COASTAL REGIONAL SEDIMENT MANAGEMENT PLAN
FOR THE SANTA CRUZ LITTORAL CELL,
PILLAR POINT TO MOSS LANDING

(Source: Adelman and Adelman, 2013)

Prepared for:
The California Coastal Sediment Management Workgroup

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UNIT CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
cubic yards	0.7645549	cubic meters
degrees (angle)	0.01745329	radians
feet	0.3048	meters
inches	2.54	centimeters
knots	0.5144444	meters per second
miles (nautical)	1,852	meters
miles (U.S. statute)	1,609.347	meters
miles per hour	0.44704	meters per second
pounds (force)	4.448222	newtons
pounds (force) per foot	14.59390	newtons per meter
pounds (force) per square foot	47.88026	pascals
square feet	0.09290304	square meters
square miles	2.589998 E+06	square meters
tons (force)	8,896.443	newtons
tons (force) per square foot	95.76052	kilopascals
yards	0.9144	meters

LIST of ACRONYMS

Acronym	Full Phrase
AMBAG	Association of Monterey Bay Area Governments
ANSR	Año Nuevo Sand Reserve
APCD	Air Pollution Control District
AQMD	Air Quality Management District
BCDC	San Francisco Bay Conservation and Development Commission
BEACON	Beach Erosion Authority for Clean Oceans and Nourishment
BEC	Beach Erosion Control
BECA	Beach Erosion Concern Area
BRRG	CSMW Beach Restoration Regulatory Guide
Caltrans	California Department of Transportation
CAA	Clean Air Act
CAR	Coordination Act Report
CARB	California Air Resources Board
CCA	California Coastal Act
CCC	California Coastal Commission
CCD	Coastal Consistency Determination
CDFW	California Department of Fish and Wildlife
CDP	Coastal Development Permit
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CGS	California Geological Survey
CH	Critical Habitat
CLEAP	Comparative Lagoon Ecological Assessment Project
CMS	US Army Corps of Engineers Coastal Modeling System
CNRA	California Natural Resources Agency
COP	California Ocean Plan
CRSMP	Coastal Regional Sediment Management Plan
CSBAT	Coastal Sediment Benefits Analysis Tool
CSLC	California State Lands Commission
CSMW	California Coastal Sediment Management Workgroup
CWA	Clean Water Act
CZMA	United States Coastal Zone Management Act
DBW	California Division of Boating and Waterways (under California Department of Parks and Recreation)

DPR	California Department of Parks and Recreation
DMMP	Dredged Material Management Plan
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ENSO	El Niño Southern Oscillation
ESA	Endangered Species Act
ESNERR	Elkhorn Slough National Estuarine Research Reserve
FONSI	Finding of No Significant Impact
FE	Federal Endangered Species
FP	State of California Fully-Protected Species
FT	Federal Threatened Species
GHAD	Geologic Hazard Abatement District
GIS	Geographic Information System
HCP	Habitat Conservation Plan
IWR	USACE Institute for Water Resources
JPA	Joint Powers Authority
LCP	Local Coastal Program
LiDAR	Light Detection and Ranging
MBARI	Monterey Bay Aquarium Research Institute
MBNMS	Monterey Bay National Marine Sanctuary
MBTA	Migratory Bird Treaty Act
MHHW	Mean Higher-High Water
MHW	Mean High Water
MLW	Mean Low Water
MLLW	Mean Lower-Low Water
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MND	Mitigated Negative Declaration
MOU	Memorandum of Understanding
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MTL	Mean Tide Level
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
ND	Negative Declaration

NED	National Economic Development
NEPA	National Environmental Policy Act
NGO	Non-Governmental Organization
NHPA	National Historic Preservation Act
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf Lands Act
PBR	Public Beach Restoration
PDO	Pacific Decadal Oscillation
PWA	Phillip Williams Associates (now under Environmental Science Associates)
PCWQCA	Porter-Cologne Water Quality Control Act
RHA	Rivers and Harbors Act
RLF	Resource Legacy Fund
RSM	Regional Sediment Management
RWQCB	Regional Water Quality Control Board
SAA	Streambed Alteration Agreement
SAG	Stakeholder Advisory Group
SANDAG	San Diego Association of Governments
SB	State Beach
SCOUP	Sand Compatibility and Opportunistic Use Program
SCC	California State Coastal Conservancy
SCRTC	Santa Cruz Regional Transportation Commission
SE	State of California Endangered Species
SHPO	State Historic Preservation Officer
SICH	Sediment Impaired Coastal Habitat
SiMON	Sanctuary Integrated Monitoring Network
SIP	Strategic Implementation Plan
SLR	Sea-level rise
SMB	Southern Monterey Bay
SMBCEW	Southern Monterey Bay Coastal Erosion Workgroup
SMRCD	San Mateo County Resource Conservation District
SP	State Park
SPWG	SABDAG's Shoreline Preservation Working Group
SSC	State of California Species of Special Concern
ST	State of California Threatened Species
SWRCB	State Water Resources Control Board
SWPPP	Storm Water Pollution Prevention Plan

TMDL	Total Maximum Daily Load
TOT	Transient Occupancy Tax
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
US	United States Fish and Wildlife Service
USGS	United States Geological Survey
WDR	Waste Discharge Requirement
WQCP	Water Quality Control Plan

EXECUTIVE SUMMARY

ES 1. Introduction

This Santa Cruz Littoral Cell Coastal Regional Sediment Management Plan (Plan) delineates a number of sediment-management objectives for the central California coastline from Pillar Point in San Mateo County to Moss Landing in Monterey County (Figure ES-1). These objectives support the mission of the California Coastal Sediment Management Workgroup (CSMW), which is a collaborative effort of federal, state, and non-governmental organizations committed to evaluating California's coastal sediment management needs on a regional scale. This regional approach to sediment management will be referred to as regional sediment management (RSM) throughout this Plan. Objectives of this Plan include: (1) restoring, preserving, and maintaining coastal beaches and other critical areas of sediment deficit; (2) sustaining recreation and tourism; (3) enhancing public safety and access; (4) restoring coastal sandy habitats; and (5) identifying cost-effective solutions for the restoration of areas affected by excess sediment.

ES 2. Description of Plan Area

The Santa Cruz Littoral Cell – a self-contained system of sand sources and sand sinks that extends from Pillar Point to Moss Landing – demarcates the geographic scope of this Plan (Figure ES-1). Point San Pedro, a prominent headland north of Pillar Point, serves to effectively prevent sand from being transported from the north, and the Monterey Submarine Canyon traps essentially all of the sand that would be transported to Southern Monterey Bay by longshore currents. The regional wave climate induces a net direction of sand transport from north to south, with estimated net transport rates as high as 300,000 cubic yards (cy) per year.

Figure ES-1. Location of the Santa Cruz Littoral Cell. All background topography and imagery in subsequent figures from ESRI, unless otherwise noted

The Santa Cruz Littoral Cell is a diverse region, with different coastal stretches (or reaches) characterized by distinct geomorphic and anthropogenic features. Acknowledging that diversity, the Plan area has been divided into seven reaches, which range from the rural and largely undeveloped rugged shoreline of southern San Mateo County to the heavily urbanized beaches and sea cliffs of northern Monterey Bay:

Reach 1: Pillar Point to Surfer's Beach

Reach 2: Surfer's Beach to Miramontes Point

Reach 3: Miramontes Point to Pescadero Creek

Reach 4: Pescadero Creek to Point Año Nuevo

Reach 5: Point Año Nuevo to Natural Bridges

Reach 6: Natural Bridges to New Brighton State Beach

Reach 7: New Brighton State Beach to Moss Landing

Each reach has distinct sediment management problems and opportunities that must be addressed in the context of a region-wide understanding of sand supply, transport, and erosion. In this context, the current scientific understanding is that the heavily used beaches that ring the northern Monterey Bay have been supplemented by the erosion of large sand dunes at Point Año Nuevo. The Año Nuevo Sand Reserve (ANSR) has recently been depleted, however, and it has been postulated this annual loss of approximately 50,000 cy of sand will result in the erosion of northern Monterey Bay beaches. In addition, it is anticipated that future sea-level rise will exacerbate beach erosion, particularly in areas where the position of the backshore has been fixed by armoring.

The construction of coastal infrastructure and modifications to contributing watersheds has also affected sediment supply and transport. There are several major coastal structures in the Santa Cruz Littoral Cell, and these structures are deemed to contribute to erosion of downdrift beaches because they reduce sediment supply. In several reaches, excess sediment has accumulated in coastal lagoons as a result of construction of coastal infrastructure and other modifications to the nearshore and beach environment. This excess sediment can impair important ecosystem functions, particularly with respect to sensitive fish species, and can induce flooding of adjacent land and infrastructure.

ES 3. Beach Erosion Concern Areas and Sediment-Impaired Coastal Habitats

An assessment of physical conditions and vulnerable coastal infrastructure was combined with input from a Stakeholder Advisory Group (SAG) and the public to formulate a list of Beach Erosion Concern Areas (BECAs) and Sediment-Impaired Coastal Habitats (SICHs). The BECAs are primarily concentrated along the heavily developed northern Monterey Bay shoreline, where well-documented beach and sea-cliff erosion threatens both public infrastructure and private development at a number of locations (Figure ES-2). These BECAs include sections of West Cliff Drive, East Cliff Drive, the Capitola Beach and Esplanade, the sea cliffs of Depot Hill, and the heavily developed beach running through Aptos and Rio Del Mar. There are also notable BECAs at the north end of the cell, where construction of the breakwaters to create Pillar Point Harbor have altered the nearshore wave environment and local sediment supply and transport.

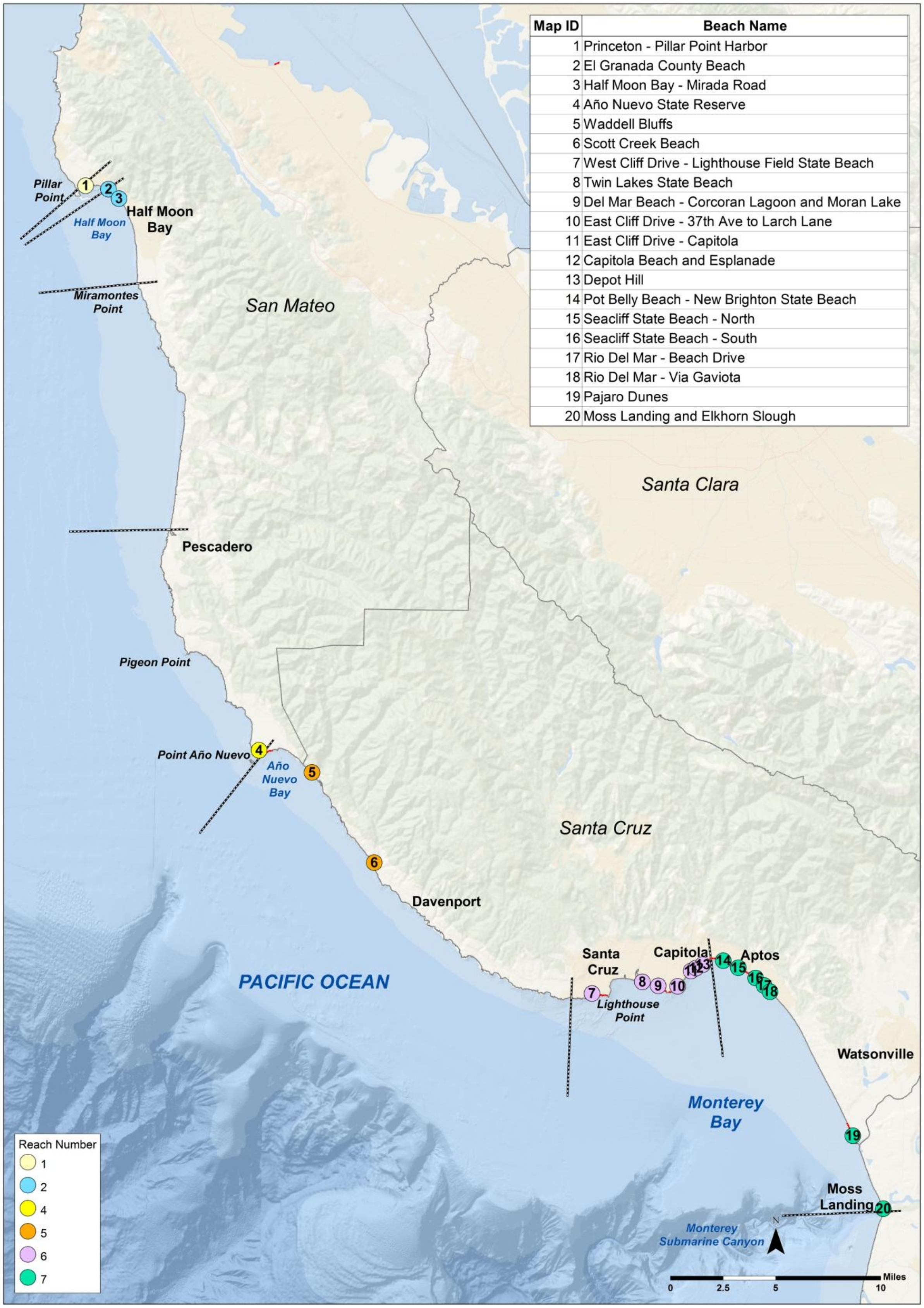


Figure ES-2. Beach Erosion Concern Areas (BECAs) in the Santa Cruz Littoral Cell

The SICHs include a number of coastal lagoons where infrastructure has restricted the natural sediment exchange between the open coast and the lagoons (Figure ES-3). Some of this infrastructure is aging and in need of rehabilitation or replacement. There are at least two locations (Highway 1 bridges over Scott and Waddell Creeks) where future infrastructure replacement could be designed to facilitate a more natural sediment regime in the presently degraded coastal lagoons. Excessive sand accumulation at the mouth of the San Lorenzo River following the construction of Santa Cruz Harbor also poses a threat to infrastructure and public safety in addition to impairing ecological functions in the lagoon.

Figure ES-3. SICHs in the Santa Cruz Littoral Cell

ES 4. Regional Sediment Management Measures

A number of RSM measures could be implemented at the BECAs and SICHs. These measures span a wide range of actions beyond beach nourishment that can restore a more balanced coastal sediment budget. Such actions can include both soft and hard engineering measures along with the relocation of development and infrastructure from erosion hazard zones (managed retreat) to facilitate natural beach and sea-cliff erosion processes (Table ES-1). Each measure has distinct advantages and disadvantages, however, and some measures may be more suitable than others at given BECAs and SICHs. The suitability of measures at individual BECAs is further discussed in Section ES 8.

Table ES-1: Descriptions of RSM measures (strategies) considered in the Plan

Measure	Description
No Action	This approach assumes that the "status quo" will continue over the next 50 years, often with local interests maintaining existing erosion control measures.
Managed Retreat	This measure involves relocating development and infrastructure away from coastal erosion hazard zones.
Restoration of Beach and Marsh Environments and Modification of Infrastructure	This measure involves actions intended to restore natural processes to a given coastal environment, and is applicable to both BECAs and SICHs.
Beach Nourishment	This measure involves the direct placement of sand on the sub-aerial beach or in the shallow waters (less than 10 feet deep) of the surf zone.
Nearshore Berm	This measure differs from direct beach nourishment in that sediment is placed in nearshore waters, outside the surf zone and often up to depths of up to 30 or 40 feet.
Perched Beach	This measure involves utilizing a submerged sill to limit offshore sand transport, and thereby create a perched beach at a higher elevation than surrounding beaches.
Multipurpose Artificial Reef	This measure involves the construction of a submerged offshore reef that is designed to reduce beach erosion and provide recreational benefits. These structures induce accretion of sediment by altering the direction of wave approach, thereby reducing the rate of littoral drift and associated erosion.
Groins and Jetties	This measure involves construction one or more shore perpendicular structures designed to retain beach sand. These structures may be particularly useful in environments with high littoral drift rates and no existing barriers to this drift.
Cliff Stabilization by Seawall	This measure involves measures designed to stabilize sea cliffs that are subject to wave attack. Typical measures include construction of seawalls and stabilization with soil nail walls.

The Plan also identifies potential sources for beach quality sand and finer sediments that could be utilized in wetland restoration projects. This assessment involved the compilation of key information about each sediment source into a Geographic Information System (GIS) database based on guidance in the Sand Compatibility and Opportunistic Use Program (SCOUP). Sediment sources were divided into broad categories and mapped for each reach. Major sediment sources include harbors, offshore sand, beach sand, and fluvial sources (Table ES-2). This assessment only represents a preliminary effort, and significant coordination and planning (including permitting, etc) will be required to obtain sediment from most of the potential sources.

Table ES-2: Examples of potential sediment sources in the Santa Cruz Littoral Cell

Sediment Source Type	Potential Site
Harbors	Pillar Point Harbor, Santa Cruz Harbor, Moss Landing Harbor
Offshore Sand	Waddell Creek Delta, located approximately 8,000 feet southwest of the mouth of Waddell Creek
Beach Sand	Seabright Beach
Sediment Impaired Coastal Habitats	Pescadero Marsh, Scott Creek Lagoon
Flood Risk Management Projects and Dams	Butano Creek Channel, San Lorenzo River, Pajaro River Bench Excavation
Major Construction Projects	N/A
Stockpile Sites	Buena Vista Drive Landfill, Elkhorn Slough Wetland Restoration Project

ES 5. Biological Resources

The Monterey Bay National Marine Sanctuary (MBNMS) abuts the Santa Cruz Littoral Cell shoreline. The littoral cell encompasses several managed areas and protected habitats, including state marine conservation areas, marine reserves, state parks and beaches, and ecologically significant habitats (Tables ES-3 and ES-4). It is also host to a variety of species, including more than twenty cetaceans (whales, dolphins and porpoises), six species of pinnipeds (seals and sea lions), otters, several species of fish, and resident birds. Being located on the Pacific flyway, it serves as a temporary home to several migratory birds.

Table ES-3: Habitats in the Santa Cruz Littoral Cell

Habitat Type	Description
Sandy Beaches, Coastal Dunes, and Strands	Sandy beaches provide primary habitat for invertebrates; forage, resting, and nesting habitat for birds, including threatened western snowy plover; and spawning habitat for California grunion. There is evidence that snowy plovers nest on sandy beaches within the littoral cell.

Habitat Type	Description
Coastal Rivers, Creeks, Sloughs, and Lagoons	There are several rivers and creek mouths in the littoral cell, many of which serve as critical habitat for salmonids and tidewater goby. The mouths of rivers and creeks form estuary and adjacent wetland habitat where salmonids rear and gobies inhabit during all life stages.
Coastal Wetlands	Coastal wetlands include saltwater marshes, freshwater marshes, brackish marshes, swamps, mudflats, and fens.
Estuaries	Estuaries provide critical habitat for some life stages of several plants, fish, shellfish, and other organisms. Bays, sloughs, and associated wetlands provide a variety of habitats ranging from open water, mudflats, eelgrass beds, marshes, salt flats, and pannes and may support thousands of species of plants, invertebrates, fish, amphibians, reptiles, birds, and mammals.
Inlet Embayments	These areas have a relatively deep-water connection to the ocean and provide more protected habitats than the open ocean because of headlands, structural breakwaters, and distance from the open ocean. These protected embayments support hundreds of species, including a variety of invertebrates, fish, aquatic vegetation, fish-eating birds and waterfowl, and transient occurrence of marine mammals.
Littoral	Littoral habitat is found in the nearshore waters of the continental shelf, from the high water mark (typically mean high water) to a depth of approximately 660 feet.
Sublittoral	Sublittoral zones include the nearshore waters from the intertidal zone to a depth of approximately 660 feet.
Sandy Intertidal Zone	Sandy intertidal zones are characterized by soft bottom sands, shells, and occasionally cobble in the area between the highest and lowest tides. This zone provides important habitat for various organisms living under the surface of the sand, including clams, crabs, and other invertebrates, as well as feeding ground for invertebrates and shore birds.
Rocky Intertidal Zone	This habitat is found on rocky substrate between the lowest and highest tidal water levels. Rocky substrate habitats are capable of supporting hundreds of species of plants, invertebrates, and fish.
Rocky Subtidal	Rocky subtidal habitat is a highly productive zone inhabited by many species. Much rocky subtidal habitat in the littoral cell is characterized by dense kelp forests, comprised of giant kelp and bull kelp.
Kelp Forest, Eelgrass, and Surfgrass	Surfgrass beds are highly productive areas supporting invertebrates and many species of algae. Kelp beds grow in waters just beyond the breaker zone to depths of about 100 feet. They support hundreds of species of invertebrates and fish, many of which are prey for marine mammals. Eelgrass meadows occur on soft substrates in protected coastal areas, mainly embayments, but also may occur in the nearshore where suitable conditions exist.
Submarine Canyon and Deepwater Habitats	The canyon floor and the waters over the canyon provide unique habitat which extends from the shallow waters of the continental shelf to deep sea areas. Upwelling from the canyon supports most of the primary productivity for the entire Monterey Bay.

Table ES-4: State parks, State marine conservation areas, and State reserves

REACH	STATE MARINE CONSERVATION AREAS AND RESERVES	BECA OR SICH	NOTES
1 – 7	Monterey Bay National Marine Sanctuary (MBNMS)		Entire littoral cell is within the MBNMS. All sediment management activities conducted in the sanctuary will require approval from the MBNMS.
1	Pillar Point State Marine Conservation Area		Take of all living marine resources is prohibited; except for recreational take of pelagic fish, Dungeness crab, and squid.
1	James V. Fitzgerald Marine Reserve		Includes 5.5 miles of coastline along the park. Considered an area of special biological significance, which is a state water quality protection area.
4 and 5	Año Nuevo Point and Island and Año Nuevo State Marine Conservation Area	BECA 4: Año Nuevo State Reserve	Area includes waters from the mean high tide line to 200 feet shoreward. All species are protected in this area. Only hand harvesting of giant kelp is allowed. Several pinnipeds use the island and beaches as haul outs and/or rookeries.
4 and 5	Greyhound Rock State Marine Conservation Area		Area includes waters from the mean high tide line to three nautical miles off shore. Recreational and commercial fishing of giant kelp (by hand), salmon, and market squid. Recreational hook and line fishing of other fin fish is also allowed. All other species are protected.
5	Natural Bridges State Marine Reserve		Includes waters from the mean high tide line to a distance of 200 feet seaward. No fishing or other collection of organisms is allowed.
7	Elkhorn Slough State Marine Conservation Area National Estuarine Research Center	BECA 20: Moss Landing / Elkhorn Slough	Elkhorn Slough has ongoing and proposed restoration projects. Only recreational hook and line fishing of fin fish and clamming is allowed. Take of all other species is prohibited.
7	Elkhorn Slough State Marine Reserve	BECA 20: Moss Landing / Elkhorn Slough	Take of any species is prohibited.
7	Soquel Canyon State Marine Conservation Area		Includes 14,200 acres located 8 miles west of Moss Landing and 7 miles south of Santa Cruz. Only recreational and commercial fishing of pelagic finfish is allowed.

