River	Mid-term	overwater/underwater structures, roads/armoring, coastal erosion	Sanctuary and estuary managers (possibly Marin County Parks, State Parks, NPS, Sonoma County Parks) in partnership with communities.	Education and outreach, CCC permit or federal consistency review.	Reduces erosion (problem for Bolinas Lagoon), creates habitat for estuary movement. May be perceived by the community as a loss of flood protection.	estuaries	Priority
4	Dynamic Management	Let go of pocket beaches that can't retreat, and do not intervene with management actions.	Those that can't be nourished or retreat.	Long-term	coastal erosion, sea level rise	CCC (LCP plan approval), Sanctuary, NPS	Public outreach will be required to explain inaction.		beaches/dunes	Priority
5	Dynamic Management	For sediment-heavy estuaries, conduct instream and upstream restoration work to reduce sediment delivery and flash floods. Activities could include: - restore impaired and incised creeks - add large woody debris - reconnect creeks to floodplain - restore incised creeks by raising elevation to allow overflows/sediment deposition - dechannelize upstream segments - restore stream complexity - remove old road crossings and legacy roads, parking lots and other sediment sources - plant vegetation (e.g., drought/heat tolerant native species) - incentivize best land management practices that enhance soil health and decrease runoff and erosion (e.g., rotate land uses on agricultural upland properties, plant drought-tolerant natives, forest management) - build retention ponds/catchments that can be used for upland water management opportunities **For all activities listed, note that environmental conditions (e.g. storms, flooding, erosion, drought, SLR) can shift areas within estuaries between sediment-starved and sediment-heavy, so this action will need to be dynamic and respond to changing estuary conditions in the future.	Potential locations: areas within Pescadero Marsh, Bolinas Lagoon, San Gregorio, Tomales Bay, Drakes Estero.	Near-term	sediment supply, turbidity, land use change	Land owners (NRCS, Resource Conservation District, local cities and counties), SWRCB (TMDL info), Coastal Conservancy, upland managers, NPS for Drake's Estero.	Site-specific research to avoid invasive species introduction (vegetation management, impact assessments). Education and outreach will be needed to gain public buy-in, as footprint to restore the floodplain may be large, and may endanger houses and infrastructure. CCC permit or federal consistency review.	May alter habitat in upland areas. Could cause stream vs. estuary conflicts. Land owner/infrastructure challenges. Helps trap sediment/paces sediment release, enhancing estuary function. Enhances wetland filtering characteristics. Supports water infiltration and percolation. May benefit freshwater wetlands. Can help mitigate marine debris associated with storms.	estuaries	Priority
6	Dynamic Management	Encourage a climate-smart response to erosion events that smother the rocky intertidal by developing a diagnostic decision support tool so management agencies know how to respond to either 1) recover the habitat by removing material, 2) leave material and encourage surfgrass growth or 3) leave material and take the opportunity for creation of a new beach. Have the knowledge to take advantage of the new situation due to erosion events. Ideally would have some options with the ultimate goal of leveraging resources to provide the best response.	There are proximal (cliff failure) and more distant (debris flow from coastal watersheds) sources of sediment - to address more distant sources, perhaps focus on the largest coastal watersheds (including Garcia, Guialala and Russian Rivers, Pescadero and Gazcos Creeks) with soils, topography, etc. that are likeliest to yield the greatest amount of debris flows. To address more proximal causes (cliff failure), identify intertidal areas that are particularly vulnerable. Identification of slide-prone areas and pursue cliff failure prevention (see strategy 16).	Near-term	coastal erosion, wave action, precipitation	USGS	Requires modeling done by USGS scientists.	For distance sources of sediment, this action also requires watershed management efforts to reduce devastating impacts of wildfires that remove extensive vegetation and result in debris flows that are more likely and larger.	rocky intertidal	Priority
7	Dynamic Management	Maintain streamflow to mitigate estuarine temperature increases and salinity changes. Activities to help maintain streamflow could include: - upland water management (e.g., implement best management practices) - dam releases - upland restoration - building and using water retention ponds (land owners draw water from ponds rather than stream)	Smaller estuaries and estuaries with closed bars. Potential location: Esteros de San Antonio and Americano.	Near-term (as needed)	temperature, mixing/stratification, precipitation, oxygen, pH, salinity	Regulatory agencies, CDFW, Resource Conservation District, NPS, land owners, local water supply and flood control agencies	Education/outreach; communicate how water use impacts estuary function and other habitats; Collaboration: can potentially coordinate with/build off regulation of instream flows. CCC permit or federal consistency review.	Consider the balance of human water supply (agriculture and residential) vs. ecosystem needs. Sediment supply/transport may increase; which may not benefit sediment-heavy estuaries. Moderating temperature may help mitigate algal blooms.	estuaries	Priority
8	Education	Develop a comprehensive education/outreach plan to address all of the 10 categories of strategy approaches in this report, including: partnerships with environmental education organizations, schools and other public entities, social media and other communication strategies, interpretive signage and collaboration with other agencies and public entities to create a goal for climate literacy.	Region-wide	Near-term	all	Sanctuary			all	Priority
9	Education	Enhance education programs (including marsh and tidepool education and interpretation programs) through training and guidance to communicate the implications of climate change and the exacerbating stressor of trampling and recreation on coastal habitats. Target existing programs (e.g. Duxbury and Fitzgerald Marine Reserves) and identify other highly-visited areas that need attention from volunteer docents. Docents should all have a common training core that includes climate change impacts and the exacerbating stressor of trampling and recreation on intertidal habitats, as well as tidepool etiquette and safety and the impact that impaired safety will have on natural resources. (i.e. boat groundings and the impact of emergency response). Strategies could include SLR visualizations and clean-ups.	Highly visited beaches, estuaries and tidepools.	Near-term	recreation/trampling	Sanctuary as the lead, in partnership with California Academy of Sciences, local cities and counties, NPS visitor center, Marine Mammal Center, Headlands Institute, State Parks, education programs and schools.	Existing docent programs. Funding and staff required to produce materials, curricula and trainings.	Effect on public access, public opinion. Opportunities for environmental education. Could link to Marin and San Mateo Counties YESS program and other school curricula	all	Priority

10	Habitat Protection and Restoration	Remove or modify structures that disrupt the delivery of sediment via long-shore sediment transport (jetties, breakwaters, storm and wastewater discharge pipes), and coastal and near-shore structures that contribute to erosion. Prioritize areas that are already impacted by these structures, and remove where possible. If the structure cannot be removed, then enable for managed retreat (for bluffs to feed the beach as sea level rises) and support beach nourishment to allow for beach expansion.	Potential locations: Pillar Point jetty which disrupts the delivery of sediment to surfer's beach in Half Moon Bay, areas along the Bolinas Lagoon shoreline where structures can be modified or living shorelines can be implemented, Oceanside Water Pollution Control Plant (including the Westside transport box and Lake Merced Tunnel) and the Great Highway that impact Ocean Beach in San Francisco, structures that impact Fort Funston. Narrow road culvert at Schooner Bay, Drakes Estero.	Mid-term	coastal erosion, sediment supply and movement, wave action, wind, precipitation, overwater/underwater structures, sea level rise	Structure removal - Army Corps of Engineers, San Mateo County Harbor District, CCC, Sanctuary; Managed retreat - Caltrans, City of Half Moon Bay, CCC; Beach nourishment - Sanctuary, MBNMS, CCC, Army Corps of Engineers, SFFJC, Daly City, other local governments, Coastal Sediment Management Workgroup, Ocean Beach Master Plan, NPS.	Army Corps of Engineers staff, time and funds; CCC permit; political and local will. Living shorelines may need to be used to replace artificial structures and may require regulatory oversight through restoration - also may not be feasible on exposed outer coast beaches. Specific to the Pillar Point jetty, a feasibility study is near completion, and environmental impact review will be required regardless of the final action (though beach nourishment may only need an assessment). The MBNMS management plan may need to be updated for longer term beach nourishment. A living shoreline to replace structure removal may require regulatory oversight through restoration.	The Pillar Point jetty is causing the erosion of surfer's beach, but the negative consequences of removing this structure may be too great for the community (in which case, managed retreat and beach nourishment should be implemented). This strategy protects and encourages expansion of sandy beach habitat, restores sediment influx, protects dune systems and infrastructure inland of beach, enhances recreational value, improves public access, prevents the impact of flooded infrastructure to natural system, reduces further risk of erosion adjacent to the problem erosion areas, and allows coastal systems to respond naturally. This strategy may also result in changes to shoreline erosion, e.g. accelerate where shoreline is currently protected and decreased where currently accelerated.	beaches/dunes	Priority