The littoral cell is also habitat for several special status species, including species protected under state and federal ESAs, protected marine mammals, migratory birds, and other state protections, such as fully protected species or species protected under various

California Fish and Game (CFG) codes. Table ES-5 identifies the designated critical habitats associated with each BECA or SICH.

Table ES-5: Designated Critical Habitats Associated with Each BECA or SICH

REACH	BECA OR SICH	NAME	CRITICAL HABITATS[1]
1	BECA 1	Princeton - Pillar Point Harbor	- Nearby Denniston Creek is Central California Coast (CCC) steelhead Evolutionary Significant Unit (ESU) Critical Habitat (CH) - Black Abalone[2] CH is located in a portion of Pillar Point Harbor
2	BECA 2	El Granada County Beach	- Black Abalone[2] CH
	BECA 3	Half Moon Bay – Mirada Road	- Black Abalone[2] CH
3			
4	SICH 1	Pescadero Marsh	-Tidewater goby CH; red-legged frog CH - Pescadero and Butano Creeks are CCC steelhead ESU CH and CCC coho salmon ESU CH - Black Abalone[2] CH at the coastal end of the marsh.
	BECA 4	Año Nuevo State Reserve	- Black Abalone[2] CH; Steller Sea Lion CH; California red-legged frog CH
5	BECA 5	Waddell Bluffs	- Black Abalone[2] CH; Marbled murrelet CH; California red-legged frog CH
	SICH 2	Waddell Creek	- Tidewater goby CH; CCC steelhead ESU CH; CCC coho salmon ESU CH; Marbled murrelet CH; California red-legged frog CH - Waddell Creek beach is western snowy plover CH - Black Abalone[2] CH along the nearby coastline
	BECA 6	Scott Creek Beach	- Black Abalone[2] CH; Western snowy plover CH; California red-legged frog CH - Directly adjacent to Scott Creek which contains additional CH (see SICH 3)
	SICH 3	Scott Creek	- Tidewater goby CH; CCC steelhead ESU CH; CCC coho salmon ESU CH; California red-legged frog CH - Runs though Scott Creek beach which contains additional CH (see BECA 6)
6	BECA 7	West Cliff Drive	- Black Abalone[2] CH
	SICH 4	San Lorenzo River	- CCC steelhead ESU CH; CCC coho salmon ESU CH - Black Abalone[2] CH at the coastal end of the river
	BECA 8	Twin Lakes State Beach	- Black Abalone[2] CH - Santa Cruz tarplant CH is located to the immediate north of Schwan Lagoon at Twin Lakes State Beach
	SICH 5	Schwan Lagoon	- Santa Cruz tarplant CH to the immediate north

Reach	BECA or SICH	Name	Critical Habitats[1]
	SICH 6	Corcoran Lagoon	- Tidewater goby CH - Black Abalone[2] CH along the adjacent coastline
	BECA 9	Del Mar Beach –Corcoran Lagoon and Moran Lake	- Tidewater goby CH; Black Abalone[2] CH
	SICH 7	Moran Lake	- Adjacent to the southern end of designated Black Abalone[2] CH
	BECA 10	East Cliff Drive – 37th Ave to Larch Lane	--
	BECA 11	East Cliff Drive – Capitola	--
	BECA 12	Capitola Beach and Esplanade	- Adjacent Soquel creek is CCC steelhead ESU CH
	BECA 13	Depot Hill	--
7	BECA 14	Pot Belly Beach – New Brighton State Beach	--
	BECA 15	Seacliff State Beach - North	--
	SICH 8	Aptos Creek	- Tidewater goby critical habitat; CCC steelhead ESU CH
	BECA 16	Seacliff State Beach - South	--
	BECA 17	Rio Del Mar – Beach Drive	--
	BECA 18	Rio Del Mar – Via Gaviota	--
	BECA 19	Pajaro Dunes	- Western Snowy Plover CH - The Pajaro River directly adjacent down coast (0.5 miles) is Tidewater Goby and South-Central California Coastal Steelhead ESU CH
	BECA 20	Moss Landing and Elkhorn Slough	- Elkhorn Slough is South-Central California Coastal Steelhead ESU CH - Adjacent to Tidewater Goby, Western Snowy Plover and Monterey Spineflower CH at Moss Landing State Beach

Notes:

[1] Marine habitat in the entire littoral cell falls within Leatherback turtle critical habitat, which stretches along the California Coast from Point Arena to Pont Arguello. The marine areas of the entire littoral cell are also within green sturgeon critical habitat, which extends from Monterey Bay, California North and East.

[2] Black Abalone critical habitat is present in reaches 1-5 and the northern portion of reach 6 in the littoral cell. This includes rocky intertidal and subtidal habitat, and all waters from mean higher high water to a depth of 20 feet.

Coastal sediment management options, such as beach nourishment and construction of sediment retention structures, have the potential to affect these habitats and species in a variety of ways. In addition, removal of sand from aquatic and upland sources also has the potential to adversely affect biological resources in the littoral cell. Biological and natural resources are protected by various federal, state, and environmental laws and regulations.

ES 6. Regulatory and Policy Considerations

Implementing any of the RSM measures outlined in this Plan requires following a regulatory compliance process. Although the precise requirements and process depend on the specifics of each project, regulatory compliance can generally be broken down into two major components or processes: 1) Environmental Review and 2) Permitting.

Environmental review consists primarily of compliance with the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA), but also with several other state and federal laws. Environmental review is typically completed or nearly completed prior to embarking on the permitting process, because the information developed during this phase will be used by permitting agencies in reviewing the project and making permit decisions (Table ES-6).

Table ES-6: Relevant regulations affecting beach restoration projects

POLICY/REGULATION	REQUIREMENT	PERMITTING/APPROVAL AGENCY
	FEDERAL	
NEPA	Compliance	Lead NEPA Agency
Coastal Zone Management Act (CZMA)	Coastal Consistency Determination (CCD)	California Coastal Commission (CCC)
Rivers and Harbors Act (RHA)	Section 10 Permit	U.S. Army Corps of Engineers (USACE)
Clean Air Act (CAA)	Title V Operating Permit	California Air Resources Board (CARB) (below under State)
Clean Water Act (CWA)	Section 401 Certification or Waiver (401 Permit)	Regional Water Quality Control Boards (RWQCBs)+
CWA	Section 402 NPDES Permit (NPDES Permit)	RWQCBs+
CWA	Section 404 Permit (404 Permit)	USACE
Endangered Species Act (ESA)*	Section 7 Consultation	U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS)
National Historic Preservation Act (NHPA)*	Section 106 Approval	State Historic Preservation Officer (SHPO)

Fish and Wildlife Coordination Act (FWCA)*	Coordination Act Report (CAR)	USACE
Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)*	Assessment of Impacts to Essential Fish Habitat (EFH)	NMFS
Outer Continental Shelf Lands Act (OCS)	Lease Agreement for Utilization of Outer Continental Shelf Sand	Minerals Management Service (MMS)
	STATE	
CEQA	Compliance	Lead CEQA Agency
California Coastal Act (CCA)	Coastal Development Permit (CDP)	CCC
Porter-Cologne Water Quality Control Act (PCWQCA)	Compliance Permits under CWA Sections 401, 402, and 404	State Water Resources Control Board Regional Water Quality Control Boards
California State Lands Public Resources Code	Lease Agreement for Utilization of Sovereign Lands	California State Lands Commission (CSLC)
California Public Resources Code Section 1600	Streambed Alteration Agreement (SAA)	California Department of Fish and Wildlife (CDFW)
California Endangered Species Act (CESA)	Section 2081(b) Incidental Take Permit (State) Section 2081.1 Consistency Determination (State and Federal)	CDFW
Water Quality Control Plans (WQCPs) California Ocean Plan (COP)	Consistency Compliance	Regional Water Quality Control Boards (RWQCBs)+
Clean Air Act (CAA)	Title V Operating Permit	Air Pollution Control Districts (APCDs) and Air Quality Management Districts (AQMDs)

* Review and compliance is usually triggered through the initial CWA Section 404 permitting process by USACE.

+ The State Regional Water Resources Control Board (SWRCB) has lead responsibility when a project involves jurisdiction by more than one RWQCB.

Federal agencies involved in conducting, reviewing, approving, or permitting potential RSM projects identified in this plan include USACE, the USEPA, the National Oceanic and Atmospheric Administration’s (NOAA) Monterey Bay and Gulf of the Farallones National Marine Sanctuaries (MBNMS and GFNMS), the U.S. Geological Survey (USGS), and the Minerals Management Service (MMS). The USEPA and USACE are the two main agencies involved in regulating discharges of fill and dredged material; however, numerous other federal agencies are also involved in the review of proposed beach-nourishment projects and must provide approval before permits can be issued. For example, any RSM project proposed within the boundaries of the MBNMS, which abuts the entire Santa Cruz Littoral Cell shoreline, will require sanctuary review and approval.

State agencies involved in conducting, reviewing, or approving potential RSM projects include the California Coastal Commission (CCC), California State Lands Commission (CSLC), State Coastal Conservancy (SCC), California Geological Survey (CGS), and Department of Parks and Recreation (DPR), including its Division of Boating and Waterways (DBW). The agencies with primary regulatory responsibility over shoreline protective structures are the CCC and the CSLC. The SCC and DBW are both involved with funding shoreline maintenance projects and data generation; the DPR is involved as a land manager; and the CGS is the state agency responsible for identifying geologic hazards.

ES 7. Economic Considerations

The beaches of the Santa Cruz Littoral Cell are a valuable source of recreation for locals and tourists alike, and they are a central part of the local economies. The coastal communities in the Plan area are home to approximately 108,000 people and 40,000 households. The vast majority of the population, property, and infrastructure at risk from coastal storm damage and erosion are located in and around the cities of Half Moon Bay and Santa Cruz.

In some locations, coastal erosion threatens the quality, accessibility, and existence of beaches. This affects not only the recreational value of the coast, but also puts infrastructure, homes, and businesses at greater risk of damage from storms. There is a history of storms causing damage to homes, businesses, parks, and public infrastructure located along the coast in this region. Although the specific timing, frequency, and magnitude of future damaging storms are unknown, their occurrence is a virtual certainty. Expected future sea-level rise will only increase the risk to the beaches and the assets behind them.

Beach nourishment is one of the ways to reduce the risk posed by coastal storms and more gradual long-term erosive forces. This economic impact evaluation uses existing data and describes some of the economic value at risk from coastal erosion in the Plan area. This evaluation could provide a basis for future, more-detailed feasibility and cost-benefit analyses of potential beach nourishment projects. A benefit-cost analysis would compare the anticipated reduction in future adverse impacts from erosion due to the project with the total cost of the project over its lifetime. The estimate of project benefits would consider impacts to recreation value as well as to properties and infrastructure. A project would be considered economically-justified if the total economic benefits exceeded the total economic cost of the project.

Regional Benefit Assessment – Beach Attendance

The most intensively used beaches in the Plan area are located along the largely urbanized shoreline of northern Monterey Bay, with the relatively small Capitola City Beach having the highest intensity of use. As an estimate, more than six million people visit those beaches each year. Many of those visitors travel from other cities and counties and bring in important tourism dollars to the local economies (Tables ES-7 and ES-8).

Table ES-7: Beach attendance and intensity of use

Reach	Beach or Area Name	Usable Beach Area (acres)	Estimated Annual Attendance (1,000s)	Intensity of Use Factor**
1	Princeton-Pillar Point Harbor	n/a	n/a	n/a
2	El Granada (Surfer's)	5.0	40	8
	Half Moon Bay State Beach	45.7	684	15
3	San Gregorio	18.8	373	20
	Pomponio	22.5	201	9
	Pescadero	21.7	178	8
4	Bean Hollow	3.7	128	35
	Año Nuevo	26.2	178	7
5	Waddell Creek	6.2	179	29
	Natural Bridges	3.7	807^	n/a
6	Lighthouse Point & Field	1.2	3,742^	n/a
	Santa Cruz Main	26.2	750	29
	Twin Lakes	32.9	535	16
	Capitola	4.4	386	87
	New Brighton	5.9	348	59
7	Seacliff	32.6	558	17
	Manresa	47.9	241	5
	Sunset	68.9	273	4

Notes:

*Usable beach area an approximation - measured in a GIS using CA State Park Boundary shapefiles and aerial imagery.

**Intensity of Use Factor is the ratio of Annual Attendance and Usable Beach Area.

^Intensity of Use not calculated because no beach-only attendance data available.

Annual attendance estimates for all but three beaches provided by the California Department of Parks and Recreation. Other sources include local surfers (Surfer's), United States Lifesaving Association (Santa Cruz), and the City of Capitola (Capitola).

Visitors to beaches stimulate the local economy by purchasing goods and services (gas, food, sunscreen, surf lessons, hotel stays, etc.) at or near the beach. The impact to the local and regional economy of tourist spending is a function of the number of tourists, the average spending per visitor, and to what extent each tourist dollar gets spent again in the local economy (known as a multiplier). This impact is classified as a market impact because it can be measured in a market transaction (sales). This is the type of impact local governments are typically most interested in because of the impact on employment, income, and tax revenue in the region.

From a local or regional perspective, the actual impact of these direct expenditures exceeds their dollar value as the spending stimulates additional demand for goods and services. Economists classify the impact of spending on aggregate demand as either a direct, indirect or induced effect. For example, store shelves or inventories are restocked, and income received by owners and employees is spent elsewhere in the economy (indirect and induced expenditures). Table ES-8 shows the estimated total annual expenditures associated with five of the most popular beaches in the study area. The estimates rely on previous surveys of beach visitor expenditures conducted by others and the same major assumptions are applied to all of the beaches.

Table ES-8: Estimate of total expenditures for select Santa Cruz County beaches

Beach Name	Annual Attendance (2013)	Direct Expenditures Minus Leakage (1,000s)	Indirect & Induced Expenditures (1,000s)	Total Annual Expenditures (1,000s)
Natural Bridges	807,000	$27,845	$13,923	$41,768
Santa Cruz Main	750,000	$25,879	$12,939	$38,818
Capitola	358,900	$12,384	$6,192	$18,576
New Brighton	347,700	$11,997	$5,999	$17,996
Seacliff	558,000	$19,254	$9,627	$28,881

Notes:

1) Inflation-adjusted spending per group: Overnight (20%) - $275; Day Use (80%) - $100 (SC County Visitor Profile, 2012).

2) Average of 3.13 persons per group (SC County Visitor Profile, 2012).

3) Assumptions: 80% capture rate, sales multiplier of 1.5.

Erosion Impact Assessment

This evaluation used the 2050 Coastal Erosion Hazard Zone developed by Philip Williams and Associates for a 2009 report by the Pacific Institute to define the extent of the land that is vulnerable to coastal erosion. It should be noted that there is a more recent erosion hazard dataset (developed by ESA in 2014) that considers multiple future scenarios and improves upon the resolution of the projections. This more recent dataset, however, is restricted to Santa Cruz County rather than covering the entire Plan area. For this reason the more recent dataset was not used in this analysis. A comparison of the datasets indicates that, although the extents of the predicted erosion zones are similar, using the more recent dataset (which is more detailed but also extends to the year 2060) would have resulted in a modest overall increase in the estimated impact of erosion in this area.

The vast majority of the value at risk is located at a handful of beaches – most of them in the cities and towns of Santa Cruz, Capitola, and Aptos. These popular beaches have significant regional and national recreation values and have a large number of private properties and infrastructure in the erosion zone. At least $862M in private land and structures across more than 1,200 parcels, nearly 10 miles of roadways, 1 mile of railway, and at least 11 miles of sewer and storm lines are in the erosion hazard zone (Table ES-9).

Table ES-9: Quantitative description of assets in the erosion hazard zone – select beaches

Beach/Area Name	# Private Parcels Affected	Assessed Value of Private Land (1,000s)	Assessed Value of Private Structures (1,000s)	Private Parcel Acreage	Roads (miles)	Railways (miles)	Storm & Sewer Lines (miles)
Surfer's	23	n/a	n/a	2.5	0.7	0	n/a
Santa Cruz Main	36	$16,434	$20,446	24	0.8	0.6	1.3
Twin Lakes	109	$60,527	$22,425	9	1.2	0	2.2
Capitola	118	$36,523	$17,803	5	0.6	0	1.3
Depot Hill	30	$29,700	$18,000	7	0.1	0	0.08
Seacliff	258	$140,011	$51,255	23	2.4	0	6.1
Manresa	166	$93,919	$59,988	61	0.6	0.3	0.5
Sunset	526	$183,208	$112,258	71	3.1	0	0.1
Total		$560,322	$302,175	203	9.5	0.9	11.58

Notes:

1) Land and structure values from Santa Cruz County Assessor, August 2014.Because of California's Proposition 13, the actual current value is greater than the assessed value shown here.

2) Only privately-owned parcels and acreage included in data.

3) Assessor data and utility data not available for San Mateo County

ES 8. Recommended Regional Sediment Management Strategies

This Plan is not intended to prescribe a specific RSM measure at a given BECA or SICH, but rather present several potentially viable measures (or strategies) that could be considered for future implementation. Table ES-10 lists strategies that could facilitate the restoration and maintenance of beaches and coastal environments in accordance with the mission of the CSMW. It is important to note that the table only represents a preliminary step in addressing coastal sediment management issues on a regional scale, and it is up to the responsible stakeholders, jurisdictions, and agencies to decide which, if any, of the strategies should be implemented in the future.

Table ES-10: Recommended RSM strategies at BECAs and Sediment Impaired Coastal Habitats

BECA / Sediment Impaired Coastal Habitat	No Action	Managed Retreat / Infrastructure Realignment / Restoration	Sediment Removal / Dredging	Beach Nourishment	Perched Beach	Multi-purpose Artificial Reef	Groin (s) / Jetties	Cliff or Bluff Stabilization / Seawall / Revetment
Princeton - Pillar Point Harbor	X	-	-	X	X	-	-	X
El Granada County (Surfer's) Beach	X	X	X (Pillar Point Harbor)	X	-	X	-	X (described under No Action)
Pescadero Lagoon - Butano Creek	X	X	X	-	-	-	-	-
Waddell Beach and Lagoon	X	X	-	-	-	-	-	-
Scott Creek Beach and Lagoon	X	X	X	-	-	-	-	-
West Cliff Drive - Lighthouse Field State Beach	X	X	-	X	-	-	-	X
San Lorenzo River - Main Beach	X	-	X (Seabright Beach)	-	-	-	X (River Mouth)	-
Twin Lakes State Beach	X	-	-	X (described under No Action)	-	-	-	X (described under No Action)
Schwan Lagoon	X	X	-	-	-	-	-	-
Corcoran Lagoon	X	X	-	-	-	-	-	-
Moran Lake	X	X	-	-	-	-	-	-
Del Mar Beach	X	X	-	X	-	X	-	X
East Cliff Drive	X	-	-	X	-	-	X	X
Capitola Beach and Esplanade	X	-	-	X	-	X	X	-

BECA / Sediment Impaired Coastal Habitat	No Action	Managed Retreat / Infrastructure Realignment / Restoration	Sediment Removal / Dredging	Beach Nourishment	Perched Beach	Multi-purpose Artificial Reef	Groin (s) / Jetties	Cliff or Bluff Stabilization / Seawall / Revetment
Depot Hill	X	X	-	X (if combined with groins)	-	X	X	X
New Brighton State Beach	X	X	-	X	-	-	-	-
Seacliff State Beach	X	X	-	X	-	-	X (Aptos Creek)	X (described under No Action)
Rio Del Mar	X	X	-	X	-	-	-	X (described under No Action)
Pajaro Dunes	X	X	-	X	-	-	-	X (described under No Action)
Moss Landing and Elkhorn Slough	X	X (described under No Action)	X (sand capture at Monterey Submarine Canyon)	-	-	-	-	-

ES 9. Implementation and Governance Structure

This Plan recommends a diverse set of sediment-management measures (Section ES 8) and planning processes, which are distributed widely throughout the various sub-regions and individual BECAs. Simply put, implementation of the Plan would involve a coordinated effort among stakeholders to establish and maintain a RSM program and to evaluate and carry out these recommendations or other types of coastal management. Some of the recommendations in the Plan involve continuing existing activities – e.g., the ongoing Moss Landing and Santa Cruz Harbor dredging and opportunistic beach nourishment efforts. Others would be entirely new projects or planning processes that would require additional funding, staffing, resources, and feasibility studies. Although local jurisdictions would independently continue to plan and implement individual projects, implementing elements of this plan would allow for a Coastal RSM program that provides many potential benefits from a regional perspective through stakeholder coordination and cross-jurisdictional collaboration.

It is recommended that Plan implementation involve five main components: developing a governance structure, establishing a process for RSM stakeholder coordination, developing an Outreach and Education Program, establishing and maintaining a dedicated funding source, and investigating and pursuing options for a streamlined permitting program. This section describes each of these components in more detail and provides potential options and specific recommendations for each. Examples are also provided from other CRSMPs that have been adopted in various regions in California.

This Plan's recommended activities would be located throughout a large and diverse geographical area that includes upland streams and rivers and the entire 75-mile stretch of shoreline. Therefore, full implementation of this Plan will require extensive coordination among numerous overlapping jurisdictions including close collaboration among state and federal agencies, local jurisdictions, and a variety of other stakeholders. Moreover, to fully implement this Plan, a governance structure that meets the specific needs of the Santa Cruz Littoral Cell region would have to be developed and adopted by local governments and stakeholders.

Developing an RSM governance structure typically entails establishing a coordinated CRSMP implementation approach led by an entity that has appropriate jurisdictional authorities and the ability to enter into contracts, oversee staffing resources, and facilitate a process for input and collaboration with local stakeholders as well as federal, state, regional, and local entities. Because of the complexities involved with the Santa Cruz Littoral Cell region and the lack of an obvious governance model and lead agency, further discussion among stakeholders and a more detailed assessment of alternatives are needed before informed decisions can be made, by local jurisdictions, on determining the appropriate governance structure and implementation model. Therefore, rather than recommending a specific governance model, this Plan identifies and describes a range of potential scenarios and encourages local jurisdictions, agencies, and other stakeholders to engage in a collaborative effort to further evaluate the options and make an informed decision on the most appropriate governance structure for the region.

Once a decision has been made on a governance structure and implementation model, the next steps would be: official adoption of the Plan, establishing and maintaining a coordination mechanism and an agreement and among the participating stakeholders that clearly states roles and responsibilities and formalizes the process, establishing a means to administer and seek funding and enter into contracts to conduct studies and collaborative planning efforts, and establishing and overseeing staff necessary to coordinate CRSMP implementation.

Local governments in the Santa Cruz Littoral Cell region are currently not budgeted to finance significant RSM projects and programs. Therefore, any level of Plan implementation will require a dedicated source of funding. A recommendation of this Plan is to work with local jurisdictions to identify and assess funding options for RSM activities and implementation of this Plan. As a starting point for these discussions, this Plan provides an initial description of potential federal, state, and private funding sources. In addition to funding sources, staffing resources are also required to implement the Plan and carry out recommended RSM measures. In the near term, it is recommended that funding be sought to establish a new staff position to coordinate initial RSM Plan implementation. This interim CRSMP coordinator, who could be seated within an existing agency, municipality, or other organization, would initiate and oversee Plan implementation and outreach efforts, coordinate governance structure development, and carry out some of the initial activities identified in this Plan. A long-term staffing plan should also be developed, which includes a dedicated program manager to oversee plan implementation and coordinate with stakeholders on a variety of recommended projects, studies, management, and funding strategies. In addition to a program manager, other support staff and technical specialists should be hired, if resources are available.

This Plan recommends developing a strategy with USACE, the MBNMS, the CCC, local jurisdictions, and other regulatory agencies described in Section ES 6 to identify options for and to pursue a regional streamlined permitting program. As part of the permitting streamlining process, it is also recommended to collaborate with MBNMS, the CCC, and other state and federal resource agencies to develop science-based resource protection guidelines aimed at avoiding and mitigating potential environmental impacts of sediment management projects in the region.

The Plan also includes a list of recommended next steps that would be required in the near term during the initial phases of implementation and outreach efforts (Table ES-11). It also lists potential options for short-term, long-term, and ongoing implementation actions, which can provide a basis for discussion during initial outreach and stakeholder collaboration efforts.

Table ES-11: Overview of recommended next steps for RSM Plan implementation

RECOMMENDED ACTION	CATEGORY
Begin an evaluation of options for governance structure, including considerations for potential lead agencies and partners, and processes for decision-making and information sharing.	Governance structure development
Develop a comprehensive list of potential partners and stakeholders and identify their possible roles in plan implementation.	RSM stakeholder coordination process
Connect with the relevant stakeholders, including agencies and local municipalities, to provide information about the Plan, discuss potential opportunities for collaboration, and assess their interest in participation.	RSM stakeholder coordination process
Reconvene the SAG that was formed for the development of this Plan for meetings to: present the final Plan; initiate discussions on RSM options; solicit recommendations on initial plan implementation, and; discuss the possibility of and options for the workgroup playing a permanent role in ongoing implementation of the Plan.	RSM stakeholder coordination process
Coordinate with the CSMW on initial plan implementation and stakeholder outreach strategies.	Outreach and education program
Establish a list of prioritized initial outreach actions and identify existing CSMW outreach products and tools that could be used to support initial implementation of the Plan.	Outreach and education program
Initiate focused outreach efforts by providing presentations to local governmental organizations, and holding individual meetings with stakeholders. Provide an explanation of what the Plan consists of, why it was developed, and how it could be carried out.	Outreach and education program
Partner with the CSMW to host at least two public workshops once the Plan has been finalized – one in Santa Cruz and another in Half Moon Bay – to present the final Plan and obtain input on initial implementation.	Outreach and education program
Develop and implement an initial outreach and education strategy to get the Plan into the hands of stakeholders that will use it and to ensure their input on RSM issues and plan implementation.	Outreach and education program
Seek near-term funding to establish a new staff position within an existing agency, municipality, or other organization to coordinate initial plan implementation.	CRSMP Funding
Begin to develop a detailed permitting roadmap and explore options for a streamlined regional RSM permitting program.	Permitting program

1. INTRODUCTION

This Plan was developed by USACE in partnership with the MBNMS for the CSMW. The CSMW is a collaborative effort by federal, state, and local agencies and non-governmental organizations committed to evaluating and addressing California's coastal sediment management needs on a regional basis. It was established in 1999 and is co-chaired by USACE South Pacific Division and the California Natural Resources Agency (CNRA). Its creation was a response to concerns – raised by the state, representatives of local governments, USACE, and environmental groups – about the piecemeal identification of problems and implementation of site-specific solutions that did not effectively address critical problems along the coastline.

California's beaches are extremely valuable resources that provide critical habitats for endangered species, exceptional recreational opportunities, infrastructure protection, and over $15 billion annually in tourism-generated tax revenue (CSMW, 2002). Coastal beaches, wetlands, and watersheds have been affected, however, by extensive human alteration of the natural flow of sediment to and along the coast (Figure 1-1). Watersheds no longer provide a sufficient supply of sediment to beaches, wetlands are often compromised by too much or too little sedimentation, and beaches erode because of a lack of sand.

Anthropogenic coastal alteration is widespread along the California coast, and a number of Coastal Regional Sediment Management Plans (CRSMPs) have been developed to formulate region-specific strategies to address these issues. This Plan presents strategies to accomplish a number of CSMW-informed sediment-management objectives for the central California coastline from Pillar Point in San Mateo County to Moss Landing in Monterey County (Figure 1-2). These objectives include: (1) restoration, preservation, and maintenance of coastal beaches and other critical areas of sediment deficit; (2) sustainment of recreation and tourism; (3) enhancement of public safety and access; (4) restoration of coastal sandy habitats; and (5) identification of cost-effective solutions for restoration of areas affected by excess sediment.

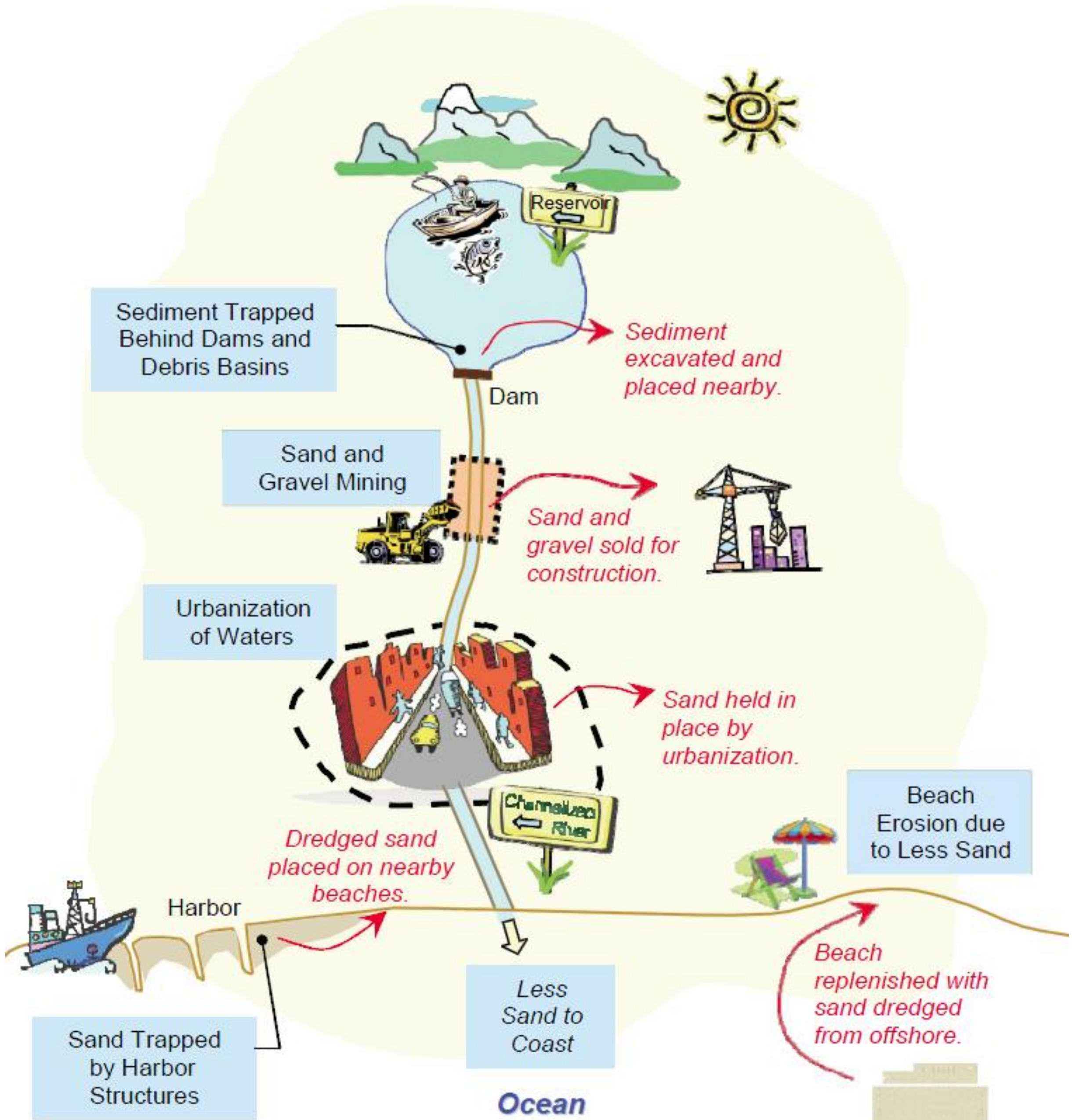


Figure 1-1. Existing Coastal Sediment Management Practices in Many Regions
Source: California Coastal Sediment Master Plan Status Report (CSMW, 2012)

Figure 1-2. Location of the Santa Cruz Littoral Cell

The development of these strategies was an iterative process of several steps. The first step involved an assessment of physical conditions, such as wave climate and sediment supply, and coastal erosion processes in the Plan area (Section 2). The results of this assessment was then combined with input from a Stakeholder Advisory Group (SAG) and the public to develop a preliminary list of Beach Erosion Concern Areas (BECAs) and sediment impaired coastal habitats (Section 3). Subsequent steps involved identification and description of potential erosion mitigation measures and coastal sediment sources (Section 4), an evaluation of sensitive biological habitats and species (Section 5), and an evaluation of economic implications of continued coastal erosion in the Plan area (Section 7). Datasets generated by these tasks were compiled into spatial layers to facilitate inclusion of these data into CSMW's GIS database as appropriate for visualization and ease of use by coastal decision makers.

The CSMW also partnered with the MBNMS to conduct governance and outreach activities through a Public Outreach Program consisting of mailings, website postings, and meetings. Key tasks included development of a list of technical advisors and reviewers, who were then asked to serve on the SAG, and coordination with both the MBNMS and GFNMS to address governance issues related to CRSMP implementation. Outreach occurred concurrently with the technical tasks so that input from the SAG and public could be incorporated during development of the draft Plan. The key findings from these coordination activities were incorporated into a discussion of regulatory and policy considerations (Section 6) and recommendations regarding governance (Section 9) in the Plan.

The Plan culminates with a detailed discussion of potential site-specific RSM measures for each of the BECAs and SICHs. This discussion details specific advantages and disadvantages associated with several management measures at each site, and it is not intended to prescribe a specific measure for a specific BECA. Rather, this discussion was developed with the intention of presenting several potentially viable measures (or strategies) that could be considered for future implementation by the responsible jurisdiction or agency.

2. DESCRIPTION OF PLAN AREA

2.1 LITTORAL CELL CONCEPT AND REGIONAL CONTEXT

The littoral cell concept emerged from the coastal geology literature in the early 1960s (e.g., Inman and Chamberlin, 1960) when researchers recognized that the California coast could be divided into self-contained regions, or cells, for the purpose of developing beach sediment budgets (Pastch and Griggs, 2007). The emergence of this concept has been an important advancement in the field of coastal processes, as it provides a framework for understanding how coastal erosion hazards may develop in response to changes in the overall sediment budget of a specific region. Thus, the coastal management community increasingly utilizes littoral cells as the underlying geographic basis for developing recommendations in terms of sediment management, specifically with respect to addressing critical erosion areas (CSMW, 2010).

Littoral cells are defined as self-contained systems of sand sources and sand sinks, with longshore transport (or littoral drift) moving sand throughout the systems. Sand budgets for individual littoral cells can be developed by taking into account sources, sinks, and rates of net transport. Typical sand sources for littoral cells in California include coastal streams, erosion of coastal bluffs, and relict sand dunes (Patsch and Griggs, 2007). Along the California coast, typical sand sinks include the heads of submarine canyons, where gravity flow move sand down the canyon and effectively out of the littoral cell. Sand is also transported offshore by large waves during storm events, where it may be stored offshore sand bars and eventually reworked onshore during more quiescent periods. Boundaries of littoral cells are often delineated by sank sinks or other physical barriers (headlands, coastal structures) that prevent sand from moving to an adjacent littoral cell. However, these boundaries do not necessary represent an absolute barrier to all sand transport, and recent research has suggested that sand may be transported around headlands under certain wave conditions (George et al., 2014)

Sand is typically transported by the littoral drift process, which involves waves approaching the shoreline at an angle and washing sediment onto a given beach. The receding swash then transports sand down the beach face perpendicular to the shoreline, resulting in net transport of sand. The net transport of sand along much of the California coast is generally from north to south and west to east, although there are some smaller sub-cells that are characterized by net sand transport from south to north (PWA et al., 2008). There is also considerable temporal variability to the direction and rate of sediment transport, often driven by seasonal changes in wave climate, especially in southern California (Moffatt & Nichol, 2009).

Changes to the sediment budget of a littoral cell can alter the dynamic equilibrium at a given beach and cause either erosion or accretion of sand. These changes can result from a number of factors that serve to increase or decrease sediment supply or alter littoral transport processes. Some of the more well-documented factors include decreased sand deliveries from coastal rivers as a result of damming (Willis and Griggs, 2003; Slagel and Griggs, 2008), and disruptions to the littoral drift process resulting from engineered coastal structures (Lajoie and Mathieson, 1985). A compete coastal regional management plan will need to evaluate how changes in the sediment budget have and might continue to affect beaches and other coastal resources, especially those of concern to the public.

Coastal RSM is typically concerned with sediment that will remain on beaches and effectively circulate throughout the littoral cell. If sediment is too fine, it will be easily transported offshore and eventually settle out in depths outside of the littoral zone. Thus, sediment must reach a certain grain size threshold to be considered part of a sand budget of a given littoral cell, and this threshold is often referred as the littoral-cut-off diameter (Hicks, 1985). Best and Griggs (1991) determined that the littoral-cut-off diameter for the Santa Cruz littoral cell is 0.18 mm (or 2.5 Φ units), and this value has been used in subsequent analyses of the sand budget in this cell (e.g., Patsch and Griggs, 2007).

However, the effective management of finer sand and sediments may also provide benefits, and recent research has addressed the fate and transport of fine sediments placed during beach nourishment (Warrick, 2013). In addition, the Santa Cruz Littoral Cell encompasses a number of coastal lagoon and other lower energy environments with significant quantities of finer sediments that may present RSM opportunities. Thus, while this Plan primarily focuses on sediment with a littoral-cut-off diameter greater than 0.18 mm, it will also address potential RSM measures involving finer sediments.

2.1.1 Santa Cruz Littoral Cell

The general consensus among researchers is that the headland at Pillar Point is the northern boundary of the Santa Cruz Littoral Cell and the Monterey Submarine Canyon is the southern boundary (Limber, 2005; Patsch and Griggs, 2007). Thus, the Santa Cruz Littoral Cell encompasses an approximately 75-mile-long stretch of coastline extending through San Mateo, Santa Cruz, and Monterey counties (Figure 1-2). The northern portion of the littoral cell is characterized by a relatively rugged coastline that runs south from

Pillar Point before gradually bending to the southeast at Point Año Nuevo. The southern section of the littoral cell encompasses the northern shoreline of Monterey Bay, which extends east from Santa Cruz before curving to the south-southeast toward Moss Landing. These fundamental differences in physical setting serve to influence the present day physical processes that govern sand transport and beach erosion and accretion in the littoral cell.

2.2 Physical Processes

There are several important physical processes that work in concert to shape the diverse shoreline environments of the Santa Cruz Littoral Cell: wave climate, tidal regime, and changes in sea-level.

2.2.1 Wave Climate

The wave climate of the Santa Cruz Littoral Cell is somewhat complex, with waves of varying periods, size and seasonality affecting different areas of the littoral cell depending on coastline orientation (Figure 2-1). Most wave energy approaches the Santa Cruz Littoral Cell from the northwest and west, often in the form of swell generated by extratropical cyclones and cold fronts in the North Pacific (Storlazzi and Wingfield, 2005). This swell tends to peak in size and period during the winter months, and is responsible for the largest waves that impact the shoreline of the cell (Storlazzi and Wingfield, 2005). Additional wave energy from the northwest approaches the cell in the form of wind waves, which occur most frequently in between April and October as the California high pressure system generates northwesterly winds (Storlazzi and Wingfield, 2005).

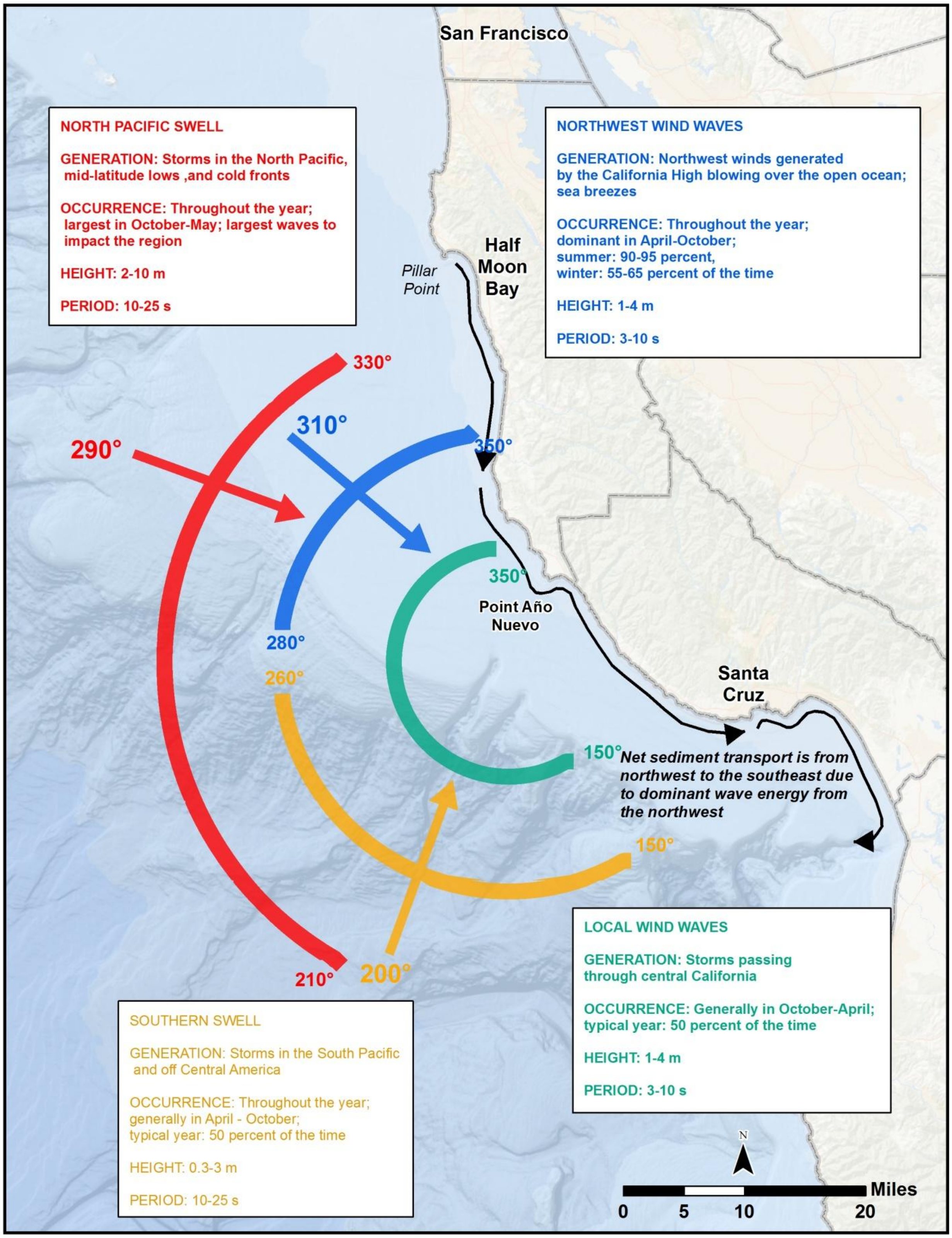


Figure 2-1. Santa Cruz Littoral Cell wave climate and net sediment transport. Wave climate data and graphics adapted from Storlazzi and Wingfield (2005).

Wave energy also approaches the Santa Cruz Littoral Cell from the south and southwest, although this occurs with less frequency and intensity than the North Pacific swell (Storlazzi and Wingfield, 2005). In the summer months, strong storms in the southern hemisphere generates swell that can reach certain sections of the northern Monterey Bay, including the Santa Cruz area. Passing winter storms may also generate local wind waves, which can propagate in wide range of directions depending on the storm's track. However, when taken together, the predominant wave energy approaches the cell from the northwest, and the scientific consensus is that the net direction of sediment transport is from the northwest to the southeast (Patsch and Griggs, 2007; Figure 2-1).