11	Habitat Protection and Restoration	Create local and regional sediment management plans for full range of the sanctuary that are climate informed.	Exist: S. Monterey Bay, Santa Cruz, San Francisco (littoral cell internal draft is under review); still needed for: Marin, Sonoma, S. San Mateo County, San Francisco (central bay)	Immediate	coastal erosion, sediment supply and movement, wave action, wind	Army Corps of Engineers, Coastal Sediment Management Workgroup, State Parks, BCDC, local flood control districts, NMFS, CDFW, CCC, NPS, local cities and counties	Funding and staff		all	Priority
12	Habitat Protection and Restoration	Restrict and direct human access on cliff base, face and top; including motorized transport.	Devil's slide (though this impact may be ameliorated by the tunnel), Jenner, Bolinas.	Immediate	coastal erosion, sea level rise, wave action, recreation, road/armoring	NPS, State Parks, BLM, local land trusts	Installation of fencing and signage; enforcement. Local governments can plan for restrictions to public access in their LCPs. CCC would need to approve signage and LCP updates. With consideration to Article 1, Section 25 of California Constitution that guarantees access to fishing grounds for citizens.		cliffs	Priority
13	Habitat Protection and Restoration	Monitor dredge materials to be used for beach restoration or expansion for contaminants, make sure existing regulatory mechanisms control for contaminant exposure and take into account interaction with additional stresses from climate change (e.g. temperature, dilution concentrations, pH)	Region-wide	Immediate	dredging	SWRCB, RWQCB, EPA, Army Corps of Engineers.	Requires sediment/sand testing/approval by RWQCBs. Report out at the San Francisco Bay Long Term Management Strategy (LTMS) meetings. POC: Brian Ross, EPA, CCC permit or federal consistency review.		beaches/dunes	Priority
14	Habitat Protection and Restoration	In the aftermath of a spill of oil or other contaminant, ensure that restoration of affected areas takes into account climate considerations (type of restoration, location of restoration, what should actually be restored based on climate envelope modeling to predict what species will likely become dominant). Oil spill restoration plans need to explicitly account for climate impacts on restoration of affected sites.		Near-term	pollution (oil spills)	CDFW OSPR, NOAA Restoration Office, NPS, USFWS, CCC	Collaboration of the responsible party with Federal, State of California, and tribal trustee agencies. Climate change modeling.	This recommendation is applicable to all habitats and affected areas.	all	Priority
15	Habitat Protection and Restoration	Identify and purchase 1) cliff lands that are less likely to erode to provide enduring cliff habitat and public access, and 2) lands behind cliffs to allow for landward migration of cliff habitat.		Near-term	coastal erosion, sea level rise, land use change	State Parks, USGS, TNC, local land trusts, counties and cities, academic institutions	Funding, staff, research to identify cliffs less susceptible to erosion.		cliffs	Priority
16	Habitat Protection and Restoration	Stabilize cliffs through revegetation (with native, climate appropriate species) and natural netting (e.g. jute, not chain-link fence). Design any hardening methods to take into account ecosystem needs (e.g. seabird nesting).	Places experiencing vegetation loss through social trails or other means (social trails are paths not created by the land manager, but created by people walking repeatedly through a particular area to create a worn path)	Near-term	coastal erosion, sea level rise, wave action	California Conservation Corps, California Native Plant Society, Caltrans, land owners/managers (public and private)	Appropriate species that will persist in the context of future change, permits.		cliffs	Priority
17	Habitat Protection and Restoration	In restoration projects, use native, drought tolerant and heat resistant species or strains that fulfill ecological function of beach and dune processes.	Any location where restoration is proposed.	Near to mid-term	invasive and problematic species, air temperature	NPS, State Parks, land owners, National Audubon Society, California Conservation Corps, Friends and stewards programs of the seashores and parks, Point Blue (use STRAW program's plant palette modified for dunes/beaches), CCC (through permit conditions or LCPs), local governments, Surfrider Foundation.	Create database of useful species to fill this niche (similar tool created for the Bayland Ecosystem Habitat Goals Update), source/supplier, staff and money, consider paleo/historic record to ID plants that thrived under previously similar conditions)		beaches/dunes	Priority
18	Habitat Protection and Restoration	Restore and/or create high marsh/upland transitional vegetation, wetland habitat, and deltas in areas that are flood-prone for multiple purposes: to accommodate landward marsh migration, to provide refuge habitat for marsh and upland species during high tide events, and to provide flood protection	Undeveloped upland areas adjacent to marshes and flood prone areas adjacent to estuaries, including Bolinas Lagoon north end and east side drainages.	Near-term: acquire habitat Long-term: restoration activity	temperature, sea level rise	Land owners in partnership with Land Acquisition Funds, National Audubon Society, NPS	Identify transitional wetland habitat using regional estuary modeling and inventories, and obtain land by coordinating with land acquisition action. CCC permit or federal consistency review.	Tradeoff with existing habitat: may require some modifications. May restrict grazing opportunities. Provides habitat for the threatened and endemic red-legged frog. Creates refuge habitat from temperature and high water events.	estuaries	Priority
19	Habitat Protection and Restoration	Construct/augment coastal dunes. Remove/relocate shoreward constraints to dune movement and evolutions.	Many coastal locations (e.g. Stinson Beach, North and South beach of PRNS).	Mid to long-term	coastal erosion, wave action, sediment supply and movement	NPS, local governments	CCC permit or federal consistency review.	Impacts to recreation and visitor facilities through managed retreat and dune/wetland restoration. Shoreline recreation may be preserved but facilities may require relocation to offsite with shuttle to access beach. Would provide added protection to the town of Stinson Beach from SLR.	beaches/dunes	Priority
20	Habitat Protection and Restoration	Protect beaches in order to protect cliffs (see beach strategies: 4, 8-11, 13, 14, 17, 19, 22, 23, 25-27, 29, 32-39, 42, 44, 45, 49, 50, 54, 59, 60, 62, 66-71, 75, 76, 78).			coastal erosion, sea level rise, wave action				cliffs	Priority
21	Human Disturbance	Restrict human access to critical rocky intertidal areas. The type of access to rocky intertidal ecosystems that seemed appropriate in the 1960s may not be as appropriate now based on current knowledge of the increasing impact of people on these changing and likely more fragile ecosystems.	Critical habitat in the study region that deserves protection from human impact: important larval source, highly visited, highly impacted.	Near-term	recreation/trampling	CCC in partnership with Sanctuary, CDFW, NPS, Coastal Conservancy, local governments in their LCP updates.	CCC review of LCP updates or other plans.	Effect on public access, public opinion. Species populations might continue to improve under additional protections against human disturbance.	rocky intertidal	Priority