The relatively exposed coastline north of Santa Cruz typically bears the brunt of impacts from northwest swell and wind waves, as the indentation of the coastline east of Santa Cruz provides a sheltering effect to northern Monterey Bay beaches (Griggs et al., 2005). If strong winter storms follow a more southerly track than usual, however, large waves may directly approach Monterey Bay from a more southwesterly direction without any energy loss from refraction around headlands. This scenario occurred during the winter of 1983, when a series of El Niño related storms caused severe beach erosion and property damage throughout northern Monterey Bay (Dingler and Reiss, 2002; Griggs et al., 2005).

Wave climate also fluctuates over inter-annual and longer time periods in concert with ocean-atmosphere oscillations such as the El Niño Southern Oscillation (ENSO). It is widely accepted by the scientific community that unusually strong storms and large damaging waves are associated with moderate to strong El Niño conditions in the Pacific (Seymour, 1998; Storlazzi and Griggs, 2000; Griggs et al., 2005). These storms tend to follow a more southerly track when El Niño conditions are strongest, resulting in more direct impacts from storms along the California coast. El Niño conditions generally occur every 3 to 7 years, although the particularly intense and damaging El Niño events (e.g., 1982 - 1983, 1997 - 1998) tend to occur on the scale of every 10 to 20 years (Storlazzi and Griggs, 2000). Recent research also suggests that the frequency of strong El Niños could double under current global warming projections (Santoso et al., 2013).

There is also evidence that a longer-term (20 to 30 year) climatic oscillation in the North Pacific may influence storm activity along the California Coast (Bromirski et. al, 2003 and 2013). This periodic change is now commonly referred to as the Pacific Decadal Oscillation (PDO), with phases of anomalously warm ocean conditions alternating with cooler conditions (Mantua and Hare, 2002). Similar to El Niño conditions, PDO warm phases have been associated with periods of increased storm frequency and intensity, resulting in accelerated erosion rates (Orme et al., 2011; Russell and Griggs, 2012). Several studies have linked the oscillations of the PDO to changes in beach width, with beach narrowing (i.e., erosion) occurring during warm phases and widening (i.e., accretion) during cool phases (Revell and Griggs, 2006; Zoulas and Orme, 2007). These studies occurred in southern California, however, which has a somewhat different wave climate because of a more east-west orientation and the presence of the Channel Islands. Even with these regional differences, the alternating phases of the PDO still exert considerable influence over the wave climate along much of the California coast.

2.2.2 Tidal Regime

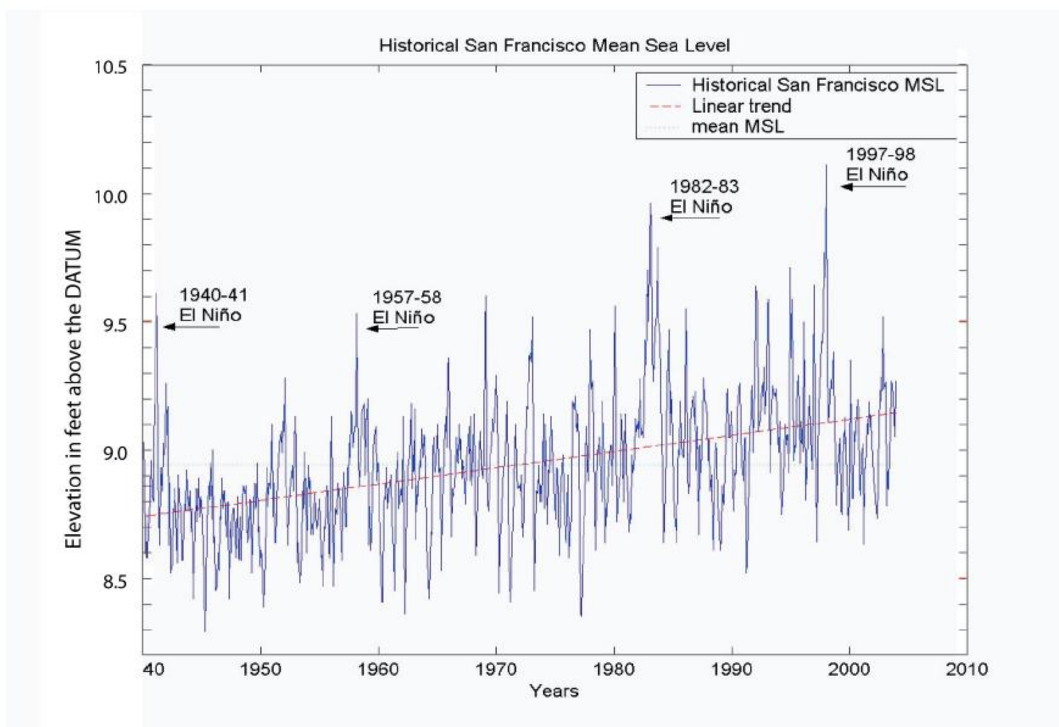
The tidal regime of the Santa Cruz Littoral Cell is mixed semidiurnal, with two high tides and two low tides each day. The two high (and low) tides that occur each day are of unequal height, and this difference varies with longer-term tidal cycles. The closest tidal station to the Santa Cruz Littoral Cell is at Monterey Harbor (Table 2-1), which has a diurnal tidal range (mean higher-high water minus mean lower-low water) of 5.3 feet (PWA et al., 2008; NOAA, 2012a). The role of tides becomes important when high tides coincide with peak wave energy and surge during storms to increase the chance of inundation of beaches and damage to coastal infrastructure. This scenario occurred in January 1983, when a series of large storms struck during some of the highest tides of the year, resulting in significant damage to infrastructure throughout the Santa Cruz Littoral Cell (Griggs, 1985; Table 2-1).

Table 2-1: NOAA tidal datums for Monterey Harbor relative to mean lower-low water.

Tidal Datum	MLLW (ft)	NAVD 88 (ft)
Mean higher-high water (MHHW)	5.34	5.48
Mean high water (MHW)	4.64	4.78
Mean tide level (MTL)	2.87	3.01
Mean sea level (MSL)	2.84	2.97
Mean low water	1.10	1.24
Mean lower-low water (MLLW)	0	0.14
Highest observed water level (27 January 1983)	7.88	8.02

2.2.3 Changes in Sea-Level

The average global sea-level has been rising since the start of the observational record in the mid-nineteenth century, increasing the vulnerability of coastal infrastructure to coastal erosion (Russell and Griggs, 2012). This trend has also been documented by tidal stations located near the Santa Cruz Littoral Cell, including the Monterey Harbor and San Francisco stations. Sea level data from the Monterey station only became available in 1973, so data from the San Francisco station is often used to identify long-term trends for the region (Figure 2-2). Data from the San Francisco station shows that relative sea-level has risen at a rate of 0.084 inches per year from 1906 to 2004, although sea level tends to widely fluctuate around the mean with spikes correlating with El Niño seasons (PWA et al., 2008). In addition, recent research suggests that sea-level rise on the U.S. West Coast has been suppressed by wind stress patterns associated with the warm phase of the PDO, and may accelerate in response to a recently observed change in wind stress patterns (Bromirski et al., 2011).



Source: Adapted from Conforto Sesto (2004). Note: Mean sea level is relative to station datum.

Figure 2-2. Monthly averaged sea level at San Francisco. Source: PWA et al. (2008).

Although there is strong consensus that sea-level is expected to rise in the future, there is still considerable uncertainty regarding the magnitude of this rise, with differences of over several feet between high and low scenarios predicted by the National Research Council (Figure 2-3). As a result, the federal government, specifically USACE, is incorporating this uncertainty in into its missions by evaluating how a number of sea level scenarios would affect future coastal projects (USACE, 2013). In addition, the National Research Council (NRC) completed a region-specific assessment of sea-level rise data for the U.S. West Coast, which includes a comprehensive overview of region-specific factors (climate, tectonics) that influence sea-level change along the California coast (NRC, 2012).

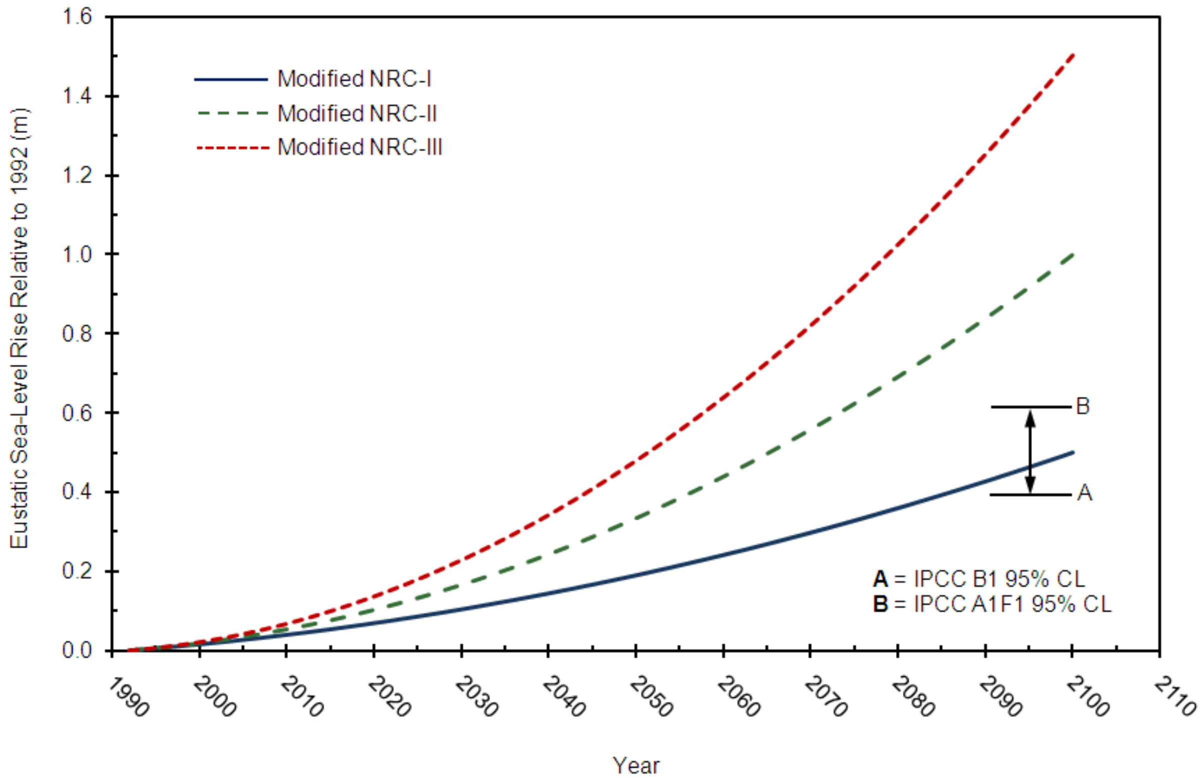


Figure 2-3. Modified NRC (1987) global mean sea-level rise scenarios and the Intergovernmental Panel on Climate Change (2007) scenario. Source: USACE (2011)

Local and state governments are also involved in planning for future sea-level rise, with municipalities (e.g., City of Santa Cruz, 2011) and state agencies (California Coastal Commission, 2014) studying the potential impacts of sea-level rise on coastal infrastructure. In 2009, a California Ocean Protection Council funded report presented maps of future coastal erosion hazard areas based on high (55") and low (39") sea-level rise scenarios in the year 2100 (PWA 2009). The scope of this report was broad and covered much of northern and central California, including the entire 75 miles of the Santa Cruz Littoral Cell. Thereafter, the Monterey Bay Sanctuary Foundation and others funded a more focused sea-level rise vulnerability assessment for the coast extending from the City of Monterey to the northern boundary of Santa Cruz County (ESA-PWA, 2014). Given the extensive work that has gone into projecting the impacts of sea-level rise, this Plan will leverage this work to identify opportunities for utilizing sediment management practices to mitigate for such impacts.

2.3 Geomorphology and Physical Setting

The coastline of the Santa Cruz Littoral Cell is geomorphically diverse. It includes coastal dune systems in central Monterey Bay, marine terraces fronted by sandy beaches in northern Monterey Bay, and resistant headlands interspersed with pocket beaches from Monterey Bay to the south end of Half Moon Bay. In addition to the distinction between Monterey Bay and the more exposed and rugged coastline to the north, the literature often divides the Santa Cruz Littoral Cell into smaller reaches based on differences in geomorphic setting (Patsch and Griggs, 2007). For the purpose of this document, the Santa Cruz Littoral Cell has been divided into seven reaches, with each reach characterized by distinct physical settings, such as beaches, sea cliffs, or coastal structures (Figure 2-4).

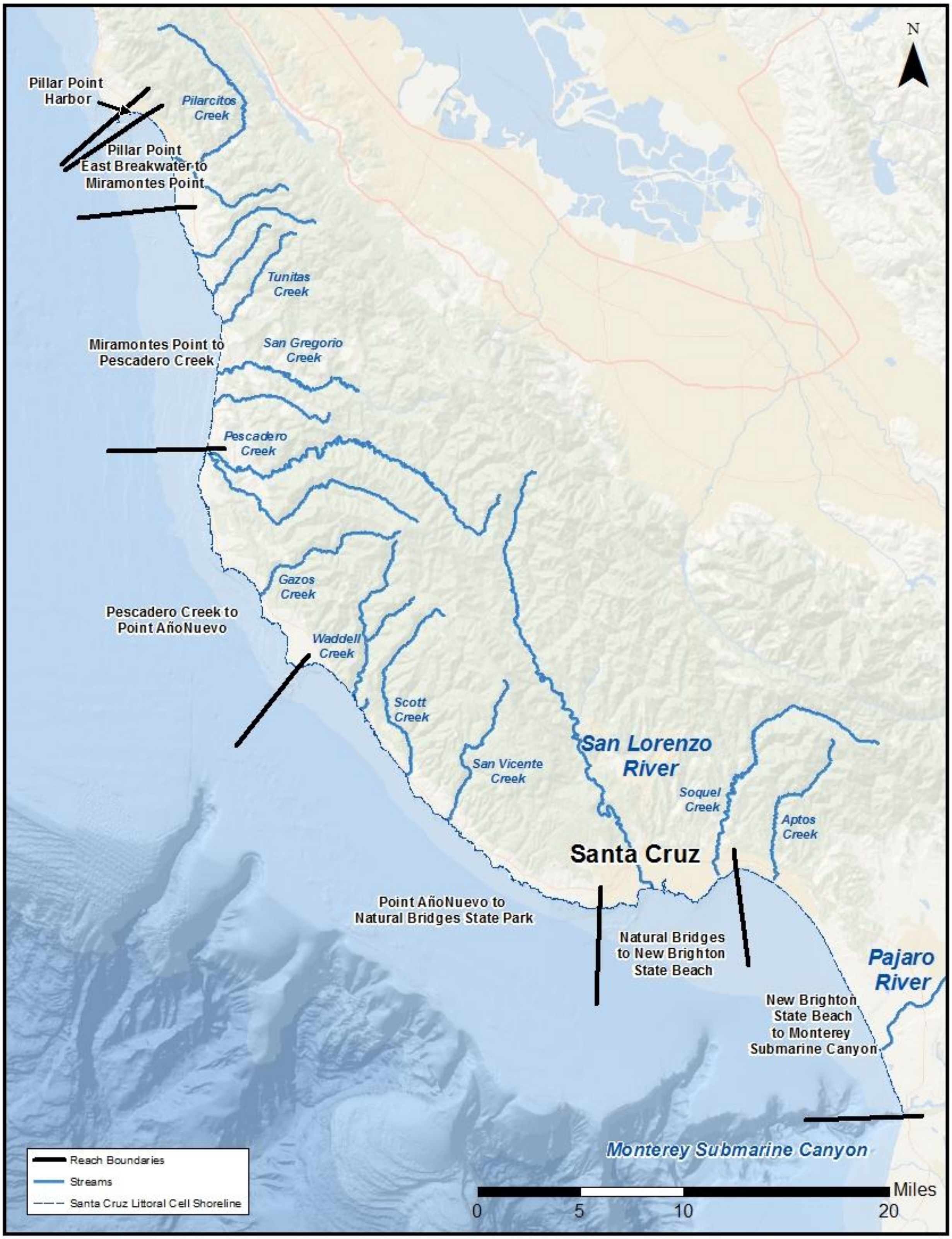


Figure 2-4. Santa Cruz Littoral Cell reaches

2.3.1 Pillar Point Harbor

The northernmost reach encompasses the interior of Pillar Point Harbor and is no longer exposed to the prevailing wave climate due to the presence of two large breakwaters. These structures were constructed from 1956 to 1960 and have significantly impacted sediment transport in the harbor, resulting in changes in erosion and sediment deposition patterns. Erosion has become a concern along the toe of the bluff comprising the western boundary of the harbor and along the shoreline fronting Princeton. As a result, a number of small riprap revetments have been placed in front of vulnerable properties in Princeton. The erosion issue at Princeton has been addressed by a number of studies (e.g., Moffatt & Nichol, 2001), and San Mateo County is actively preparing a plan to address this and other issues in the vicinity of Princeton (Section 2.5.1).

Excessive sediment deposition has also impacted navigation in the harbor. It is believed that approximately 85% of the sand that accumulates in the harbor originates from the littoral zone outside of the harbor, with the remaining 15% of the sediment originating in the three streams that drain into the harbor (USACE, 1996). It has been hypothesized that this sand is transported through and over the relatively porous breakwaters (particularly the East Breakwater) when storm waves approach from the west-southwest (USACE, 1996). The impacts on navigation are most acute at the boat launch ramp in the eastern section of the harbor, where the San Mateo County Harbor District (SMCHD) dredged up to 5,000 cy of sediment to maintain access to the boat ramps in 2013 (SMCHD, 2015). A much greater quantity of (up to 250,000 cy) sand has accumulated along the harbor side of the East Breakwater, and the potential for utilizing this sand for nearby beach nourishment is discussed in Sections 2.5.2 and 8.2.2.

2.3.2 Pillar Point East Breakwater to Miramontes Point

The reach extending from the East Breakwater of Pillar Point Harbor to Miramontes Point encompasses a moderately urbanized five mile long hook shaped bay (Figure 2-5). The north end of the reach has been most acutely affected by development, including the construction of two large breakwaters at Pillar Point Harbor. The impacts of these breakwaters on wave and sediment transport patterns has been the focus of discussion and study for several decades (Lajoie and Mathieson, 1985; Griggs et al., 2005), as increased beach and bluff erosion adjacent to the outside of the East Breakwater has threatened significant public infrastructure including Highway 1. Researchers have estimated that erosion rates may have ranged up to 6 to 7 feet per year in the section immediately adjacent to the East Breakwater, with the impacts of the breakwaters extending approximately one mile down coast (Lajoie and Mathieson, 1985; Hapke et al., 2006).

Figure 2-5. Pillar Point to Miramontes Point

The response to this erosion problem began in 1959, with periodic placement of broken concrete and riprap to protect Highway 1 and other infrastructure. These placement efforts were unable to stem erosion from the 1960s to the early 1980s, and a county road and sewer lines were ultimately undermined and destroyed (Griggs et al., 2005). Following the major storms of 1983, more significant riprap was placed along Highway 1, and it currently protects an approximately 800-foot-long section of the highway from further erosion. Three-quarters of a mile south of the harbor, approximately 1600 feet of riprap was placed between 1978 and 1983, which currently provides some protection to the structures lining Mirada Road. However, erosion in this area remains a major concern, and USACE is currently studying erosion mitigation alternatives including beach nourishment and other engineering approaches (Section 2.5.2).

South of Pillar Point Harbor, beaches backed by eroding bluffs form a curved bay down to the headland at Miramontes Point. This curve gradually opens up to the south, which is typical of a crescent shaped bay formed by wave refraction around a headland (e.g., Pillar Point) or other feature resistant to erosion. The beaches fronting the bluffs are thought to be comprised of sand locally eroded from the bluffs, which generally consist of weak sediments (Lajoie and Mathieson, 1985). The beaches tend to increase in width from north to south, which suggests that the net quantity of available beach-building sand increases as one moves downcoast through the cell. However, the sand contribution from these bluffs is believed to be relatively minor, perhaps less than 10,000 cy of sand per year (Patsch and Griggs, 2007). These bluffs gradually increase in height to the south, culminating in the headland at Miramontes Point. These bluffs are also fairly erosive, and some riprap has been placed to protect private development on this bluff.

2.3.3 Miramontes Point to Pescadero Creek

This reach extends approximately 12 miles along a relatively rugged and rural stretch of coastline, which is characterized by sea cliffs, small pocket beaches, and narrow seasonal beaches adjacent to creek mouths (Figure 2-6). The northernmost six miles of the reach consists of sandstone and mudstone sea cliffs, which are subject to selective erosion along joints and cracks. Seacliff erosion rates are highly variable in this area, with the highest rates in the littoral cell (up to 4 feet per year) found approximately 0.5 miles north of Martins Beach (Griggs et al., 2005; Hapke and Reid, 2007).

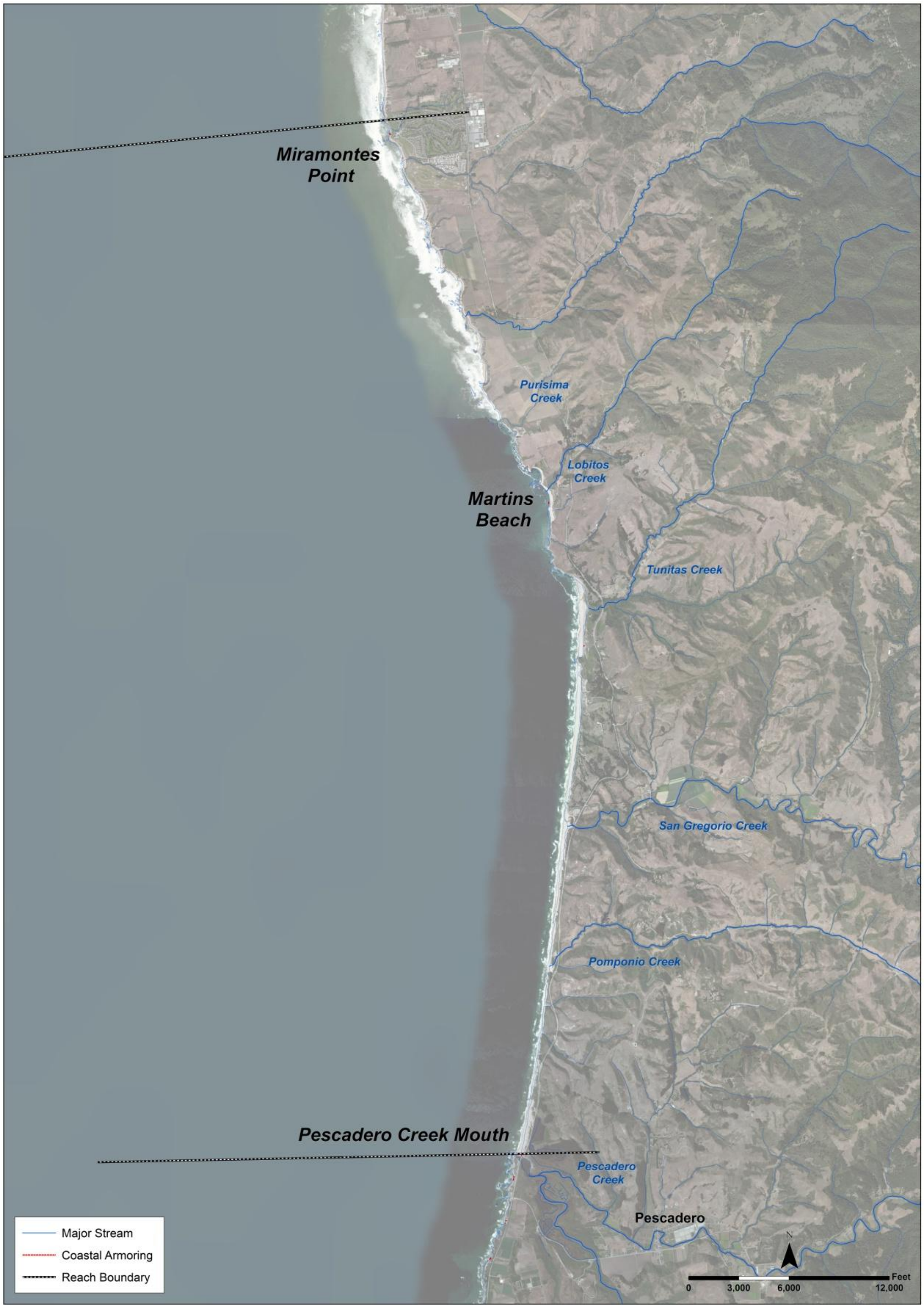


Figure 2-6. Miramontes Point to Pescadero Creek

The southernmost six miles are characterized by coastal bluffs and sea cliffs fronted by modest beaches. There are several narrow canyons carved out by coastal streams including Tunitas Creek, San Gregorio Creek, Pomponio Creek, and Pescadero Creek (Griggs et al., 2005). There is also a tidal lagoon and marsh complex at the confluence of Pescadero and Butano Creeks, which is separated from the open coast by a sand spit, dunes, and Highway 1. The highway has essentially fixed the position of the spit and mouth and could thereby limit sediment exchange between the marsh and open coast. This limited sediment exchange may in turn contribute to excessive sedimentation in the marsh complex, which has implications for ecosystem function (Largier, pers. comm., 2014). This topic has been the focus of recent research and planning efforts (section 2.5.4).

Fluvial input from these streams and gully erosion is believed to deliver a modest amount of sand to the beaches fronting the bluffs – perhaps on the order of several thousand cy per year (Patsch and Griggs, 2007). There is considerable uncertainty, however, regarding the source(s) of sand supplying these beaches. Specifically, is the sand exclusively derived from local streams or from north of the littoral cell boundary at Pillar Point (Aiello, pers. comm.., 2014). This uncertainty, which reflects a broader debate regarding if headlands can serve as rigid littoral cell boundaries, is the subject on ongoing research (George et al., 2014).

Aside from several residential structures at Martins Beach and on the bluffs above Tunitas Creek, this reach is largely undeveloped, with Highway 1 representing the most prominent infrastructure. Thus, there is no armoring along this reach with the exception of a 200-foot-long retaining wall and 963 feet of temporary riprap (placed on an emergency basis) at Martins Beach (California Coastal Records Project, 2012; Surfrider Foundation, 2015). There is also concern the sand spit and dune complex at the mouth of Pescadero Creek will migrate inland in response to predicted sea-level rise, and potentially threaten Highway 1 (Griggs et al., 2005).

2.3.4 Pescadero Creek to Point Año Nuevo

Rocky cliffs, small pocket beaches in the north, and more extensive beach and dune systems in south (at Franklin Point and Point Año Nuevo) characterize this nearly 13-mile-long reach (Figure 2-7). This reach is generally rural in nature, with agriculture and various protected open spaces as the primary land uses. Development adjacent to the coast is limited to Highway 1, the Pigeon Point Lighthouse facilities, and some widely scattered residential properties just south of Lake Lucerne (California Coastal Records Project). The shoreline is largely untouched with the exception of two relatively small riprap revetments protecting Highway 1 just south of Pescadero Creek.

Figure 2-7. Pescadero Creek to Point Año Nuevo

The sandstones, mudstones, and boulder conglomerates comprising the rocky cliffs in much of this reach are typically quite resistant to wave erosion (Griggs et al., 2005). Thus, the erosion rate of these sea cliffs is minimal, and they contribute little sand to the littoral cell (Patsch and Griggs, 2007). The sea cliffs in the south toward Franklin Point are overlain with a sand-and-gravel terrace and sand dunes. Some of the sand dunes along the north side of Franklin Point have significantly eroded during storms.

The coastline south of Franklin Point is dominated by Point Año Nuevo and Año Nuevo Island, which lies 2,300 feet offshore of the southernmost point. Point Año Nuevo is a wide, relatively low headland extending approximately 1.7 miles to the west from the base of the Santa Cruz Mountains (Lajoie and Mathieson, 1985). The relatively flat surface of the headland is an uplifted marine terrace, which is overlain by a layer of highly erodible sand, gravel and silt, and capped with a 5,000- to 6,000-year-old dune field (Griggs et al, 2005). This dune field was active up until the past century or so, when a combination of native and introduced vegetation, changes in groundwater related to agriculture, and the erosion of a beach along the north shore stabilized the dunes (Lajoie and Mathieson, 1985; Griggs et al., 2005). The erosion of the beach on the north side of the dunes has been quite rapid, and represents the greatest shoreline recession rates (up to 8 feet per year) in the littoral cell (Hapke et al., 2006). The dune field also became depleted from sand-quarrying operations related to the construction of Highway 1 in the 1950s (Lajoie and Mathieson, 1985; California State Parks, 2012).

The current scientific consensus is that Año Nuevo Island was relatively recently connected to the mainland, forming sometime between the late seventeenth and mid-eighteenth century (Griggs et al., 2005). Prior to its separation from the mainland, Año Nuevo Island served as a headland that trapped significant amounts of sand moving south as littoral drift. This sand formed extensive beaches along the north side of the headland, along with supplying sand to the dunes capping the marine terrace (Patsch and Griggs, 2007). Current research also suggests that the peninsula connecting the island to the mainland experienced significant erosion in response to sea-level rise and perhaps movements associated with seismic activity along the San Gregorio Fault Zone (Griggs et al., 2005).

Regardless of the cause, the erosion of the peninsula and formation of the channel between the island and the mainland released up to 12 to 18 million cy of previously trapped sand into the littoral cell over the past several hundred years (Griggs et al., 2005). This release effectively increased the sand budget by 50,000 cy per year, resulting in widening of some beaches downdrift of the point (Griggs et al., 2005). This source of sand has now largely been depleted, which will result in a decreased sand supply to downdrift beaches (Patsch and Griggs, 2007).

2.3.5 Point Año Nuevo to Natural Bridges

This reach extends 25 miles from the prominent headland at Point Año Nuevo to the heavily visited Natural Bridges State Beach on the outskirts of Santa Cruz (Figure 2-8). Much of the coastline is characterized by moderately erosive mudstone sea cliffs fronted by shore platforms. This mudstone is typically fined-grained and produces only a minimal amount of sufficiently coarse sand to the littoral sand budget (Patsch and Griggs, 2007). There are also several notable streams in this reach, which probably contribute up to several thousand cy of sand to the littoral cell (Patsch and Griggs, 2007). The mouths of these streams are fronted by relatively extensive sandy beaches, including Waddell Beach and Scott Creek Beach.

Figure 2-8. Point Año Nuevo to Natural Bridges

There is little significant development in this reach, with the exception of Highway 1 and the large cement plant at Davenport, which closed in 2010. Otherwise the broad marine terraces running along this reach are dedicated to agricultural uses or protected open spaces (Griggs et al., 2005). Likewise, nearly all of this reach is free of armoring, except for several riprap revetments protecting Highway 1 at the base of the Waddell Bluffs and Scott Creek Beach (California Coastal Records Project, 2012).

The construction of Highway 1 infrastructure (bridges and embankments) over Scott and Waddell Creeks has had a significant impact on the form and function of lagoon habitats. This infrastructure serves as an artificial boundary between beach and lagoon habitats, with lagoons at both sites experiencing net sediment accumulation and reduced tidal exchange (ESA PWA and SWCA, 2012). This reduction in tidal exchange has several important implications for ecological functions of these lagoons, including reductions in seasonal salinity signals and loss of habitat diversity. The current configuration of infrastructure also has reduced the ability of beach and lagoon habitat to migrate inland in response to anticipated sea-level rise.

In addition to ecological concerns, road infrastructure at the Scott and Waddell Creek sites is vulnerable to wave attack and the dynamic nature of the creek mouths. This vulnerability is expected to increase in association with future sea-level rise, with the Scott Creek Bridge being the more vulnerable of the two creek crossings (ESA PWA and SWCA, 2012).

2.3.6 Natural Bridges to New Brighton State Beach

The Natural Bridges area marks a transition in terms from predominately rural northern Santa Cruz County to the urbanized coastline of central Santa Cruz County and northern Monterey Bay (Figure 2-9). The approximately 10-mile-long reach from Natural Bridges to New Brighton State Beach is characterized by 25- to 75-foot-high sea cliffs fronted by beaches of varying widths (Patsch and Griggs, 2007). There are also several low-lying areas where coastal streams have carved paths to the ocean through weaker materials and formed extensive sandy beaches at their mouths. The largest of the coastal streams is the San Lorenzo River, which has been estimated to deliver an annual average of 89,000 (+/- 36,000) cy of sand to the coast (Slagel and Griggs, 2008). It represents the largest single source of sand in the littoral cell.

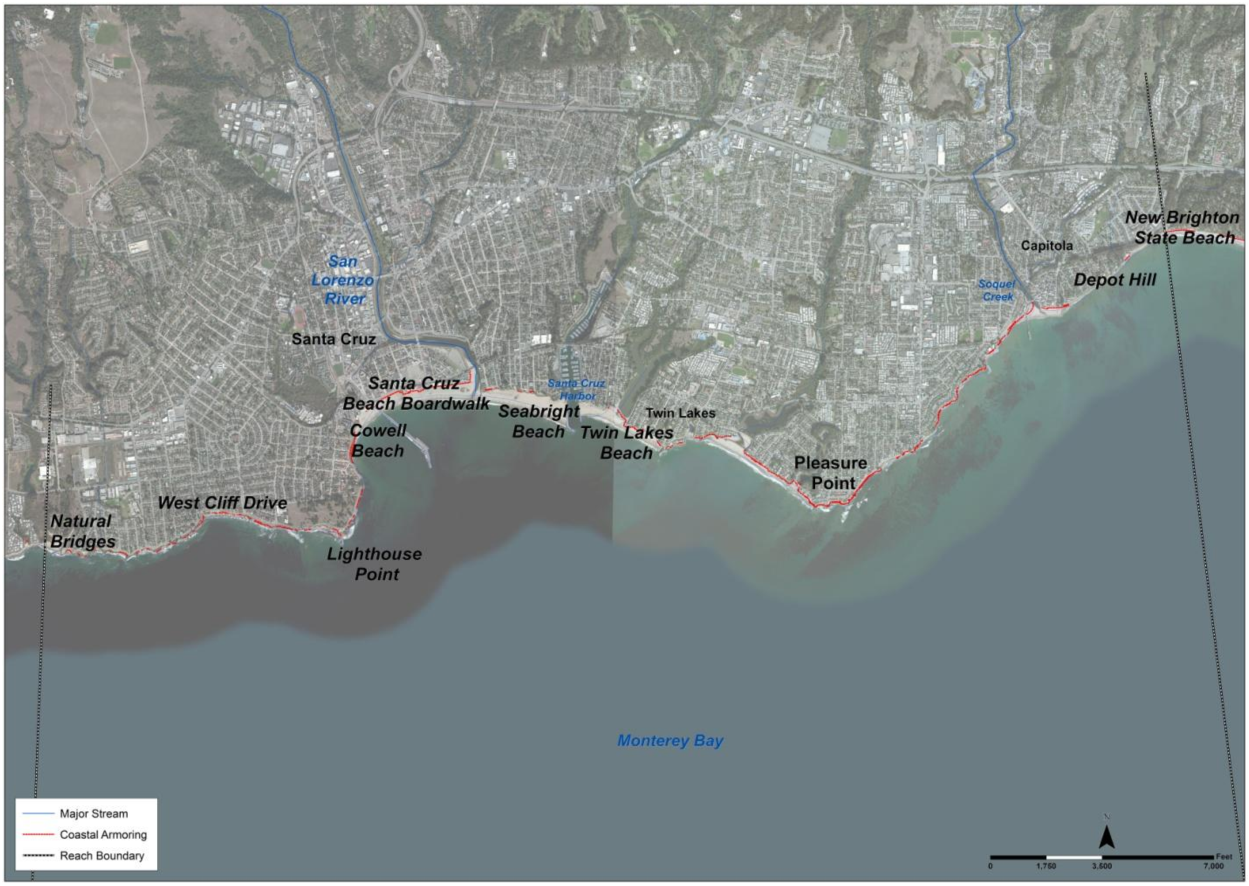


Figure 2-9. Natural Bridges to New Brighton State Beach

The widest beaches are typically found at the mouths of streams or in locations immediately updrift (north) of features that trap sand such as headlands or jetties (Patsch and Griggs, 2006). These wide beaches, which include the main beach in front of the Santa Cruz Beach Boardwalk, Seabright Beach, and the beach at Capitola, are subject to heavy recreational use. In areas where there are no barriers to littoral transport, beaches are generally narrow or non-existent, as is the case of the shoreline running north from Lighthouse Point to Cowell Beach, and from Pleasure Point to Capitola (Patsch and Griggs, 2006). Seacliffs in these areas are particularly vulnerable to erosion, as they are subject to direct wave attack.

The sea cliffs in the immediate vicinity of Natural Bridges are composed of Santa Cruz Mudstone, and are subject to comparatively modest erosion rates of up to 4- to 8-inches per year. The Santa Cruz Mudstone dips below the younger and more erosive Purisima Formation approximately 1 mile east of Natural Bridges, and this transition is marked by the more pronounced indentations in the coastline east of this point (Griggs et al., 2005). Over the past century or so, the Purisima Formation bluff tops have been subject to significant development including residences, roads, and other infrastructure. This development combined with relatively rapid cliff erosion rates of up to 2 feet per year (Hapke and Reid, 2007), has resulted in a number of efforts to mitigate or altogether stop cliff erosion.

Altogether, approximately 5 miles, or half, of this reach are protected by shoreline armoring, predominately in the form of riprap (California Coastal Commission, 2005). Significant riprap revetments have been placed at a number of locations, including at the base of West Cliff Drive and along the southwest side of Pleasure Point (California Coastal Record Project, 2012). The rapidly eroding sea cliffs running northeast from Pleasure Point to Capitola have been stabilized by a variety of armoring, including recently installed sculpted soil nail walls between 32nd and 36th Avenues (Santa Cruz County Redevelopment Agency, 2012a, b). Seacliff erosion remains a concern throughout this reach, particularly in the Depot Hill area northeast of Capitola (Griggs et al., 2005).

Beaches in this reach have been subjected to changes in littoral sediment transport, and have responded by adjusting their size to maintain their equilibrium with the altered sand supply. The most significant change in littoral transport occurred as a result of the construction of the Santa Cruz Small Craft Harbor (1962 to 1965). This project included the construction of two rubble-mound jetties, which were designed to stabilize the entrance of the harbor. Actually, these jetties served to disrupt the net eastward littoral drift, with sand becoming trapped on the updrift side of the approximately 1,300-foot-long west jetty.

This impoundment of sand along the west jetty has had two major impacts on beaches in the vicinity: accumulation of excess sand at Seabright Beach and the mouth of the San Lorenzo River, and erosion of beaches southeast (downdrift) of the harbor. The growth of Seabright Beach has provided both protective and recreational benefits, as this section of beach was essentially non-existent prior to the construction of the harbor (Griggs et al., 2005). However, growth of Seabright Beach is starting to affect the mouth of the San Lorenzo River, because excess sand has spread west around San Lorenzo Point and formed a sand bar that blocks the flow path of the river during the dry season (Griggs, 2012). Thus, the flow path of the river is frequently directed toward the west, where it threatens Santa Cruz Beach Boardwalk infrastructure and presents a safety hazard to beach visitors.

This threat to infrastructure and public safety has increased in recent years, with the City of Santa Cruz constructing a berm to redirect the river away from the Santa Cruz Beach Boardwalk in March 2012 (Figure 2-10). This response provided only a temporary solution, with the flow path of the river returning to its previous course by October 2012 (Griggs, 2012).

Figure 2-10. Emergency response to redirect the flow of the San Lorenzo River away from Santa Cruz Beach Boardwalk infrastructure (Source: Griggs, 2012)

The erosion of beaches downdrift of the harbor has primarily been addressed by two measures. Starting in 1965, material dredged from the harbor entrance channel has been placed on the adjacent downdrift beach (Twin Lakes Beach), to supply sand to the beaches to the east (Figure 2-11). The quantity of sand removed from the harbor entrance has averaged approximately 270,000 cy per year since 1997, and factors influencing variations in dredge volumes are discussed in detail in section 2.4.2 (Strelow Consulting and Santa Cruz Port District, 2009). The second measure involved stabilizing the beach fronting Capitola with approximately 2000 truckloads of sand and a 250-foot-long groin at the east end of this beach (Griggs et al., 2005). These efforts have been fairly successful at stabilizing the beaches east of the harbor; although erosion still remains a concern at Twin Lakes Beach, where Santa Cruz County is undertaking a project to stabilize the shoreline (Section 2.5).

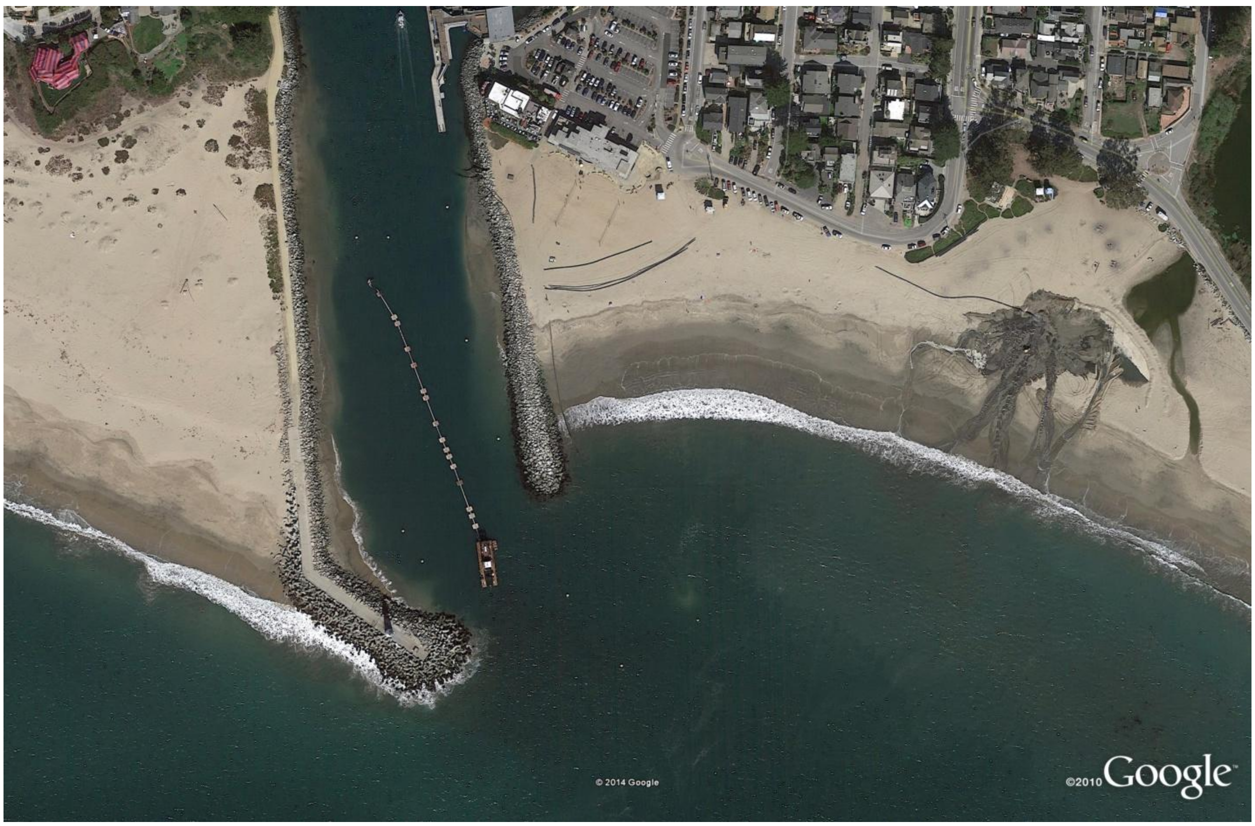


Figure 2-11. Aerial photograph (taken 23 Feb 2014) showing typical maintenance dredging operations at Santa Cruz Harbor. Source: Google Earth, 2015.

2.3.7 New Brighton State Beach to Moss Landing

The approximately 15-mile-long reach from New Brighton State Beach to Moss Landing is characterized by a long stretches of relatively wide beaches backed by an uplifted marine terrace in the north (Figure 2-12), transitioning to relict and active sand dunes in the south (Griggs et al., 2005). The northern portion of this reach has experienced extensive residential development, whereas the southern section is characterized by agricultural activities and scattered resort development. The southern end of this reach is defined by the head of the Monterey Submarine Canyon at Moss Landing, which also serves as the southern boundary of the Santa Cruz Littoral Cell. Here, three branches of the canyon extend to within 300 feet of the shoreline, and effectively capture the remaining littoral drift (Best and Griggs, 1991).