22	Human Disturbance	With the expectation that climate change impacts (such as those from storm activity and sea level rise) will reduce or cause major marine mammal haul-outs and seabird nesting sites to change, monitor and identify new locations of major marine mammal haul-outs and seabird nesting sites (see strategy 43) and provide protections for those locations. Reduce human disturbance, especially during times of heavy surf and inundation that will reduce availability of these habitats. Protect from major sources of disturbance from land, air and sea when appropriate, either as Special Closures, low overflight regulation zones or land-based closures. For example, NPS creates seasonal closure depending on the location of new elephant seal colonies and exposure to storm surf.	Historical areas - Pescadero Rocks, Bean Hollow, etc. Prioritize the locations with the largest amount of disturbance to the largest breeding sites. Fitzgerald Marine Reserve already has this protection (closes sites out when mammals are present, and rangers are present). Pillar Point haulout has no protection. Spatially identify where these sites are and if there are new areas that will need protection due to SLR if used by marine mammals.	Near-term onward	wave action, recreation/trampling	CDFW - for vessel-based impacts, BLM, NPS, or USFWS for land-based impacts, Sanctuary or NPS for air-based and water-based impacts. Partners include: State Parks, NPS, county and city parks, Marine Mammal Center, Sanctuary (Beach Watch), MARIne, universities, Seabird Protection Network, CCC permit conditions for signage.	Public education (staffing for education and enforcement and resources like ropes and signs, interpretive materials). Provide spotting scopes for people to see mammals/seabirds up close. Better coordination amongst organizations and agencies to report new haulout areas, changing uses, etc. Landscape design of observation points, most protective to mammals and best vantage point.	SLR and storminess will flood haul out locations, especially during pupping season which overlaps with upwelling season - this may cause concentration of haul outs to fewer locations (erosion of north-facing beaches). Species conservation planning for marine mammals. Safety of boaters and pilots need to be considered.	all	Priority
23	Human Disturbance	Minimize access through dunes to protect dune stability.	Highly visited beaches that require access through dunes.	Near-term	coastal erosion, sea level rise, wave action, recreation	CCC, NPS, local cities and counties		LCP policies and permit conditions are potential ways to implement this management action	beaches/dunes	Priority

24	Invasive Species Management	Prevent non-native invasive species establishment (aquatic and terrestrial) in estuaries. Potential activities to prevent establishment include: - plant natives (e.g., in disturbed areas) - remove invasive species that are near/adjacent to estuaries that have the potential to invade (e.g., invasive tunicate, green crabs).	Region-wide	Near-term	invasive & other problematic species, sediment supply	Sanctuary in partnership with National Aquatic Invasive Species Group, SF Estuary Partnership, SF Estuary Institute, and other relevant estuary management agencies (CDFW, NPS, Marin County Parks).	Need an understanding of what species may invade the area, monitoring and maintenance, collaboration on education and outreach work with local community and other management agencies to mitigate introductions and enhance participation. CCC approval of permits and LCP updates.	This action specifically prevents establishment (as compared to removing invasives that are already established)	estuaries	Priority
25	Invasive Species Management	Update the definition of introduced/invasive/non-native aquatic and terrestrial species for Sanctuary management. An example for aquatic species may be that if it is a California Current species, it should be managed as a native, and expansions into the study area should be considered a migration or expansion.	Throughout study region.	Near-term	invasive & other problematic species, sediment supply	Sanctuary and relevant species management agencies	Specific definition might want to be revised by local experts - may want to re-word and change from California Current designated in this strategy and incorporate terrestrial species. Take into consideration the definition provided by the National Aquatic Nuisance Species Task Force and the Western Regional Panel.		all	Priority
26	Invasive Species Management	Enhance/establish the detection and monitoring of species changes (southern species moving north, northern species moving out and invasive species moving in) via a novel rapid assessment program. Something similar to Reef Check, partner with PISCO and MARINE (currently monitoring sites two times per year, needs to be more frequent and in more locations). Engage land managers (such as PRNS, CDFW, Sanctuary via LIMPETS) to leverage pre-existing efforts to detect and monitor. Create a uniformity of practice across the region.	Existing sampling sites (e.g. MARINE), especially those that are less disturbed, urban/more disturbed sites like Fitzgerald and Duxbury where volunteers and visitors can be engaged. Leverage citizen science networks and programs.	Near-term	invasive & other problematic species, sediment supply	MARINE, CDFW (base of of existing protocols for community assessments), Sanctuary should lead the effort if it is determined a novel program is warranted. NPS.	Monitoring programs, volunteer removal programs; outreach to corporations, schools, communities to volunteer. Protocols for identifying invasive species as well as the response - trigger criteria to launch a rapid response. Permit for collection of novel identified organisms. Funding will be needed. Build capacity through citizen science training (e.g. LIMPETS).	Check with Pete Raimondi on existing efforts (biodiversity plots) and consider altering this recommendation for better continuity and support.	all	Priority
27	Invasive Species Management	Rapid response of non-native invasive species removal following detection to protect natural systems (e.g., control invasives via manual removal, flooding, fire in transition zones; reestablish natives).	Region-wide with focus on National Parks (GGNRA, PRNS), State Parks, and private lands	Near-term	invasive & other problematic species	Sanctuary, NPS, State Parks, land owners, National Audubon Society, California Conservation Corps, friends and stewards programs of the seashores and parks	Build and use volunteer base for manual projects. Will require monitoring and maintenance. Education and outreach with community, visitors, management agencies. Funding, CCC approval of permits and LCP updates.	Rare plants and snowy plovers may benefit, but need to mitigate for increased degradation of plover chicks. Where European beachgrass and iceplant are pervasive, removal cannot be accomplished and sustained by volunteers or heavy equipment. May mitigate range expansions with warmer water. Helps restore sediment and hydrological movement. Volunteer engagement can enhance education/outreach efforts. Disturbance associated with removal could create habitat/opportunity for other invasives.	all	Priority
28	Invasive Species Management	Remove non-native invasive plants (e.g. jubata grass) that undermine cliff integrity, and where appropriate, replant with natives or drought-heat-tolerant species that support cliff structure.	Cliff habitat throughout study region.	Near-term	invasive & other problematic species	NPS, State Parks, CalTrans, local counties	Training, funds, CCC approval of permits and LCP updates.	Similar to actions for strategy 15 "Stabilize cliffs through revegetation"	cliffs	Priority
29	Landward Migration	To the extent practicable, remove/redesign roads in locations that act as barriers to natural expansion of habitats. Prioritize roads that are already impacted by high tides and start with those immediately. Always remove roads where possible; if not possible, redesign the road. Steps to accomplish this action in a changing climate include: 1) Identify areas that: A) are critical for estuary expansion and that have roads that impede estuary migration, and B) have roads vulnerable to sea level rise, flooding, other climate impacts 2) Develop Rapid Climate-Ready Response plans: develop plans that will allow for road removal/redesign in case of a disaster (e.g., road is wiped out in a flood) 3a) Post-disaster (flooding/road failure): implement the Rapid Climate-Ready Response plan to move/redesign road to enhance future resilience 3b) If road is not impacted by climate change/sea level events, remove/redesign the road as available during standard maintenance schedule timeframes (i.e., when the opportunity arises to replace/redesign the road, take it)	Potential project locations: 1) Highway 1 along the east shore of Tomales Bay 2) North end of the Bolinas "Y" 3) Highway 1 at Pescadero Marsh 4) Sir Francis Drake Blvd near Drakes Estero (re-route or re-design) 5) Pescadero Creek Road 6) Highway 1 at Surfer's Beach in Half Moon Bay 7) Great Highway at Ocean Beach in San Francisco 8) Dillon Beach to Lawson's Landing	1) Long-term 2) Near-term (higher urgency) 3) Long-term 4) Near-term (higher urgency) 5) Near-term assessment; Long-term implementation 6) - 8) Mid to long-term	sea level rise, roads/armoring	Local governments can plan for road relocation in their LCP updates. 