Figure 2-12. New Brighton State Beach to Moss Landing

The beaches lining the northern section of this reach are largely sheltered from northwesterly wave energy by the headlands in Santa Cruz, resulting in a favorable environment for sediment deposition and relatively wide beaches (Griggs et al., 2005). These beaches have proved attractive to recreation and development, with extensive residential and recreational facilities constructed on sections of the back beach from Pot Belly Beach south through Rio Del Mar. These properties are typically protected from inundation and wave attack by a wide beach, but have been subject to extensive damage from inundation and wave attack when large waves, unencumbered by headlands, approach from a westerly or southwesterly direction. This scenario, combined with unusually high astronomical tides, resulted in the destruction of a number of properties during the storms of January 1983 (Griggs et al., 2005). As a result, nearly all of the development on the back beach from New Brighton State Beach to Rio Del Mar is protected by some form of armoring, including riprap, a variety of bulkheads, and a large seawall (California Coastal Records Project, 2012).

South of Aptos Creek, the marine terrace transitions from the sandstones of the Purisima Formation to bluffs composed of significantly less-consolidated relict dune sand (Griggs et al., 2005). These bluffs are particularly prone to erosion due to a number of causes (heavy rainfall, seismic activity, or wave attack), with erosion rates exceeding 2 feet per year in the vicinity of Manresa State Beach (Hapke and Reid, 2007). The bluffs then gradually transition in active sand dunes in the vicinity of Sunset State Beach extending south to the Pajaro River. Some development has occurred on active dunes, including the Pajaro Dunes development, located just north of the mouth of the Pajaro River. Sand dunes in this area have been subject to significant erosion during severe storm events, followed by accretion during more quiescent periods. In response to severe erosion during the storms of January 1983, riprap has been placed along approximately 1 mile of shoreline fronting the Pajaro Dunes development (Griggs et al., 2005; California Coastal Records Project, 2012).

Like the San Lorenzo River, the Pajaro River supplies a substantial amount of sand to the Santa Cruz Littoral Cell – an estimated average annual contribution of 60,500 cy (Patsch and Griggs, 2007). This sand supply feeds the wide beaches and active dunes that characterize the undeveloped shoreline from the Pajaro River to Moss Landing. This sand remains in the littoral cell relatively shortly, however, because it can only travel 2.5 to 3 miles to the south before nearly all of it is captured by the head of the Monterey Submarine Canyon.

There is also a relatively small amount of sand and finer sediments that accumulate in Moss Landing Harbor, and the USACE currently dredges the entrance and lagoon channels on a 3-year cycle (USACE, 2014c). The average volume of material dredged from the federal channels is approximately 54,000 cy, with clean sands often directed to a beach nourishment site on the South Spit. The sand is typically placed on the beach via a pipeline, with just over 46,000 cy of sand placed during the last nourishment episode in 2007. However, sand and other dredged material has also been transported to a site (SF-12) located approximately 11,000 feet offshore in depths of 100 to 150 feet, as this site has been designated as the least costly practicable alternative for placing clean material (Figure 2-13). It should also be noted that in April 2007, the Environmental Protection Agency (EPA) designated a new federal dredged material placement site (SF-14), which is located approximately 1.3 nautical miles offshore.

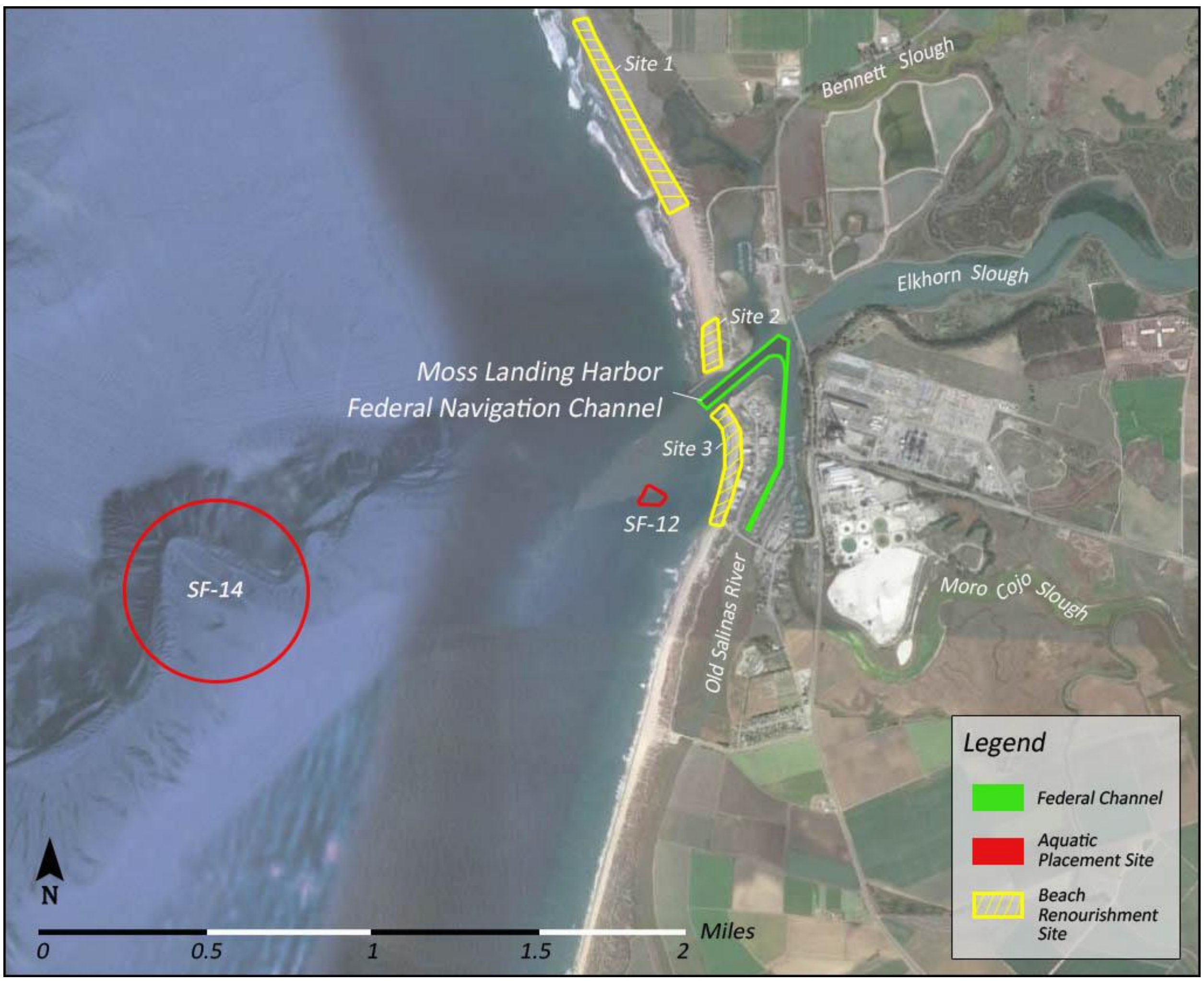


Figure 2-13. Moss Landing dredged material placement sites and beach nourishment sites. Source: USACE, 2014c

2.4 Sand Budget

As described in the previous section, the Santa Cruz Littoral Cell contains a variety of sand sources, sand sinks, and physical features that affect littoral transport. To examine the overall state of the littoral cell and determine if there are any trends with implications for regional sediment management, it is necessary to develop a sand budget for the entire littoral cell.

The formulation of a sand budget involves a considerable amount of uncertainty as it is often difficult to directly measure and account for all sand sources, sinks, and transport paths. In the case of the Santa Cruz Littoral Cell, there has been considerable research focused on understanding the local coastal environment, including several estimates of net sediment delivery and transport throughout the cell (e.g., Best and Griggs, 1991). Much of this research was summarized in a 2007 report prepared for the CSMW (Patsch and Griggs, 2007), and the findings from this report will serve as the basis of for discussing the major elements of the Santa Cruz Littoral Cell sand budget.

2.4.1 Sand Sources

As in most California littoral cells, research suggests that the primary source of sand is delivery from coastal streams. For the Santa Cruz Littoral Cell, the San Lorenzo River and the Pajaro River likely supply over half of the total sand input. Recently CSMW-funded research efforts (Patsch and Griggs, 2007; Slagel and Griggs, 2008) used suspended sediment ratings curves to estimate annual sand delivery from the San Lorenzo River (89,000 cy) and Pajaro River (64,000 cy). But, there can be considerable error – approximately ±40% – associated with the suspended sediment rating curve method. In addition, recent sediment transport modeling over a 50-year period estimated that the annual sand contribution from the San Lorenzo River is approximately 30,000 to 60,000 cy, depending on the volume of stream flow (USACE, 2014a; Snyder, pers comm., 2014). In light of this uncertainty, this Plan will use the fluvial input numbers developed by Patsch and Griggs (2007), with the caveat that the fluvial input estimates are approximate.

There is significantly less information regarding fluvial sediment inputs from the smaller streams that drain the mountainous coast from Santa Cruz north to Tunitas Creek (Aiello, pers. comm., 2014). It is likely that these streams contribute far less sediment than the San Lorenzo River, with research suggesting annual sediment discharges of 1,300 to 2,500 cy from Waddell and Scott Creeks (Best and Griggs, 1991).

As discussed above, it has been well documented that fluvial sand delivery is episodic in nature in California, with both seasonal and longer-term variability in stream flow and associated sediment delivery (Inman and Jenkins, 1999). On a seasonal basis, the greatest stream flows tend to occur in winter months, when coastal California is subject to periods of rainfall associated with storms originating over the Pacific Ocean. In addition, there is considerable inter-annual variability in precipitation and stream flow, with some winter seasons characterized by prolonged periods of storminess and heavy rainfall. As previously discussed, these anomalously stormy conditions are often associated with El Niño conditions in the Pacific Basin, suggesting that there is a link between climatic variability and the delivery to and movement of sand in a given littoral cell.

The construction of dams in coastal watersheds may reduce sand delivery by creating a favorable environment for sediment deposition behind the dam, which effectively impounds sand that would otherwise reach the coast. There is one notable dam within the coastal drainage basins of the Santa Cruz Littoral Cell, the Newell Dam, which blocks a tributary of the San Lorenzo River to form the Loch Lomond Reservoir. Previous studies (e.g., Willis and Griggs, 2003) estimated that the Newell Dam reduced the sand supply on the order of 1,000 to 2,000 cy per year, and this number was incorporated into the sand budget prepared by Patsch and Griggs (2007). Slagel and Griggs (2008) have estimated that the Newell Dam has reduced the average annual sand and gravel flux from 106,000 cy per year to 89,000 cy per year, with an estimated total of 770,000 cy of sand trapped behind the dam (Slagel and Griggs, 2008). The sand budget developed for this Plan assumes that the construction of Newell Dam has reduced sand and gravel flux by approximately 17,000 cy per year.

When compared to river inputs, it has been estimated that bluff and gully erosion supply relatively modest amounts of sand to the cell (Patsch and Griggs, 2007). Bluff erosion rates are highly spatially and temporally variable throughout the cell, depending on localized variations in geology and the magnitude and frequency of erosion-inducing episodic events (Griggs et al., 2005). In particular, the Purisima formation and Santa Cruz mudstone are composed of fine grain sediments, which contribute a negligible amount of littoral sized sand to the cell (Patsch and Griggs, 2007; Weber, personal communication, 2014). The CSMW report estimated that bluff and gully erosion contributed 33,000 and 8,000 cy annually. These estimates are based on relatively old studies (e.g., Best and Griggs, 1991), and should be updated to reflect the emerging understanding (via new technologies such as LiDAR) of sea cliff and gully erosion in the cell.

Armoring of coastal bluffs can reduce the amount of sand entering a littoral cell by effectively impounding sand under or behind structures, and this process has been well documented along a number of sections of the California coast (Runyan and Griggs, 2003). Historically, coastal bluffs contributed approximately 41,000 cy/yr of sand to the Santa Cruz Littoral Cell, but it has been estimated that armoring has reduced this annual contribution by around 20% to approximately 33,000 cy per year (Patsch and Griggs, 2007).

In addition to river inputs and bluff erosion, the Santa Cruz Littoral Cell has been supplied with sand from the erosion of the 12 to 18 million cy of sand between Point Año Nuevo and Año Nuevo Island. This sand reserve (Año Nuevo Sand Reserve or ANSR) has supplied an additional 50,000 cy/yr of sand to the cell, and a number of beaches downdrift of Point Año Nuevo increased in width in response to this introduction of additional sand (Hapke et al., 2006). This increase in beach width may only be temporary; a number of researchers have proposed that this “sand reserve” has now been depleted, and have suggested that increased erosion of downdrift beaches will become more likely in the future (Griggs et al., 2005; Weber, 2014, personal communication). In their sand budget, Patsch and Griggs (2007) assume that the Santa Cruz Littoral Cell is no longer receiving any sand from ANSR, resulting in a net decrease of 50,000 cy/yr of littoral input.

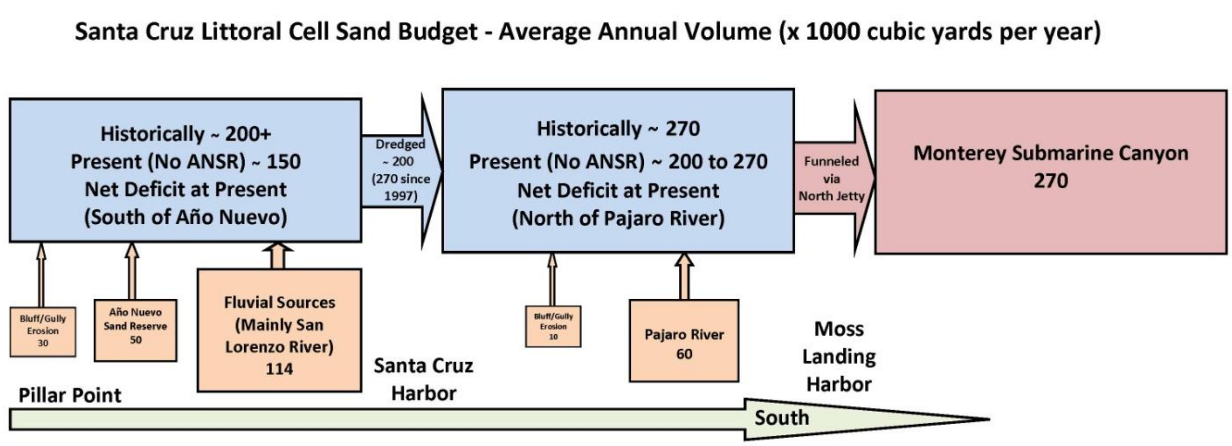


Figure 2-14. Sand budget for the Santa Cruz Littoral Cell, developed with data from Patsch and Griggs (2007), Slagel and Griggs (2008), and Santa Cruz Port District (2014)

2.4.2 Sand Transport

As described in Section 2.2.1, sand transport in the Santa Cruz Littoral Cell is from northwest to southeast. The rate at which this sand is transported is an important factor in developing a sand budget, and has implications for a variety of coastal engineering activities such as maintenance of harbor entrance channels and beach nourishment. Maintenance dredging of harbor entrances stabilized by jetties or breakwaters typically involves removing sand that has accumulated as a result of the structures disrupting net littoral drift. Thus, records of the sand removed from harbor entrances can provide reasonable estimates of the net littoral drift rate.

Dredging records from Santa Cruz Harbor show that there has been a general trend of increasing volumes in recent years, with an annual average of 270,000 cy per year removed from 1997 to 2014 (Santa Cruz Port District, 2014). This trend of increasing dredge volumes can be attributed to changes in dredging operations that allowed for more sediment to accumulate in the channel, and natural variability of storm activity. The 2009 Santa Cruz Harbor Dredge Management Plan describes four distinct phases of entrance channel dredging activities, with the most recent phase (1997 to 2014) characterized by a deepened channel that is open nearly all winter (

Table 2-2; Strelow Consulting and Santa Cruz Port District, 2009). This deepened channel effectively traps and allows little bypassing of sand, and therefore the dredge volumes from 1997 to the present likely offer the best representation of littoral drift in this section of the Santa Cruz Littoral Cell.

Table 2-2: Summary of dredge volumes from the Santa Cruz Harbor entrance channel, 1965 to 2007. Source: Strelow Consulting and Santa Cruz Port District (2009); and Santa Cruz Port District, 2014

YEAR	VOLUME	REMARKS
1965	70,000	
1966	34,000	1964 to 1976:
1967	57,000	USACE average/year was based on one-time dredging of the harbor in spring. The harbor was shoaled in from November to December each year. The shoaled condition acted as a seal and limited sand from entering the harbor.
1968	60,000	
1969	79,000	
1970	94,700	
1971	108,300	
1972	90,000	Total: 951,000 cy for 12 years
1973	109,000	
1974	60,000	Annual Average: 79,300 cy/yr
1975	91,000	
1976	98,000	
1977	199,000	
1978	55,000	1977 to 1986:
1979	162,000	USACE contracted multi-phase dredging –
1980	190,300	Two to four dredging episodes per year. This kept the entrance channel clear for more of the time, but also allowed more sand to enter and settle in the harbor entrance.
1981	187,700	
1982	138,200	
1983	154,500	

Year	Volume	Remarks
1984	79,500	Total: 1,518, 700 cy for 10 years
1985	145,200	Annual Average: 152,000 cy/yr
1986	207,300	
1986-87	206,400	1986 to 1996:
1987-88	230,400	Santa Cruz Harbor assumes dredging responsibility with continuous dredging from November to April each year. System maximizes open channel and also allows significantly more sand to enter into the deepened channel.
1988-89	214,500	
1989-90	173,600	
1990-91	163,300	
1991-92	220,600	
1992-93	124,300	
1993-94	234,400	Total: 1,958, 300 cy for 11 years
1994-95	170,700	
1995-96	101,900	Annual Average: 178,000 cy/yr
1996-97	118,200	
1997-98	399,310	1997 to 2014:
1998-99	317,900	Santa Cruz Harbor assumes dredging responsibility with continuous dredging from November to April each year. System maximizes open channel and also allows significantly more sand to enter into the deepened channel. More frequent Pacific storms are attributed to the increase in volumes during the 1997-2014 period.
1999-2000	340,900	
2000-01	195,050	
2001-02	238,400	
2002-03	342,220	
2003-04	290,800	
2004-05	160,330	
2005-06	245,220	Total: 4,598,000 cy for 17 years
2006-07	226,000	
2007-08	243,700	
2008-09	210,960	
2009-10	456,830	Annual Average: 270,500 cy/yr
2010-11	331,727	
2011-12	270,441	
2012-13	185,684	
2013-14	112,000	

Dredge volumes from 1997 to 2014 have exhibited considerable temporal variability, with a maximum of 456,830 cy removed in 2009-2010 and a minimum of 112,000 cy removed in 2013-2014 (Figure 2-15). The greatest dredge volumes all tended to occur during winters characterized by El Niño conditions (e.g., 2009-2010), which are typically associated with increased storminess, rainfall and sediment delivery to the coast. In addition, the increase in storm activity may also enhance littoral drift rates via larger waves and associated longshore currents (Strelow Consulting and Santa Cruz Port District, 2009). Thus, nearshore sand transport is similar to fluvial sand delivery in that climatic variability likely plays an important role in explaining much of the temporal variability.

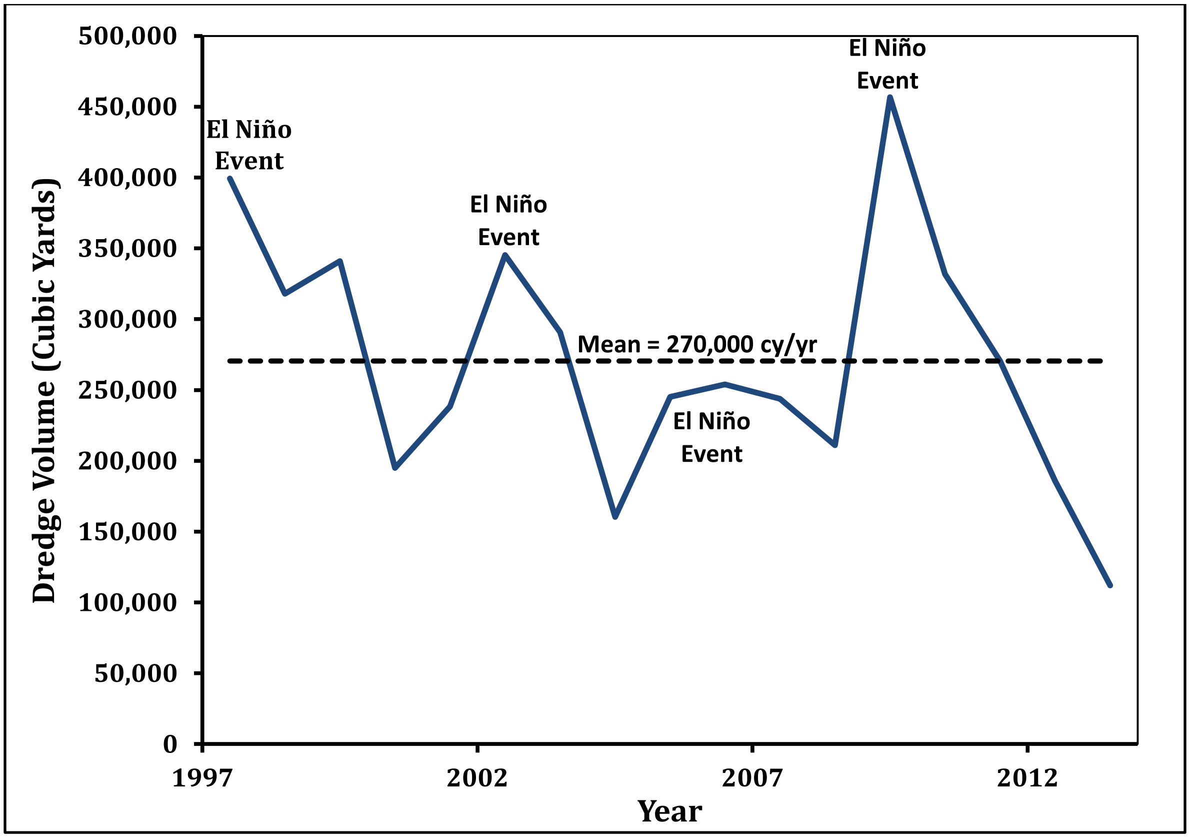


Figure 2-15. Dredge volumes from the Santa Cruz Harbor Entrance Channel, 1997 to 2014. Data source: Santa Cruz Port District (2014).