1) A state agency should be identified to organize implementation in partnership with Caltrans, Sanctuary, CCC, County of Marin, and NPS. 2) Marin County Parks, County of Marin, Sanctuary, NPS 3) Caltrans, San Mateo County, CCC, State Parks, scientists 4) NPS and San Mateo County, CCC, USCG (need facility access), private ranching community, farm bureau 5) San Mateo County, NMFS, CDFW, Pescadero Fire Station (currently working on moving their flood-vulnerable facility) 6) Caltrans, City of Half Moon Bay, CCC 7) Caltrans, City of San Francisco, CCC 8) Caltrans, Marin County, CCC	1) Do not anticipate the need for policy change in order to implement. Post-disaster planning might need to interface with local hazard mitigation plans. 2) Likely requires permit and environmental impact review; Needs project coordinator and adequate resources for assessments; Funding. Do not anticipate the need for policy change in order to implement. CCC approval of the plan, especially if elements are in the LCP update. 3) Need a place to move Hwy 1 5) Funding: partners can help leverage funding	Creates space and facilitates estuary movement in response to SLR, reducing vulnerability to flooding. Facilitates water and sediment movement throughout the estuary, improving hydrologic function. Improves connectivity between upland and lagoon habitats, with positive impacts on riparian and nursery habitat. Site specific benefits and consequences: 1) Provides more areas for seagrass restoration in Tomales Bay. Reduces flood risks for human communities and infrastructure, enhancing long-term resilience. Also improves driver safety and traffic flow. Potential conflicts with tourism, transportation, infrastructure needs, etc. Road redesign may be the only feasible alternative since it is Highway 1. May need a causeway or reroute over the hills to the east at various locations. 2) Provides transitional habitat in an estuary where most of the edges are hardened. Road removal may cause loss of non-native and native species in habitat on other side of the road with unintended consequences; however, this area will eventually be inundated anyway. Transportation conflicts: local residents, tourists. Part of Marin County's sea level rise project - this action supports local efforts. 3) May improve dynamism of marsh morphology - Hwy 1 has low point near marsh, estuary bar is fixed under Hwy 1 bridge and can't move around, which likely affects marsh morphology. However, no records show the historical outlet so it is unknown how marsh morphology may change. Societal impacts of moving road: directing it toward a small town, tourism/recreation, safety routes, etc. Could negatively impact marsh depending on design. 4) This road (culvert/bridge) is at the pinch point at the head of Drakes Estero, and floods every winter. Would allow connectivity of habitats on each side of road, and prevent costly infrastructure maintenance. May be able to link to county program: San Mateo is identifying all roads vulnerable to SLR and affected by flooding. There are communities on each side of road; may affect access. 5) Road is at head of marsh and floods frequently because channel is filled with sediment. Could provide additional wetland habitat. County is moving fire station (Pescadero Fire Station Replacement Project) and looking at options for the road. There is an opportunity to leverage projects for multiple benefits.	all	Priority
30	Landward Migration	For roads that can't be raised/moved, or in conjunction with raising/moving roads, look for opportunities to create functional habitat (e.g., replace hard/grey infrastructure such as rip-rap with living shorelines and migration space)	Region-wide Potential location: install a horizontal levee at Bolinas Lagoon/Hwy 1	Bolinas Lagoon: Mid-term Region-wide: long-term, leverage opportunities when they exist	sea level rise, overwater/underwater structures, roads/armoring	Caltrans, Sanctuary, Army Corps of Engineers, RWQCB, NPS (GGNRA and PRNS), Sonoma County Parks, State Parks, land owners	Capitalize on natural destruction events, rebuild smarter. CalTrans would likely need policy adjustments (repair vs. rebuild); develop pre-planned response to road failures; revise planning horizons. CCC approval of a plan.	Creates functional habitat and space in areas that can't be moved/expanded. Short-term impacts to existing species/vegetation with habitat modification (e.g., may need to fill part of lagoon to create sloped transitional habitat).	estuaries	Priority
31	Landward Migration	For locations identified as having coastal area available for developing new rocky intertidal habitat (see strategy 43), allow cliffs to erode to create new habitat. Discourage the creation of seawalls that would inhibit cliff erosion.	Create unfettered sea-to-land linkages for new habitat development. Where possible maintain the thread-like habitat continuity of rocky intertidal habitat north to south - avoid where possible large stretches of total inundation of rocky intertidal habitat. If design is possible, create new habitats that are less powerfully affected by storm damage, i.e., is there "wobble room" to design new habitats that will be resilient to increasing storm surges.	Long-term	sea level rise	Sanctuary, NOAA Restoration Office, USGS, local cities and counties, land owners	Excellent marine geomorphologists, oceanographers, CCC federal consistency review.	May require efforts to clean up contamination sites, remove infrastructure at risk to provide adequate setbacks for development of new habitat - would link to efforts to control or manage coastal cliff erosion intersects with intertidal species conservation strategies.	rocky intertidal	Priority
32	Landward Migration	Explore legal and economic mechanisms to encourage coastal habitat protection in exchange for something analogous to an agricultural tax credit (e.g. coastal protection tax credit or transfer of development rights).		Near-term	coastal erosion, sea level rise, wave action, roads/armoring	CCC, local cities and counties, land owners	May need state legislature	LCP policies and permit conditions are potential ways to implement this management action	beaches/dunes	Priority
33	Landward Migration	Exclude development in critical habitat areas and areas of potential habitat expansion through various policy changes. Exclusion language should be integrated into policies for retrofitting existing buildings, new construction, and rebuilding post-disaster. Add sea level rise conditions to general plans and local coastal plan updates.		Near-term	sea level rise, coastal erosion	CCC, Coastal Conservancy, local cities and counties, Center for Ocean Exclusion (policy guidance), Georgetown Law Center, State Attorney General (legal guidance), UCLA Model Ordinance project (policy guidance)	Education and outreach: make changes amenable/understandable by the public. If needed, explore and investigate opportunities for how exclusion has been accomplished elsewhere (e.g., along the Napa River, other floodplain examples), and confer with groups with expertise in this realm (e.g., Nature Conservancy, Coastal Conservancy). Capitalize on large natural disasters - prevent vulnerable re-building that would negatively affect estuary migration.	Prevents construction/retrofits that can impede estuary migration. Prevents building construction that could fall into estuary habitat in the future. Public opinion may be hard to change. In long-term, benefits counties, cities, and homeowners: saves money by preventing the construction of structures vulnerable to SLR and flooding.	all	Priority

34	Landward Migration	Prioritize locations, purchase or redesign available land for inland movement of beach and dune habitat, using Open Space/Conservation Easements	Any site that is vulnerable to SLR and has potential to move inland.	Near to long-term	coastal erosion, sea level rise, wave action	CCC, local cities, counties and land trusts, Coastal Conservancy, land owners, State Parks, NPS, State Lands, BLM, TNCC, Caltrans, FEMA (through Hazard Mitigation Plans), Army Corps of Engineers	Spatial prioritization, funding, knowledge of sediment circulation and supply	Might be in conflict with adjacent land management that is trying to abate SLR	beaches/dunes	Priority
35	Landward Migration	Move or remove infrastructure that blocks or impedes habitat migration, or presents a potential risk of contamination to critical habitats, including utilities (e.g. power lines, sewer pipes), buildings, roads, or agriculture endeavors.	Places where lifetime of structure is ending or structure is creating a coastal hazard. Will likely be similar locations as road removal/redesign; all projects involving Hwy 1.	Near-term and long-term	sea level rise, overwater/underwater structures, coastal erosion	CCC, local cities, counties and land trusts, Local Coastal Programs, Coastal Conservancy, relevant utilities agencies and/or project lead of other barrier removal projects.	Planning for infrastructure relocation can be part of a local government's LCP update.	Deals with multiple obstructions at same time (co-benefits, leverage projects); facilitates estuary expansion. Availability of utility services	all	Priority