2.4.3 Sand Sinks

The head of the Monterey Submarine Canyon approaches the shoreline at Moss Landing, where the harbor entrance is stabilized by a pair of jetties. The north jetty, which is approximately 1,520 feet long, extends several hundred feet into the head of the canyon, where it effectively funnels littoral drift sand from the north into the canyon (Figure 2-16; Smith et al., 2007). Although there may be rare instances when sand is able to bypass the mouth of Moss Landing Harbor, this Plan was formulated under the assumption that the head of the canyon serves as the primary sand sink for the cell. But, there are still a number of details to be worked out regarding the timescale of sand transport down the canyon (Aiello, personal communication, 2014), and this topic has been the subject of recent research efforts (e.g., Stevens et al., 2014).

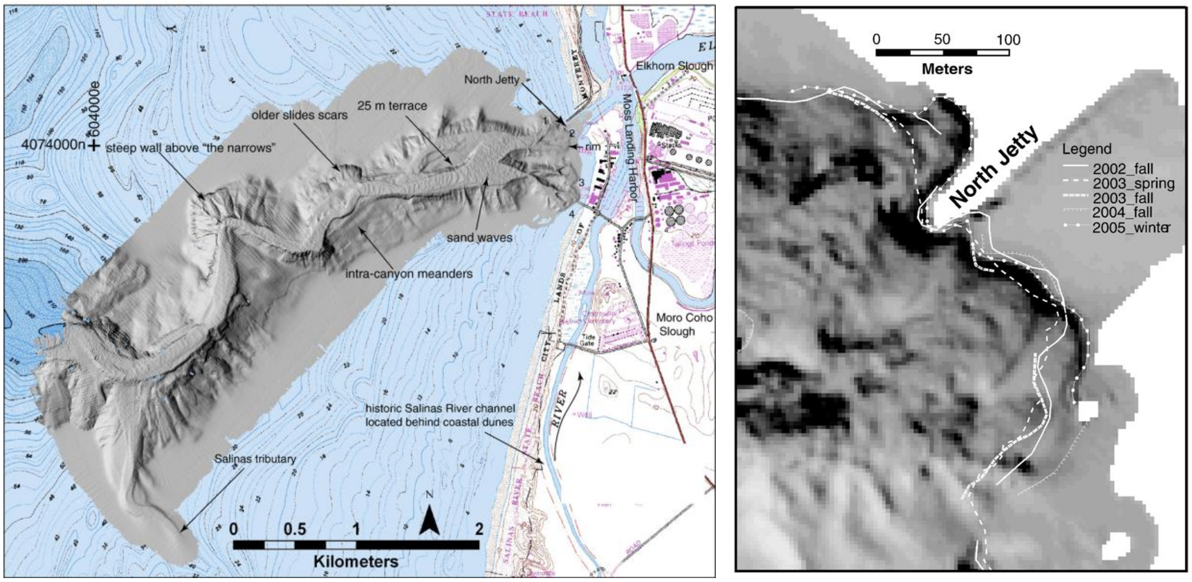


Figure 2-16. (a) Location of the Monterey Submarine Canyon, and (b) shaded digital elevation model (DEM) showing the North Jetty extending into the head of the Monterey Submarine Canyon. Source: Smith et al. (2007).

The sand budget outlined in Figure 2-14 suggests that approximately 270,000 cy per yr of sand enter the canyon and are permanently removed from the littoral cell. Given the assumption that a large amount of sand is entering the canyon, there has been some interest in finding ways to capture sand before it is lost from the littoral cell. For example, a report was prepared several years ago that outlined three potential sand capture concepts (Moffatt & Nichol et al., 2009). The first concept involved utilizing jet pumps to redirect sand originating in the north away from the head of the canyon and towards the beach south of the jetties. This sand could then be transported east to Parsons Slough (Elkhorn Slough) or south into the Southern Monterey Bay Littoral Cell. The second and third concepts would involve utilizing a breakwater and hopper dredge, respectively, to capture sand coming from the south before it enters the canyon head, and back-passing the sand south into the Southern Monterey Bay Littoral Cell. In the absence of the implementation of these concepts, this Plan will assume that sand will continue to be lost to the Monterey Submarine Canyon at the present rate.

There are several other minor sediment sinks in the Santa Cruz Littoral Cell, but they have not been incorporated into the Patsch and Griggs (2007) or this Plan's sand budget. Sand may transported offshore onto the continental shelf, but this process is still poorly understood and it is typically assumed that there is no net loss or gain from this process (Patsch and Griggs, 2007). Sand may also be permanently removed from the littoral cell if wind pushes it inland onto permanent dunes; however, active dunes are present only along a small section of the coastline in the cell, and rates of sand transport onto these dunes have not yet been quantified.

Sand and finer sediment may also become impounded in coastal lagoons and marshes as a result of infrastructure altering the form and functions of these environments. This is the case in the lowest reach of Waddell Creek, where the channel bed experienced 7.5 feet of accretion following construction of Highway 1 across the creek mouth (ESA-PWA and SWCA, 2012). Finally, the mining of sand from the Año Nuevo area in the 1950s was not well documented, so it is unknown how much sand was removed by this practice (Lajoie and Mathieson, 1985; California State Parks, 2012).

2.4.4 Implications for Regional Sediment Management

The sand budget of the Santa Cruz Littoral Cell has undergone a number of changes over the past several decades, and these changes have implications for the future of beaches and RSM in the cell. The most significant of these changes is the depletion of the Año Nuevo sand reserve, which temporarily supplied beaches south of Point Año with additional sand resulting in accretion of number of beaches fronting northern Monterey Bay. These increases in beach width likely played a role in encouraging additional coastal development by providing wide back beach areas, and by supplementing protective beaches at the base of sea cliffs. Undoubtedly, beaches in this area will begin to adjust to the reduced sand supply through reductions in beach size, with this erosion further exacerbated by projected sea-level rise.

This combination of reduced sand supply and sea-level rise is expected to place a considerable amount of infrastructure at risk from inundation and increased wave attack. There are several sediment management measures that could be used to reduce risk to coastal infrastructure. Beach nourishment is perhaps the most well know of these measures, and it is currently practiced as part of the operations of the Santa Cruz Small Craft Harbor. Other measures include construction of structures designed to retain sand on a given beach and could include groin features or submerged breakwaters or multipurpose artificial reefs. This Plan identifies those areas where critical infrastructure is at risk and could potentially benefit from a variety of sand-management measures.

In addition to addressing infrastructure concerns, this Plan also examines sediment management issues involving impaired ecological functions at stream mouths and associated coastal lagoons. This situation occurs at several locations within the Santa Cruz Littoral Cell, where coastal infrastructure (e.g., highways) have disrupted and greatly constrained the natural sediment exchange between marsh-lagoon complexes and the open coast. Thus, this Plan identifies sediment management measures that can seek to restore natural sediment processes, to the extent practicable by infrastructure constraints.

2.5 Recent and Ongoing Projects and Studies

There are several recent and ongoing projects and studies targeted to address problems involving coastal erosion in the Santa Cruz Littoral Cell. Several government agencies have sponsored various phases of projects, including the City of Santa Cruz, Santa Cruz County, and USACE. This summary is based on a brief search of local government agencies internet sites, and is by no means a complete list of ongoing or potential future projects with implications for RSM. Close coordination with local governmental agencies and stakeholders will be critical in identifying future projects that can compliment or benefit from recommendations in this Plan.

2.5.1 Plan Princeton

The County of San Mateo is currently in the process of updating the land use plan for Princeton, which is an unincorporated community located along the northern shoreline of Pillar Point Harbor. To date, an Existing Conditions Report has been released that discusses the ongoing shoreline erosion problem and several erosion mitigation measures including a rock revetment, boardwalk, and beach fill anchored by groin(s) or a geotube (Noble Consultants in Dyett & Bhatia, 2014). These measures closely mirror those originally recommended in the 2001 shoreline protection feasibility study (Moffatt & Nichol, 2001), and will be considered during the formulation of this plan.

2.5.2 North Half Moon Bay Continuing Authorities Program (CAP) 111 Study

At the northern end of the Santa Cruz Littoral Cell, USACE is currently involved in a study of potential solutions to beach and bluff erosion just south of Pillar Point Harbor (USACE, 2009). The study, which is currently in the feasibility phase, evaluates which (if any) erosion mitigation measures are economically justified investments. Several erosion mitigation measures have been modeled with the USACE Coastal Modeling System (CMS) software, including beach nourishment and modifications to the East Breakwater. Preliminary findings suggest that dredging 150,000 cy of sand from Pillar Point Harbor and placing it at El Granada County Beach (Surfer's Beach) could provide considerable erosion mitigation effects for a period of several years (USACE, 2014b). At this time, there has been no selection of a specific plan, and there is considerable uncertainty of which (if any) actions will be recommended by this study (J. Dingler, pers. comm., 2014).

2.5.3 Highway 1 Stabilization at El Granada County Beach

The beach and bluff erosion at El Granada County Beach (Surfers Beach) is also threatening to undermine Highway 1 and public access to the beach. As a result, Caltrans and the County of San Mateo have jointly developed several short-term approaches to protect the highway and improve the coastal access (Whitman, pers. comm., 2014). The primary approach will involve the construction of 175 linear feet of rock revetment with improvements to approximately 400 feet of the California Coastal Trail and stairway access (California Coastal Commission, 2015).

The timeline for this project is rather short, with the relevant parties hoping to have construction completed before the onset of winter storms in December 2015 (Calderon, pers. comm., 2015). Design work is nearly complete, and a Coastal Development Permit (CDP) amendment was approved with a number of special conditions by the California Coastal Commission on 12 June 2015. Key special conditions include authorization of the revetment for only a ten-year period with the requirement that the applicant re-assess the project's impacts if an extension of the permit is sought, and the requirement that the applicant develop of a long-term plan to address erosion and protect Highway 1 and the public pathway (California Coastal Commission, 2015).

Given the need for a long-term solution, Caltrans is also considering several long-term approaches including relocation of the highway along with a component of managed retreat (Whitman, pers. comm., 2014). Several examples of these type of long-term approaches are outlined in a safely and mobility study that was released in 2010, and include plans to realign Highway 1 away from the coastal erosion hazard zone (Local Government Commission et al., 2010).

2.5.4 Pescadero-Butano Watershed Studies and Pescadero Lagoon Science Panel

There has been considerable attention directed at sediment management issues in the tributaries that drain into the Pescadero Marsh, and two government agencies have played a lead role in facilitating research to address these issues. The San Francisco Bay Regional Water Quality Control Board (SF RWCQB) is the process of developing a total maximum daily load (TMDL) of sediment for the Pescadero-Butano watershed, which has been designated as a sediment impaired watershed. Research conducted in support of development of the TDML suggests that upstream sediment delivery to Pescadero Marsh is 15 times greater than the historic average prior to significant human modification of the watershed (Frucht, 2015).

In addition to adverse impacts on water quality, the increase in sediment delivery from the watershed has resulted increased flood risk along lower Butano Creek by reducing hydraulic capacity of the channel. The problem is most acute in the vicinity of the Pescadero Road Bridge, and the San Mateo County Resource Conservation District (SMCRCD) led the effort to understand and develop a plan to reduce flood risk (cbec eco engineering and Stillwater Sciences, 2014). This reduced hydraulic capacity has resulted in relatively frequent flooding in the vicinity of the Pescadero Road Bridge, and there has been a perception in the community that this flooding was exacerbated by sediment accumulation farther downstream in Pescadero Marsh (Largier, pers. com., 2014). However, the research effort led by the SF RWQCD (Frucht, 2015) has concluded that the frequent flooding of Butano Creek can be attributed to excess sediment generated by land use changes in the upper reaches of the watershed, and is not influenced by coastal processes in Pescadero Marsh (Largier, pers. comm., 2014).

The Pescadero Marsh and Lagoon presents another set of sediment management challenges. As a result, the California Department of Parks and Recreation has formed an independent science panel, the Pescadero Lagoon Science Panel, to evaluate the physical and biological characteristics of the lagoon and marsh ecosystem (Largier, pers comm., 2014; California State Parks, 2015). The findings of the panel will be summarized in a report, which will be released to the public at an unspecified future date.

2.5.5 Maintenance of Highway 1 at Waddell Bluffs

An approximately 1-mile-long section of Highway 1 is vulnerable to undercutting from wave attack and high flows from Waddell Creek and blockage from sediments (primarily via rock fall) originating in the adjacent Waddell Bluffs. As a result, Caltrans has employed several measures to manage these sediment issues, including the installation of a rock revetment below Highway 1 and the active bypassing of approximately 22,000 cy of mudstone talus originating from the Waddell Bluffs into the ocean below the highway (ESA PWA and SWCA, 2012). This second measure is accomplished by clearing out talus that has accumulated in the cable net attenuation fences between the highway and the bluffs, and directly pushing the material across the highway and into the ocean (Gorman, pers. comm., 2014). This measure, which is conducted under a standing permit with the California

Coastal Commission and Monterey Bay National Marine Sanctuary, presents a good example of an infrastructure maintenance practice that seeks to restore a natural process.

2.5.6 Comparative Lagoon Ecological Assessment Project (CLEAP)

Physical modifications have degraded the ecological function of a number of coastal lagoons in Santa Cruz County, and this issue has garnered considerable attention from the environmental and science communities, In 2003, the CLEAP effort was launched to facilitate collection of physical, biological, and chemical data to "refine the tools available to evaluate relative lagoon condition, provide insight to lagoon function, improve our enhancement strategies for these unique ecosystems and focus future adaptive management efforts" (2nd Nature, 2006). There were several key findings from the CLEAP study with respect to sediment management, including the recommendation to remove barriers to connectivity between lagoons and the open coast to facilitate sediment exchange and allow natural processes to re-establish a new morphologic regime. This recommendation has in turn informed the planning process for the proposed Highway 1 bridge replacements at Scott and Waddell Creeks (ESA PWA and SWCA, 2012; Sections 8.4 and 8.5).

2.5.7 City of Santa Cruz Climate Adaptation Plan

The City of Santa Cruz has developed a Climate Adaptation Plan as an update to the Local Hazard Mitigation Plan (City of Santa Cruz, 2011). This plan includes an assessment of the vulnerability of coastal infrastructure to sea level rise, such as the relatively low sections of West Cliff Drive at the Bethany Curve Bridge (Griggs and Haddad, 2011). The plan also proposes an adaptation strategy with a number of action items ranked by priority. One of these "high priority" action items could involve dredging and other sediment management activities in the San Lorenzo River. Potential sediment management activities involving the San Lorenzo River are further discussed in Sections 2.5.8 and 4.4.5.

2.5.8 San Lorenzo River Mouth Section 216 Study

The USACE is currently involved in a study of the impacts of excessive accretion of sand at the mouth of the San Lorenzo River. This study is in the Initial Appraisal phase, where it will be determined if it is appropriate for USACE to modify the existing San Lorenzo River flood risk damage reduction project (Schrader, pers. comm., 2014, USACE, 2014a).

2.5.9 Santa Cruz Harbor Dredging and Beach Nourishment

As discussed in Section 2.4.2, the Santa Cruz Port District dredges the entrance channel on an annual basis. The dredging is typically accomplished with the Port District owned and operated dredge plant during the winter or early spring months, as the dredging season is confined to November 30 to April 1 per the 10 year USACE permit issued in 2012 (Red Hills Environmental, 2012). The Santa Cruz Port District continually evaluates the effectiveness and impacts of dredging operations, particularly with respect to any issues that arise at Seabright Beach.

One current issue involves nuisance-level odor emitted by hydrogen sulfide (H_2S) gas that is released by organic material in material dredged from the entrance channel. As a result, the Port Commission is considering changes in dredging operations that will minimize odor, and it recently released a study that evaluated eight modifications to existing dredging operations (Moffatt & Nichol and Kinnetic Laboratories, 2011). Several of these options could have implications for the efficacy of beach nourishment at Twin Lake Beach, and coordination with the Santa Cruz Port District is essential in the development of this Plan.

2.5.10 Twin Lakes Beachfront Project

The County of Santa Cruz is currently designing a project to address beach erosion and enhance public access at Twin Lakes Beach, east of the Santa Cruz Small Craft Harbor. The Twin Lakes Beachfront Project will involve construction of a shore protection structure that will match the adjacent Purisima Formation sea cliffs in appearance, and allow for public access (CCC, 2013). The project was approved by the CCC on 15 August 2013, with construction not scheduled to begin until 2015 at the earliest (Hoppin, 2013). The project recently received a $250,000 grant from the SCC, which provided the final portion of the funding necessary for construction (Clark, 2014). Since this project would involve additional armoring of the shoreline, it is necessary for this regional sediment management plan to evaluate the potential effects of this plan on adjacent beaches.

2.5.11 East Cliff Drive Bluff Protection and Parkway Project

The East Cliff Drive Bluff Protection and Parkway Project, was completed in November 2010 (Santa Cruz County Redevelopment Agency, 2012a). This project, which was constructed by Santa Cruz County, involved the installation of a soil nail wall along with the removal of riprap and rubble at the base of the sea cliff. This project originated as a USACE study in the early 1990s, which was initially authorized to address the impacts of erosion related to the Santa Cruz Small Craft Harbor (USACE, 1992). The study culminated in a Detailed Project Report and environmental documents, which essentially recommended the features constructed by Santa Cruz County (USACE, 2003).

2.5.12 City of Capitola

Maintenance of the main beach at Capitola (Capitola City Beach) and the adjacent Esplanade is a high priority for the City of Capitola. The City of Capitola presently manages the lagoon at the mouth of Soquel Creek through maintenance of a concrete box culvert, known as the “flume”, and construction of a sandbar in the early summer months (D.W. Alley and Associates, 2004). The sand bar is typically constructed around Memorial Day to enhance summer beach use, and the “flume” was designed to allow water to drain from the lagoon to Monterey Bay through the sand bar. The City of Capitola has also expressed an interest in a substantial rehabilitation of the 250 foot long groin that anchors the east end of the main beach, although there are no immediate plans for implementation of this project (Jesberg, pers. comm., 2013).

2.5.13 Elkhorn Slough Tidal Marsh Restoration

The proposed Elkhorn Slough Tidal Marsh Restoration project would restore 145 acres of vegetated tidal salt marsh, upland ecotone, and native grasslands in Monterey County (Elkhorn Slough Tidal Wetland Project Team, 2012b; Fountain, pers. comm., 2014). The project site includes 104 acres of former tidal marsh that have experienced approximately 2 feet of subsidence and no longer support extensive areas of vegetated marsh and up to 41 acres of ecotone and native grassland. The overall approach would use imported and onsite sediments to raise marsh and mudflat elevations and restore tidal marsh habitats in these areas. Sediment sources include 50,000 cy from the Santa Cruz County Bench Excavation Project on the Pajaro River, future sources as available, and the hillside adjacent to the marsh.

The entire remnant marsh plain would be raised to a more sustainable elevation, at which emergent wetland vegetation could reestablish and persist. Marsh, ecotone and native grassland would be created in the buffer area along the western edge of the Minhoto-Hester's restoration area. The project would improve marsh sustainability with sea-level rise, as the restored marsh would be higher in the tidal frame, farther from the drowning threshold, and marsh vegetation in the restored areas would accrete organic material that would help the restored marsh plain rise with sea level. The project would also reduce tidal prism in Elkhorn Slough, reducing the potential for ongoing tidal scour and associated marsh loss.

2.5.14 Moss Landing Harbor Dredging

The USACE is currently developing a Dredged Material Management Plan (DMMP) for Moss Landing Harbor (USACE, 2014c). A DMMP is required when it is anticipated that there will be insufficient dredged-material placement capacity over the next 20 years. The DMMP will only investigate additional placement options for contaminated dredged materials, and it is anticipated that the placement of clean sand will continue at the designated beach nourishment sites (Fowler, pers. comm., 2014).

3. BEACH EROSION CONCERN AREAS AND SEDIMENT IMPAIRED COASTAL HABITATS

To ensure consistency with other CSMW products, this Plan utilizes the same terminology as the *California Beach Erosion Assessment Survey 2010* when discussing sediment management. Specifically, this document will utilize the term "Beach Erosion Concern Area" or BECA to describe discrete coastal segments where erosion is currently (or will likely be) a significant concern to government agencies and local stakeholders. As in the case of the *California Beach Erosion Assessment Survey*, the list of BECAs presented in this Plan is a living document in the sense that it will evolve throughout (and possibly after) the Plan's development. The list of BECAs is also stored as a GIS database modeled after the one developed by CSMW (2010). It will be updated as problem statements are refined and new BECAs are identified.

3.1 Identifying Beach Erosion Concern Areas

The BECAs identified by this Plan typically involve significant public infrastructure or private development at risk from coastal erosion within a 50 year planning horizon. Thus, the BECAs are mostly located in the two primary urban centers of the cell (Santa Cruz and Half Moon Bay), with large sections of relatively undeveloped coast devoid of any BECAs (Figure 3-1). The only exceptions involve locations where Highway 1 is threatened by beach and bluff erosion, and development on an active sand dune complex prone to beach erosion. Otherwise, the BECAs are located in areas with significant residential and commercial development and heavy recreational use.