36	Landward Migration	Work with counties to zone for protection of dunes and cliffs (setbacks, buffers, moratoria, elevate structures, designate areas of special biological interest for protection) to reflect changing coastal conditions		Mid-term	coastal erosion, sea level rise, wave action, roads/armoring	CCC, State Lands, local cities and counties		LCP policies and permit conditions are potential ways to implement this management action	beaches/dunes	Priority
37	Landward Migration	Consider the removal of seawalls (including rip rap) and make associated modifications to support retreat.	Where appropriate.	Mid to long-term	coastal erosion, sea level rise, roads/armoring	Caltrans, City of Half Moon Bay, CCC, Marin County, homeowner's associations (if applicable), NPS, local cities and counties.	Caltrans staff and time, funding (increase gas tax in San Mateo County), create sustainable development community with transit hub		beaches/dunes	Priority
38	Landward Migration	Assess the need to move or modify visitor facilities, pavement, and parking lots.	Visitor facilities (visitor centers, kiosks, bathrooms, signage, trails and parking lots)	Depends upon timing of impact	coastal erosion, sea level rise, roads/armoring	NPS, State Parks, CCC, local cities and counties	Funds, permits, staff time		beaches/dunes	Priority
39	Science Needs	Develop a systematic research and science agenda to inform climate-smart adaptation.		Near-term		OST and NOAA			all	Priority
40	Science Needs	Conduct regional inventory and modeling to identify how existing estuaries may change and identify potential areas for estuary expansion; use this information to set regional adaptation priorities. This effort includes: - completing current estuary inventory - identifying values of different estuaries (e.g., estuary harbors endangered species [or those that may become so], has valuable wilderness character, soundscapes, landscapes, lightscapes, pinniped breeding sites and haulouts, salmon habitat, etc.) - identifying where future estuary habitat may move - better understanding how habitat types may change, and - better understanding and modeling system dynamics, and how they may change (e.g., how tidal prism may change) If possible: - Model entire region, utilizing current information/regional efforts and modeled future changes to identify net changes to estuaries - If not, model specific sites of management interest - If really limited, look only at the information we currently have (e.g., OCOF model) rather than conducting new modeling	Study region	Immediate	sea level rise, precipitation, overwater/underwater structures, roads/armoring, coastal erosion	Sanctuary to convene a regional partnership of numerous land management agencies, scientists and funders. See "required resources" for a listing of partners that need to be involved.	Funding: variety of sources/joint venture (NOAA, NPS, Stanford Natural Capital Project, Universities/Academics, Federal Highways, foundations) Modeling: leverage current data from existing regional efforts and combine with new modeling. Will need someone to lead data aggregation, plus someone to model (consider Point Blue and/or USGS) Data/models that should be used: - current estuary inventories from various management agencies/groups; combine these to make a regional inventory, and standardize/expand on detail collected for each estuary (e.g., key species, services provided, estuary values, etc.) - OCOF: use to identify what areas will be flooded; combine with salt water intrusion modeling, riverine flooding modeling (e.g., FEMA flood maps). Build in uncertainty by using max/worst case scenario projections - pollutant hotspots (critical to know if polluted area will be inundated; get data from EPA and regional/local environmental health agencies) - historical/archeological resources (NPS, State parks, counties) - sediment availability (identify if each estuary requires more/less sediment) - location of berms/levees/existing infrastructure/armoring - demonstration projects/lessons learned from regional projects (e.g., Muir Beach, Giacomini, South Bay Salt Ponds) Can create a decision matrix to go along with this process to facilitate future updates/revisions.	Identifies how estuaries may change, and areas ripe for estuary expansion. Can be used to inform locations of all other adaptation actions, and helps prioritize sites for action. Short-term benefits: can identify where short-term measures are needed/feasible and identify opportunities to leverage resources with other groups and activities. Long-term benefits: guides prioritization of projects, can identify short-term actions within longer-term processes.	estuaries	Priority
41	Science Needs	Capitalize on natural extreme events to increase monitoring and knowledge of estuary processes and climate change impacts to inform adaptive management (e.g., monitor impacts of projected El Niño, study closed/open estuaries)	Study region	Near-term	precipitation, wave action, coastal erosion, turbidity, salinity, sea level rise, pH	Sanctuary, CDFW and OST. Relevant land owners (e.g. NPS) to lead monitoring on individual sites.	May require a Sanctuary staff member to lead data management and acquisition. Need rapid response monitoring teams ready to deploy (in case of extreme events). Need a standardized monitoring framework across sites; need to identify what Sanctuary wants to monitor for. Base locations on sites identified through monitoring and inventory action. Gather input from other groups (Bay Area Climate Change Consortium, CA LCC, agency partners). There are several estuaries that contain MPAs so it would be good to link the MPA monitoring efforts to other monitoring efforts for estuaries in the region.	Can help inform adaptive management and help mitigate negative impacts of extreme events in the future by better understanding natural processes. Builds knowledge to inform adaptive management. Can be used to increase education/outreach and public engagement.	estuaries	Priority
42	Science Needs	Determine the source of sediment for vulnerable beaches in order to improve sediment supply processes.	Wherever sediment patterns are vulnerable and uncertain	Near to mid-term	coastal erosion, sediment supply and movement, wave action, wind	Sanctuary, Coastal Conservancy (for funding), academic institutions, NPS, USGS, Army Corps of Engineers, Coastal Sediment Management Workgroup	Researchers, funding	Implications for estuary management and cliff erosion. Possible counteracting sources (e.g. cliff erosion and long-shore current counteract).	beaches/dunes	Priority
43	Science Needs	Identify future viable locations for rocky intertidal habitat migration inland either through modeling or known information (how do rocky intertidal areas form, and would there be available rock inland for habitat migration? Is there rock under the cliff bluffs or under the sand?). Identify future viable locations for seabird and marine mammal breeding sites and haul-outs.	TBD through modeling analyses and site analyses. Some modeling has been done at PRNS for elephant seals.	Long-term	sea level rise	USGS, universities.	Modeling, interagency collaboration of Federal, State, County, and municipal governments; regional planning - perhaps along the lines of planning zones used in Area Contingency Plans; Army Corps of Engineers might have very useful expertise	This strategy informs the implementation of strategies 22 and 31. This activity intersects with intertidal species conservation strategies.	rocky intertidal	Priority
44	Species Protection	Designate, expand, and increase enforcement of resource management areas to enhance and support special protections for target species in the context of climate change.	Study region	Near-term	coastal erosion, sea level rise, temperature, precipitation	CDFW, NOAA OLE, BLM, USFWS, NPS, State Parks, relevant land managers	California Coastal Commission permitting		beaches/dunes	Priority
45	Water Quality Management	Improve storm water management by reducing combined sewer overflow events.	Ocean Beach, Fort Funston, Pacifica, other locations with combined sewer overflow	Near-term	precipitation, coastal erosion	SFPUC or Public Works, CCC for review of permit or LCP updates.	Funding for infrastructure improvements and/or replacements	Improves water quality	beaches/dunes	Priority
46	Water Quality Management	Capture and redirect storm water away from cliff face into better infiltration systems to reduce erosion and avoid landslides.		Near-term	pollution, precipitation	Local cities and counties, SWRCB, CCC	Hydrology information, funding for contracts to regrade/swales/etc., local permits		cliffs	Priority
47	Water Quality Management	To prevent algal blooms, Regional Water Quality Control Boards that manage TMDLs for nutrients should consider stricter prohibitions for effluent flows of excessive fertilizer to address stressors of excessive nutrients at low flow times into the ocean, a situation likely to get worse with climate change. See publication: http://pubs.acs.org/doi/pdf/10.1021/acs.est.5b00909 .	San Francisco Bay (Napa and Sonoma rivers have TMDLs for nutrients which are now under consideration for delisting), Walker Creek and Tomales Bay (mercury and pathogens only, not nutrients), and Russian (phosphorus in the Laguna de Santa Rosa) rivers all have water quality impairments for nutrients. TMDLs are under development for Fitzgerald Marine Reserve (for bacteria) and for Pescadero Marsh/Butano Creek (sediment).	Near-term (higher urgency)	pollution, oxygen, stratification	RWQCB, SWRCB, California Farm Bureau, NRCS	Local Resource Conservation Districts, Sanctuary to help track water quality changes through monitoring (ACCESS cruises) with partners (Point Blue).	Decrease the possibility of negative impacts due to blooms smothering the intertidal (macro) and changing water quality (micro). Planning to reduce debris flows from storms, efforts to reduce mercury input into coastal waters	rocky intertidal	Priority

48	Water Quality Management	Take a watershed approach for rocky intertidal areas near estuary mouths, streams, etc. to limit sediment and improve water quality entering from the watershed: 1) Watershed managers and regional water quality control boards should enforce TMDLs with forestry operations, municipalities, agriculture, etc. to limit sediment coming down into the intertidal area. 2) Incorporate climate considerations into formulation of TMDLs in specific locations (see site specific category) to respond to predicted climate change impacts on outflows of sediment, toxins and nutrients.	Potential project locations: 1) Garcia River estuary next to Point Arena intertidal reefs. Farmland and forestry operations upstream. 2) Gualala River next to Gualala Point. Logging and land recently purchased as conservation lands. 3) Russian River with rocky intertidal both north and south of estuary mouth. Mercury-rich sediments from mines upstream. Forthcoming inclusion of Lake Mendocino and Lake Sonoma in the Statewide Reservoir Mercury TMDL. 4) Pescadero Creek with rocky intertidal area just south of estuary. 5) Gazos Creek with Ano Nuevo just south. Timber logging upstream.	Near-term	coastal erosion, precipitation, land use change	For all potential projects: SWRCB and local cities and counties, relevant forestry, farming, mining, logging operations upstream. Additional: 2) Gualala River Watershed Council, Friends of Gualala River 3) Russian River Watershed Association, Russian River Watershed Protection Committee	Collaboration among rocky intertidal managers (BLM, CDFW, State Parks, Sanctuary) and RWQCBs. Need to secure immobilization of pollutants as the disturbance regimes along coastlines, coastal rivers and streams, and uplands intensify. CCC review of plans.	Negative impact on sediment-starved estuaries. Note that San Francisco Bay and Tomales Bay have TMDLs for mercury.	rocky intertidal	Priority
49	Water Quality Management	Improve storm water management by creating bioswales and other urban run-off reduction tools (e.g. permeable pavement, street trees/catchment/storage).	Pacific/Linda Mar Beach, San Francisco, Half Moon Bay and other San Mateo County Unincorporated Areas, all highway locations in the five county area	Near to mid-term	precipitation, coastal erosion	Local cities and counties, Friends of the Urban Forest, California Conservation Corps, The Arbor Day Foundation, CCC (in permit conditions or LCPs), ASBS funding	Wetland vegetation, saplings, staff or volunteers	Improves water quality, and reduces beach erosion	beaches/dunes	Priority
50	Water Quality Management	Improve storm water management by reducing agricultural (croplands and livestock) run-off (buffer strips).	San Mateo County, Lawson's Landing, Sonoma County, Tomales Bay	Near to mid-term	precipitation, sediment supply and movement	Resource Conservation Districts, SWRCB, CCC (in permit conditions or LCPs)	Grants and conservation easements for private landowners	Improves water quality	beaches/dunes	Priority
51	Alleviate Climate Impacts	Restore and enhance lower intertidal mussel beds and algae, including sea palms (a species identified as vulnerable), to buffer from storm activity by enhancing structural roughness (physical/structural resistance) to lessen impacts of storms on intertidal zones.	Consider the evolving (new) subtidal and intertidal zones	Near-term onward	wave action	Sanctuary and landowners (NPS, CDFW, State Parks, State Lands Commission) in partnership with NGOs to get funding	Marine and coastal habitat restoration ecologists; monitoring to address efficacy, CCC permit or federal consistency review.	Facilitates species colonization and recovery from disturbance due to an increase in ocean wave energy that may destabilize and transform intertidal habitats.	rocky intertidal	
52	Alleviate Climate Impacts	Restore subtidal kelp forests to attenuate waves and buffer from enhanced storm activity.	Select locations that do not currently have kelp but have appropriate conditions for kelp settlement and growth (good light and water quality, little turbidity).	Near-term onward	wave action, coastal erosion	Sanctuary in partnership with NPS, Bodega Marine Lab and UCSC, NGOs and Coastal Conservancy for funding.	Monitoring to address efficacy, CCC permit or federal consistency review.	Reduces ocean wave energy in subtidal habitats as a further step to reduce energy impacts in the intertidal zone - to modulate the intensity, frequency, and duration of storm impacts. Reduces sediment and turbidity in the intertidal. Creates habitat for subtidal systems that supports objectives for rocky intertidal ecosystems. Need to balance with any commercial programs for kelp collection. Learn from Southern California efforts. Seek funding for a research project at Bodega Marine Lab.	rocky intertidal	
53	Alleviate Climate Impacts	Restore and enhance surfgrass (<i>Phyllospadix</i>) and algal species to act as aqueous canopies and provide shading to reduce temperatures and reduce evaporation in tide pools.	Prioritize intertidal reefs that are most vulnerable to prolonged exposure and heat stress. Potential locations include: Tomales Bay headwaters, Point Reyes Headland, Falmarin, Pescadero State Beach, San Gregorio State Beach, Fitzgerald Marine Reserve, Año Nuevo State Park, Pigeon Point, and Pillar Point for <i>Phyllospadix scouleri</i> , and Moss Beach for <i>P. torreyi</i> (see callfora.org for more information on species distributions).	Long-term	air temperature, sea surface temperature, salinity	Sanctuary in partnership with NMFS, Coastal Conservancy, CDFW, NPS, other agencies that manage marine resources, and NGOs to assist with funding	CCC permit or federal consistency review.	Additional benefit is carbon sequestration and local mitigation of the impacts of ocean acidification provided by surfgrass restoration.	rocky intertidal	
54	Alleviate Climate Impacts	Diminish heat stress by testing the efficacy of shade delivery systems (including nest umbrellas/boxes/tents and revegetation) or encouraging animals to nest in more protected areas.	Farallon Islands, critical nesting sites	Near-term	temperature, precipitation	USFWS, Point Blue, State Parks, CDFW, NMFS, NPS, relevant coastal land owners and managers	Determine need for seal pup thermal protection; California Coastal Commission permitting	Make use of solar fabric for ancillary power production (e.g. fans if needed). Create possible user experience/education tie-in, such as renting similar umbrellas to beach users.	all	
55	Dynamic Management	Manage the bar: - create a breach if estuary closes and conditions are detrimental to estuarine species or resources of interest - actively close the bar if estuary is open and conditions are detrimental to estuarine species or resources of interest	Site specific: will largely depend on estuary condition (e.g., breach may be required in case of restricted passage or poor water quality; closure may be required to capture necessary freshwater outflow or to protect from marine pollutants) Potential areas for breach: Bolinas Lagoon (although natural closure may be unlikely with sea level rise), Pescadero Marsh, Russian River, Muir Beach, San Gregorio, Tunitas Creek, Pomponio, Rodco Lagoon, Gazos Creek, steelhead or salmon bearing streams that have restricted passage Potential areas for closure: Nursery grounds (e.g., Russian River - salmon), or in case of pollutants (e.g., done at Rodco Lagoon in the past to protect from oil spill)	As conditions require.	precipitation, oxygen, pH, water temperature, salinity, turbidity, currents/swimming/stratification, temperature	Partnership with land owners, County (equipment/staff), Sanctuary, regulatory agencies, Coastal Commission, community support. Lead agency may be different if species of concern isn't a key commercial or T/E species, or depending on who wants the action done	Need to first accomplish in the near-term the policy/permitting framework (programmatic permits required for each system; must be very site-specific and lay groundwork for approval ahead of time) and a better understanding of individual system dynamics to identify when this management action would be beneficial/harmful. Will also require agency coordination (esp. related to breach timing). Funding needed to monitor impacts and cover permit costs.	Creating a breach may ameliorate stagnant water impacts, poor water quality, limited passage (anadromous fish [juveniles/adults], recreation, other biota) and promote hydrologic and sediment transport. May cause earlier opening in the future, and could affect marsh accretion and water chemistry (methyl mercury production). May provide positive education opportunity around resource values, and may benefit certain human communities that believe the septic system doesn't function when estuary is closed. May also help prevent algal blooms by moderating temperature. Closing the bar may capture freshwater and protect/maintain related freshwater habitats, including nursery grounds, when runoff is pulsed. May reduce recreational use/access and/or become stagnant and smelly. Could cause loss of sediment (depending on how it's done), shorebird foraging habitat/subtidal habitat, haulouts, cordgrass, and mud organisms (due to anaerobic conditions).	estuaries	
56	Dynamic Management	Reconsider sediment requirements and stream management mandates to ensure sustainable sediment delivery to estuaries. Activities could include: - conduct sediment study for each estuary site to determine if estuary is sediment-starved or keeping pace with sea level rise - recommend that sediment management plans be climate-informed	Region-wide, but prioritize sediment-starved areas within estuaries. Potential location: Tomales Bay	Near-term	sediment supply, coastal erosion, sea level rise	Army Corps of Engineers in partnership with Coastal Sediment Management Working Group, CA State Sediment Master Plan, other sediment management and planning efforts. Coordination with SWRCBs for TMDLs, NPS.	Expand existing groups/efforts to look at estuaries. Utilize existing monitoring data from NPS, USGS, and gather high resolution data for sites of interest.	Could benefit beach systems. Enhancing sediment delivery may not be possible if streams harbor sensitive species (e.g., salmonids).	estuaries	
57	Habitat Protection and Restoration	Protect and promote eelgrass growth; protect existing beds and restore areas that have been adversely affected by human activities, such as aquaculture operations, moorings or other infrastructure.	Potential locations: Tomales Bay, Esteros de San Antonio and Americano, Bolinas Lagoon, Drakes Estero.	Immediate	pH, overwater/underwater structures, temperature	CDFW, California Fish and Game Commission, State Lands, Sanctuary, NPS	Requires funding, enforcement to protect current beds from degradation and to protect restored areas, and education and outreach. CCC permit or federal consistency review.	Enhances nursery grounds. May help regional carbon sequestration. Economic benefits (oyster farming). Need to work with oyster companies to reduce light blockage and other damage from anchors, racks, floats.	estuaries	
58	Habitat Protection and Restoration	Remove overgrowth of macroalgae (ulva blooms) from rocky intertidal habitat as they occur.	Areas impacted by major overgrowth.	Immediate	pollution, oxygen	Sanctuary	Permitting	Potential impacts to the intertidal area due to trampling and harvest - needs to be done in a way that does not impact resources (consider only free-floating harvest by vessel). Separate approach (Water Quality Management strategy) focuses on reducing pollutants from estuaries and run-off.	rocky intertidal	
59	Habitat Protection and Restoration	Beach nourishment	Potential locations: Ocean Beach: middle and southern reaches, Stinson Beach, Inverness, East Shore, Dillon Beach, Lawson's Landing, Salmon Creek, Jenner, Half Moon Bay, Surfer's Beach, pocket beaches on Farallon Islands, Point Arena, Manchester State Park, Gualala Point Regional Park, other locations as identified in the draft San Francisco Regional Sediment Management Plan	Near to mid-term	coastal erosion, sediment supply and movement, wave action, wind	City of San Francisco, Army Corps of Engineers, NPS, State Parks, USFWS, SPUJ, USGS, SFPUC, CCC, Sanctuary, local harbor districts, cities, and counties, Coastal Sediment Management Workgroup	Sand, money, staff, federal permit, CCC permit or federal consistency review.	Implications for beach and benthic invertebrates. Forestalls beach hardening to maintain habitat. Potential to establish dune vegetation. Carbon emissions from implementation may be significant. Impact to surfing uncertain. Consider where sediment source is blocked by dam or otherwise. Apply for both human and wildlife access. Preserves/prolongs beach habitat values, as well as public recreation and access.	beaches/dunes	
60	Habitat Protection and Restoration	Install beach sediment traps (add good jetties, giant fine mesh nets, sand flume cells) to accumulate sediment where needed.	Cliff-backed beaches, pocket beaches, high erosion beaches.	Long-term or emergency measure	coastal erosion, sediment supply and movement, wave action, wind	Caltrans, Army Corps of Engineers, CCC, State Lands, Sanctuary, landowners/managers	Spatial assessment, feasibility and efficacy studies, permits. Take into account wildlife impacts.	Wave energy generation. Artificial habitat created on structures.	beaches/dunes	
61	Habitat Protection and Restoration	Restrict livestock access to cliff top, including rotational grazing plans.	Hwy 1 north of Jenner; Sonoma and Marin Counties	Immediate	coastal erosion, sea level rise, land use change	NPS, TNC, local counties and land trusts, private land owners	Agreement with ranchers, resource conservation districts		cliffs	

62	Habitat Protection and Restoration	Evaluate and remove or modify barriers to riverine flow and sediment supply (dams, bridges, culverts, and flood-control gates) to allow for greater sediment transport to beaches and estuaries.	Throughout region, including dams on rivers draining to SF Bay, water district dams - Lagunitas Creek, Russian River, Guadalupe, Walker Creek. Focus upstream of sediment-starved estuaries and beaches.	Near to long-term	sediment supply and movement, precipitation, overwater/underwater structures, sea level rise, coastal erosion	Army Corps of Engineers, BLM, Resource Conservation District, Bureau of Reclamation, DWR, Coastal Commission, watershed organizations and water districts, partnerships with dam managers.	Funding, support from upstream/downstream communities, will require impact studies	Restores natural sediment regimes to help with accretion; helps hydrology and water movement; promotes healthy function; improves beach access; possible trade-off in current discharge rates; possible tie-in to salmon access. Potential negative impacts of dam removal: shifts in open water habitat, water supply and storage, hydrological regime (increased water and uncontrolled flooding), contaminant loads, upstream habitat, recreational access, change in timing of availability of water.	beaches/du nes and estuaries
63	Habitat Protection and Restoration	Engineer marshlands to enhance water flow and balance sediment transport. Activities could include sinuous channelization.	Apply to restoration projects: flood-prone estuaries; sediment-heavy estuaries; archaeological sites/past development sites (i.e., where erosion may be an issue)	Long-term	sediment supply, sea level rise, oxygen, temperature	Local counties, ranches, Resource Conservation District, NMFS (salmonids), CDFW (fairy shrimp)	Planning, coordination, and knowledge: channelization has been done at Giacomini - could use similar resources. CCC permit or federal consistency review.	Pollutant mobilization (e.g., mercury - Walker Creek), short-term impacts to existing species/vegetation with habitat modification. May moderate temperature which may help mitigate algal blooms.	estuaries
64	Habitat Protection and Restoration	If a barrier is required to protect human infrastructure, determine the most beneficial material to use and the best design to encourage rocky intertidal species to colonize and/or migrate landward. This is not a recommendation to create new barriers, and should only be implemented where totally necessary, or the barrier is already in place and opportunities exist to refashion the barrier / infrastructure in a way that promotes a simultaneous habitat use with the barrier.	Only in locations where a barrier is necessary.	NMFS, CDFW, State Parks and County Parks, NPS.	armoring, coastal erosion, wave action, sea level rise	CCC and local counties and cities, academic institutions, Army Corps of Engineers	Resources to identify best design to use for armoring, working with CCC to allow for different armoring materials and designs. Working with local universities on engineering.	Potential interactions with nearby beaches with sediment movement based on oceanographic conditions. The littoral zone - doing work on sediment movement in San Mateo/SC counties.	rocky intertidal
65	Habitat Protection and Restoration	Protect cliffs from erosion to protect rocky intertidal habitat from smothering (see cliff protection strategies: 8, 9, 11, 12, 14-16, 20, 22, 25-29, 33, 35, 39, 46, 54, 61,69).							rocky intertidal
66	Human Disturbance	Prepare for increased beach use in the event that climate change results in dryer, sunnier weather, including managing traffic, litter, visitor services, etc.	throughout region	Near-term	recreation, temperature, coastal erosion, sea level rise	State Parks, NPS, State and County Departments of Public Health, volunteer groups (such as Save Our Shores, Pacifica Beach Coalition)	Organize volunteers for beach clean-ups, funding.	Build new infrastructure (e.g. bathrooms) to accommodate more visitors. Increase schedule of litter clean up.	beaches/du nes
67	Human Disturbance	Manage pet beach experience/access (beaches, locations)	Known haul out, nesting and restoration sites, shorebird wintering sites	Near-term	recreation, temperature, coastal erosion	State Parks, NPS, BLM, County Parks, Municipal Parks	Increased signage and enforcement, CCC permit or federal consistency review.		beaches/du nes
68	Human Disturbance	Manage or control density and distribution of beach users if beaches become too impacted by high visitation, while respecting the public's right to access the coast.	Highly visited beaches.	Near-term	recreation, temperature, coastal erosion, sea level rise	State Parks, NPS, BLM, County Parks, Municipal Parks, CCC (permit conditions or LCPs)	Funding, staffing, consider reservation system (see Point Lobos example), signage, outreach, enforcement, CCC permit or federal consistency review.	Refer to the successful case study of Point Lobos, which restricts certain uses in certain areas and balances restrictions with public access. Seasonal closures may be more effective and efficient.	beaches/du nes
69	Landward Migration	Provide incentives for people to voluntarily relocate in areas that were, or could be, sensitive habitat, or where development reduces habitat resilience: - Incentivize managed retreat if space is available - Initiate and practice land trading (e.g., trade less valuable park land for private land that is vulnerable to flooding and that currently blocks habitat migration) - Purchase land, when possible, to facilitate habitat migration	Areas where habitats are impaired and can't migrate, infrastructure is projected to be inundated anyway, and/or areas where barrier removal would improve habitat function or resilience.	Near-term: land acquisition Long-term: land trading, but start laying policy foundation now	sea level rise, coastal erosion, precipitation	Agencies that own or abut land, land owners, NPS, Army Corps of Engineers, local cities, counties and land trusts, Resource Conservation Districts	Funding via joint venture with many groups, maybe insurance companies. Will need tradeable land. Policy changes may be required (e.g., congressional change to allow trading of NPS lands). Education and outreach will be critical to gain public support; utilize regional modeling to show current land owners why moving is the smartest financial decision. If needed, explore and investigate opportunities for how this has been accomplished elsewhere and confer with groups with expertise in this realm. Golden Gate and Point Reyes (NPS) have already acquired estuary-adjacent parcels that have come up for sale (NPS has a lands acquisition program).	Removes structures that are going to be destroyed by flooding and/or structures that could fall into the Sanctuary. Provides habitat/room for estuaries to expand. Land trading may affect other terrestrial habitats (i.e., may allow for construction in new areas). Can combine with removing non-functional infrastructure (e.g., eliminate old berms and flood levees). Will likely face public opposition, but there are long-term benefits to human community: structures will eventually be destroyed by flooding, cheaper to move the infrastructure now.	all
70	Landward Migration	Create a Transfer of Development Rights program in areas needing protection to reflect changing coastal conditions. In hazard areas or sensitive habitat areas that will be threatened by SLR over time, transfer development rights from vacant lots not suitable for development to other locations in the jurisdiction		Mid-term	coastal erosion, sea level rise, wave action	CCC, local cities and counties		LCP policies and permit conditions are potential ways to implement this management action	beaches/du nes
71	Landward Migration	Work with County general plans and coastal zone LCPs to consider development in anticipation of sea level rise.		Mid to long-term	coastal erosion, sea level rise, wave action, roads/armoring	CCC, local cities and counties	Could be accomplished with a state level statute		beaches/du nes
72	Science Needs	Promote estuarine research to enhance eelgrass restoration efforts. Major research questions may include: - Eelgrass distribution: why is there no eelgrass in Bolinas and Pescadero? - Do salinity and turbidity affect eelgrass establishment and persistence?	Study region	Near-term	salinity, turbidity, pH, temperature	Sanctuary, academic institutions, oyster companies	Knowledge: look at case studies from San Diego area, east coast and Gulf coast. San Francisco Bay research, Drakes Estero research to document recovery by CDFW.	Helps inform eelgrass restoration efforts, which enhances estuary habitat, and may enhance regional carbon sequestration efforts. Economic benefits (oyster farming)	estuaries
73	Science Needs	Pursue and encourage research in OA-mitigation methods including the restoration and expansion of photosynthesizers (kelp, surfgrass) to locally mitigate the impacts of OA and sequester carbon. Sanctuary should seek partnerships with technical experts who wish to establish experimental treatment plots to test these mitigation techniques.	Establish experimental treatment plots that test the effectiveness of management measures based on scientific expertise	Near-term	pH	Sanctuary (support from CDFW, State Parks, NPS, BLM, local counties)	Sea Grant funding to research institutions, CCC approval and permits for test plots.	Strategy would likely stabilize species populations, and facilitate habitat creation for new assemblages of intertidal communities whose species are shifting their range as the result of climate change impacts.	rocky intertidal
74	Science Needs	Better understand climate impacts on larval dispersal to ensure that larval source locations are effectively protected within the MPA system and are able to reach various intertidal areas (inside and outside MPAs). Investigate larval dispersal of key species and how this relates to distances among MPAs. Also consider important areas that are not currently designated MPAs.	All MPAs in the study region and additional important rocky intertidal areas.	Near-term	currents/mixing	CDFW in partnership with researchers and OST.		Strategy would address decreased larval density due to increased turbulence of the water column (reduced survival) and increased offshore advection of larvae due to increased wind.	rocky intertidal
75	Species Protection	Augment haul-out and nesting sites: floating haul outs, larger buoys, artificial offshore floating structures	Study region	Near to mid-term	coastal erosion, sea level rise	USFWS, NMFS, USCG, Sanctuary, NPS, State Parks, County Parks, CDFW, Boating and Waterways, Marine Mammal Center	California Coastal Commission permitting	Possible benefit - wave energy generation	beaches/du nes
76	Species Protection	Support animal rescue and rehabilitation services.	Study region	Near-term	temperature, precipitation	Marine Mammal Center, NOAA MMPA, USFWS, USGS Western Ecological Research Center, MBARI, Point Blue, NPS.			beaches/du nes
77	Species Protection	Incorporate climate change into fisheries management to address the impact of ocean acidification and climate stressors. Exact strategy would depend on how specific species are being impacted. Monitoring to track impacts and effectiveness of regulations will be needed.	Extend protection from harvest in the rocky intertidal to the mean high-tide line next to marine protected areas (state and fed) where feasible. Maintain seamless consistency in degree of protection/mgmt.	Near-term - actions already in place	pH, harvest	NMFS, CDFW, State Parks and County Parks, NPS.	Increased monitoring of harvested OA-sensitive species (mussels, abalone) with triggers or thresholds. Increased funds for CDFW wardens and Parks Rangers to patrol and check permits. Requires public education and cooperation - outreach and stewardship. Monitoring teams to detect effectiveness of regulations (tie-in with Ocean Science and Marine Reserve System monitoring)	Would provide greater benefit to rocky intertidal community by increasing/maintaining biomass of species and surface roughness (maintaining functional habitat).	rocky intertidal
78	Water Quality Management	Manage for flash flood and high flow events that might adversely affect existing and new vegetation by increasing absorption and decreasing runoff. Strategies may include: improve culverts, pumps, tide gates, bridges, stream management, increased use of permeable pavement and increased absorption opportunity, all communities require rain barrels.	Locations prone to flooding: Stinson Beach, Muir Beach, Lagunitas Creek, Hwy 1 in many locations	Near to mid-term	precipitation, coastal erosion	Caltrans, local cities and counties, Flood control districts, FEMA, California Office of Emergency Services, CCC (in permit conditions or LCPs), NPS	flood maps, money, community will	Sediment deposition, salmon habitat impacts from flood control actions.	beaches/du nes