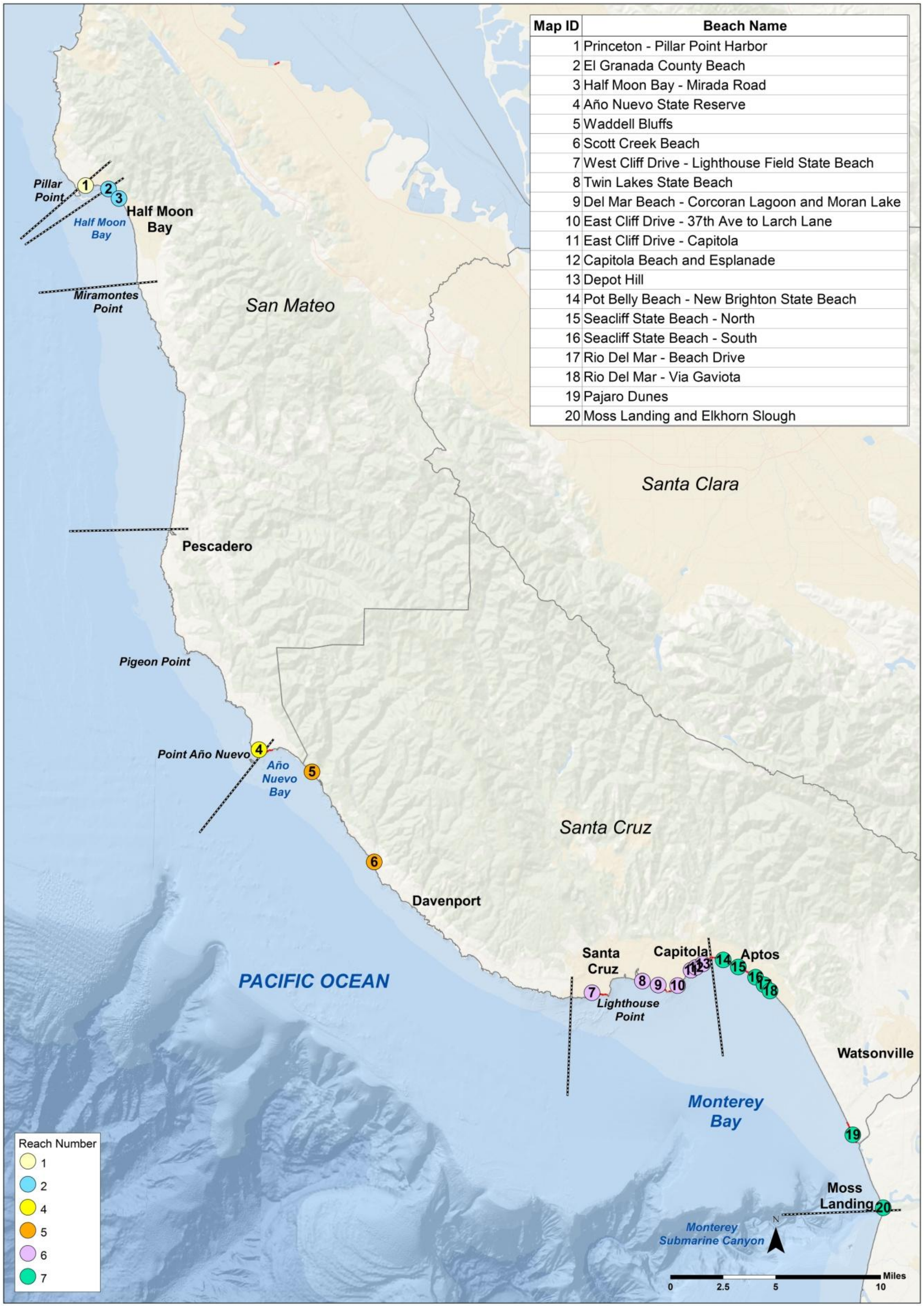


Figure 3-1. Beach Erosion Concern Areas (BECAs) in the Santa Cruz Littoral Cell.

The process of identifying BECAs involved a number of steps including: (1) literature review, (2) GIS analysis, (3) validation of GIS with aerial imagery, (4) reconnaissance site visits to select beaches, and (5) meetings with the Stakeholder Advisory Group (SAG) and the local public. These steps are meant to be iterative, particularly in response to feedback from local interests regarding the nature of problems at individual BECAs. Thus, the BECAs presented in this document are designed to serve as a starting point in helping local communities define problem areas, and thereby develop RSM measures to address coastal erosion.

The first step involved reviewing the literature for descriptions of specific sediment-related erosion problems. Coastal erosion in the Santa Cruz region has been the subject of a number of studies, and a wide range of sources (academic, private industry, local government and USACE) were consulted to compile a preliminary list of BECAs for further investigation. The key findings from the literature review are presented in section 2, which will be updated reflect any significant new studies.

The second step involved a GIS-based mapping and analysis to better define specific BECAs based on risk to public infrastructure and private development. A number of existing GIS datasets were utilized in this analysis, including infrastructure datasets obtained from local agencies and two datasets depicting coastal erosion hazard zones for several sea-level rise scenarios. The first dataset, which was developed by PWA and the Pacific Institute in 2009, depicted coastal erosion hazard zones for two sea-level rise scenarios in 2025, 2050 and 2100 for much of the state of California (Heberger et al., 2009; PWA, 2009). A similar approach was used to develop more detailed coastal erosion hazard zones for the southern half of the littoral cell from Point Año Nuevo to Moss Landing (ESA PWA, 2014).

The results of the GIS analysis include an inventory of infrastructure threatened by erosion and a series of maps showing the relationship between infrastructure and erosion hazard zones. Figure 3-2 provides a visual representation of how major roads (East Cliff Drive) and sewage infrastructure in the vicinity of Santa Cruz Harbor would be threatened by erosion under sea level rise and storm scenarios by 2060. The infrastructure located just inland of Seabright Beach appears to be particularly vulnerable, and County of Santa Cruz is currently designing a project to address beach erosion at this location (Section 2.5.10). Further detailed GIS-based analyses of potential economic losses associated with erosion hazard zones are discussed in Section 7.

Figure 3-2. Scenario based coastal erosion hazard zones (ESA-PWA, 2014) and vulnerable infrastructure (City of Santa Cruz, County of Santa Cruz) at Santa Cruz Harbor and Twin Lakes State Beach. The scenario based hazard zones are a spatial aggregation of dune erosion, cliff erosion, tidal inundation, and storm flood hazard zones.

In the third step of the analysis, various sources of aerial imagery were consulted to validate the infrastructure and erosion hazard zone maps. In general, Google Earth Pro had the most recent aerial imagery, and most of the study area was covered by imagery from October 2011 and May 2012 (Google, 2013). In addition, the detailed oblique photos provided by the California Coastal Records Project (Adelman and Adelman, 2013) were used to verify the locations of armoring and visualize the threat to infrastructure.

Reconnaissance site visits and meetings with the stakeholders and the local public were conducted from the spring 2014 through spring 2015. The first round of SAG and public meetings was held in Santa Cruz on 27 March 2014, with the second round held on 20 May 2014 in Princeton. The meetings were a forum for SAG members and the public to provide feedback on the Plan via in-person comment sessions and in writing. A third of meeting was held in March 2015 just prior to release the draft Plan to the SAG and public.

3.2 Identification of Sediment-Impaired Coastal Habitats

In addition to addressing concerns involving erosion and infrastructure via BECAs, an effective CRSMP should also evaluate how changes in sediment supply and transport can affect sensitive coastal habitats (Figure 3-3). This is a particularly important issue where coastal infrastructure has significantly reduced sediment exchange between coastal lagoon complexes and the open coast. In a typical scenario, the infrastructure in question will serve to trap excess sediment in a given lagoon, with the excess sediment leading to a loss of tidal prism and associated ecological impacts. Thus, these lagoon complexes can be conceptualized as sediment-impaired systems, which will likely require restoration of a more natural connection to the open ocean to facilitate improved ecological function.

In addition to ecological impacts, excess sediment accumulation can also induce flooding through several mechanisms. In the case of Butano Creek, excess sediment accumulation has reduced the hydraulic capacity of the channel and aggravated flooding that threatens infrastructure such as the Pescadero Road Bridge (ESA, 2004; Hammersmark et al., 2014). In the case of the San Lorenzo River mouth, excess sand has redirected the river flow path toward vulnerable infrastructure, such as the Santa Cruz Beach Boardwalk (Griggs, 2012). Although the above scenarios do not necessarily fit into the category of BECAs, they do represent cases where more effective sediment management might be able to mitigate flood hazards and other threats to infrastructure.

Figure 3-3. Sediment Impaired Coastal Habitats (SICHs) in the Santa Cruz Littoral Cell.

The process of identifying SICHs was similar to the five-step BECA identification process. But, the GIS analysis was limited, because coastal erosion hazard zones were not as extensively mapped for a number of the sediment-impaired coastal lagoons north of Point Año Nuevo. Thus, the identification of sediment-impaired coastal habitats heavily relied on formal input from the SAG (Clark, pers. comm., 2014; George, pers. comm., 2014) and the public.

3.3 Problem Assessments at BECAs and SICHs

To focus the RSM planning effort, lists of specific erosion-related problems were developed for each BECA and SICH, and the assessments were summarized (Table 3-1). Problem assessments were formulated to identify the (1) type and cause of the erosion problem or sediment impairment, (2) potential threats to infrastructure, and (3) impacts of erosion or excess sedimentation on public use and access. It is intended for these assessments to serve as a starting point for formulating (and refining) RSM measures that can provide erosion mitigation at specific BECAs and sediment impaired coastal habitats (Section 4). The following discussion provides an overview of erosion problems and sediment impaired coastal habitats in the Santa Cruz Littoral Cell, and detailed problem assessments for specific BECAs and sediment impaired coastal habitats are listed in Table 3-1.

Table 3-1: Problem Assessments at Beach Erosion Concern Areas and Sediment Impaired Coastal Habitats

BECA or SICH	Problem Assessment
Princeton - Pillar Point Harbor (Reach 1)	1. Long-term beach erosion affects habitat, recreation, coastal access, and coastal development in this 0.4 mile section of shoreline. 2. Passive erosion adjacent to areas of development with hardened shoreline prohibits lateral beach access through narrowing of the beach. (Source: CSMW, 2010)
El Granada County (Surfer's) Beach (Reach 2)	1. Bluff erosion occurs during high tides and storm wave activity. 2. Erosion threatens a wetland behind the former parking area, and private development along Mirada Road. 3. Undermining of Highway 1 is imminent. 4. Passive erosion may be contributing to beach width loss because of the presence of rigid structures behind the beach. (Source: CSMW, 2010)
Pescadero Lagoon and Butano Creek	1. Infrastructure associated with Highway 1 has essentially fixed the position of the spit separating the lagoon from the open ocean and effectively traps sediment in Pescadero Lagoon. 2. Sediment accumulation in the Butano Creek has reduced channel and floodplain capacity, which increases the flood hazard in Pescadero.

BECA OR SICH	PROBLEM ASSESSMENT
Waddell Beach and Lagoon (Reach 5)	1. Highway 1 infrastructure has somewhat isolated the lagoon from the open coast, resulting in excessive sediment accumulation, reduced tidal prism, and changes in associated physical parameters (e.g., salinity regime) that affect ecological function. 2. The current configuration of infrastructure has reduced the ability of beach and lagoon habitat to migrate inland in response to anticipated sea-level rise. 3. Wave attack and fluctuations in the flow path of Waddell Creek threaten to undermine Highway bridge abutments. The bridge abutments are currently protected by rock revetments. 4. Wave attack threatens to undermine Highway 1. The California Department of Transportation maintains revetments to protect Highway 1 and associated parking areas.
Scott Creek Beach and Lagoon (Reach 5)	1. Highway 1 infrastructure has somewhat isolated the lagoon from the open coast, resulting in excessive sediment accumulation, reduced tidal prism, and changes in associated physical parameters (e.g., salinity regime) that impact ecological function. 2. The current configuration of infrastructure also has reduced the ability of beach and lagoon habitat to migrate inland in response to anticipated sea-level rise. 3. Wave attack and fluctuations in the flow path of Scott Creek threaten to undermine Highway 1.
West Cliff Drive – Lighthouse Field State Beach, Bethany Curve Bridge (Reach 6)	1. Cliffs east of Almar Drive, which are comprised of the relatively weak Purisima Formation, are subject to erosion from wave attack. 2. Low spots in the cliffs, such as the Bethany Curve Bridge, are subject to wave overtopping during winter storms. 3. Erosion threatens public infrastructure including a bike path, sewer and storm lines, and West Cliff Drive. 4. Small pocket beaches backed by riprap will likely continue to narrow because of sea-level rise (Griggs and Haddad, 2011).
San Lorenzo River Mouth – Main Beach	1. Excess sand accumulation at the San Lorenzo River mouth often directs the flow path of the river toward the west, where it threatens Santa Cruz Beach Boardwalk infrastructure and presents a safety hazard to beach visitors. 2. This excess sand accumulation can be attributed to the west jetty at Santa Cruz Harbor impounding large quantities of sand that would move downdrift (east) under typical natural conditions.
Twin Lakes State Beach (Reach 6)	1. Relatively weak cliffs (Purisima Formation) are subject to wave attack and erosion during winter storm events. 2. East Cliff Drive between 9^{th} and 11^{th} Avenues may experience overtopping during storms. 3. Erosion threatens significant public infrastructure including significant storm drain and sewer lines. 4. Extensive riprap and armoring from 9^{th} to 13^{th} Avenues may contribute to narrowing of the beach, reducing public access and recreational opportunities.

BECA or SICH	Problem Assessment
Del Mar Beach – Schwan Lagoon, Corcoran Lagoon, Moran Lake (Reach 6)	1. Terrace deposits in this area are highly erodible and low in elevation. 2. Erosion primarily threatens private development, and large areas of the erodible bluff are armored with riprap. 3. Extensive riprap and armoring may contribute to narrowing of the beach between Corcoran Lagoon and Moran Lake, reducing public access and recreational opportunities. 4. Infrastructure separating a series of coastal lagoons (Schwan Lagoon, Corcoran Lagoon, and Moran Lake) from the open coast is vulnerable to inundation and damage from wave attack. 5. Infrastructure also impairs natural form and ecological functions of these lagoons.
East Cliff Drive – 37th Ave to Larch Lane (Reach 6)	1. Seacliff erosion threatens public infrastructure, public access, and private development. 2. Existing sporadic armoring does not provide systematic protection to the sea cliff. 3. Riprap affects public access and may present a safety hazard.
East Cliff Drive - Capitola (Reach 6)	1. Riprap and concrete armoring protecting East Cliff Drive and associated public infrastructure may fail (City of Capitola). 2. Riprap reduces beach width, affects public access, and may present a safety hazard.
Capitola Beach and Esplanade (Reach 6)	1. Capitola Beach and Esplanade are subject to erosion and inundation during winter storms. 2. Construction of Santa Cruz Harbor exacerbated erosion in the late 1960s, with the City of Capitola constructing a groin to retain beach sand. 3. Erosion threatens significant public and private infrastructure, including several "critical facilities" identified in the Local Hazard Mitigation Plan (City of Capitola).
Depot Hill (Reach 6)	1. Beach at the base of sea cliffs is narrow to non-existent because of high rates of littoral transport and lack of any natural features (e.g., headlands) that would retain sand. 2. Seacliffs are vulnerable to wave attack, and erosion threatens private residences along Grand Avenue. 3. Seacliff erosion presents a safety hazard to beach-goers because the area is popular with fossil collectors.
New Brighton State Beach (Reach 7)	1. Beach erosion threatens public infrastructure including sewer lines and a pump station. 2. Private development on beach sand is subject to wave attack and inundation when large waves approach from the west-southwest (typically El Niño conditions). 3. Riprap protecting some residences may contribute to narrowing of beach and loss of public access.
Seacliff State Beach - North (Reach 7)	1. Public infrastructure on the back beach is subject to wave attack and inundation when large waves approach from the west-southwest. Vulnerable infrastructure includes roads, recreational facilities, sewer lines, and a pump station. 2. Bulkheads and other structures designed to protect parking and picnic facilities at Seacliff State Beach have failed at least 10 times over the past 75 years.

BECA OR SICH	PROBLEM ASSESSMENT
Aptos Creek Mouth and Seacliff State Beach - South (Reach 7)	1. Public and private infrastructure on the back beach is subject to wave attack and inundation when large waves approach from the west-southwest (typically El Niño conditions). 2. The flow path of Aptos Creek is often directed downcoast (south) by net littoral drift, where it can undermine residential development along Beach Drive. 3. Private development is also subject to damage from landslides originating in the comparatively weak material comprising the bluffs on the inland side of Beach Drive. 4. Vulnerable public infrastructure includes a parking area, roads, sewer lines, and a pump station. 5. Vulnerable private infrastructure includes residential development on both sides of Beach Drive.
Rio Del Mar - Beach Drive (Reach 7)	1. Private residential development on the back beach is subject to wave attack and inundation when large waves approach from the west-southwest (typically El Niño conditions). 2. Private development is subject to damage from landslides originating in the comparatively weak material comprising the bluffs on the inland side of Beach Drive. 3. Public infrastructure (sewer line) is located beneath the back beach. 4. Armoring, including a 450-foot-long riprap revetment, may contribute to narrowing of beach.
Rio Del Mar - Via Gaviota (Reach 7)	1. Private residential development on the back beach is subject to wave attack and inundation when large waves approach from the west-southwest (typically El Niño conditions). 2. Public infrastructure (road, sewer line) is located on the back beach. 3. Armoring, including a 1,100-foot seawall fronted by riprap, may contribute to narrowing of the beach and prevent public access.
Pajaro Dunes – Sunset State Beach	1. Private development is located on active sand dunes, which are subject to erosion when large waves are superimposed on elevated water levels (high tides, El Niño conditions). 2. Riprap protecting residential development may contribute to narrowing of beach and prevent public access along Sunset State Beach.
Elkhorn Slough	1. About half (1,000 acres) of the historic tidal marsh in Elkhorn Slough has been lost since 1870, largely from diking and draining. 2. 150 acres of tidal marsh have disappeared over the past 60 years because of excess inundation. 3. Tidal marsh dieback is anticipated to accelerate with sea-level rise and without action an estimated 500 more acres are predicted to disappear in the next 50 years. (Source: Elkhorn Slough Tidal Wetland Project Team, 2012a,b)

The first step in formulating each problem assessment involved defining the type and cause of erosion or excess sedimentation that presents a threat to infrastructure, public use or coastal habitat. The coastline of the Santa Cruz Littoral Cell encompasses a variety of coastal landforms, which may be exposed to different (and often intertwining) types of coastal erosion hazards. In general, the most common types of erosion hazards include net loss of beach width, susceptibility to inundation and wave attack, sea cliff erosion, loss of wetlands from sea-level rise, and hazards associated with active sand dunes. In addition, excess sedimentation has occurred within a number of coastal lagoons, often from infrastructure interfering with natural sediment-transport processes and land-use changes in contributing watersheds.

The net loss of beach width, which is probably the most commonly recognized type of beach erosion, is an issue throughout the Santa Cruz Littoral Cell. Net loss of beach width is usually associated with an imbalance in the sand budget of a given beach, where the net littoral drift rate outpaces the supply of sand. Thus, this type of erosion is often found in locations downdrift of where the sand supply has been disrupted, and adjacent to structures that may alter wave patterns and associated littoral drift rates. This is the case at the BECA (El Granada County Beach) located just southeast of Pillar Point Harbor (Figure 3-4, Figure 3-5), where significant erosion has occurred after construction of the harbor.

Figure 3-4. Aerial photograph of the northern section of the El Granada County Beach BECA, dated September 2013. Bluff erosion is currently threatening to undermine Highway 1. Source: Adelman and Adelman

Figure 3-5. Aerial photograph of the southern section of the El Granada County Beach BECA, dated September 2013. Erosion is flanking the north end of the rock revetment fronting Mirada Road. Source: Adelman and Adelman

Loss of beach width is also associated with the placement of armoring or development on beach sand. This phenomenon, which is known as placement loss, occurs when sand that is trapped under the given structure is effectively removed from circulation and the local sand budget (Griggs et al., 1997). Placement loss is an issue at a number of BECAs along the somewhat sheltered northern Monterey Bay shoreline, where extensive sections of the back beach have been filled and developed into residential areas. In addition, by fixing the location of the back beach, armoring increases the likelihood of future narrowing of the beach as sea-level rises. This process is often referred to as passive erosion, and is also a significant concern in southern Monterey Bay (PWA et al., 2008).

In addition to contributing to placement loss, development on the back beach is also subject to inundation, wave attack, and associated damages. This is a particular concern at BECAs along the northern Monterey Bay shoreline (Figure 3-6), where storm waves approaching from the west-southwest can impact the shore with minimal loss of energy. When combined with high tides and elevated sea levels, waves approaching from this direction have proven destructive, specifically during the El Niño winter of 1982-1983 (Griggs et al., 2005). Private and public interests have completed a number of improvements to armoring since 1983, although it remains to be seen how these structures will perform in the face of predicted sea-level rise, and associated increases in frequency of wave attack.

Figure 3-6. Aerial photograph of the Rio Del Mar-Via Gaviota BECA, dated October 2013. The extensive development on the back beach is largely protected from wave attack and inundation by a seawall and rock revetment. Source: Adelman and Adelman

The urbanized shoreline of northern Monterey Bay is also subject to sea cliff erosion, particularly where development has occurred on the relatively weak rocks of the Purisima Formation (Griggs et al., 2005). This is the case at a number of BECAs along northern Monterey Bay, including West Cliff Drive, East Cliff Drive, and Depot Hill (Figure 3-7). Sea-cliff erosion is primarily driven by wave attack and undermining, although other factors such as excessive runoff and seismic activity have caused cliff failure in this region (Griggs et al., 2005). Because this Plan focuses on coastal sediment management, however, it will only address potential erosion mitigation measures that reduce the exposure of sea cliffs to wave attack.

Figure 3-7. Aerial photograph of the western end of the Depot Hill BECA, dated October 2013. Note the significant sea cliff erosion, which threatens public and private infrastructure. Source: Adelman and Adelman

Sandy beaches backed by active sand dunes characterize the shoreline of central Monterey Bay. Most beach and dune areas are free of significant development and infrastructure, with the exception of the Pajaro Dunes development just north of the mouth of the Pajaro River (Figure 3-8). The dunes underlying this development are dynamic features, and typically erode and accrete in response to variations in wave climate. Significant erosion occurred during the El Niño winter of 1982-1983, and private interests have responded with the placement of a riprap revetment on the seaward edge of the dune. But, the revetment has fallen into disrepair over the past two decades, and much of the rock is scattered across the beach (Griggs et al., 2005).

Figure 3-8. Aerial photograph of the southern end of the Pajaro Dunes-Sunset State Beach BECA, dated October 2013. The extensive development on active sand dunes is subject to wave attack and inundation from the adjacent mouth of the Pajaro River. Source: Adelman and Adelman

In addition to erosion along the open coast, erosion of tidal marshes poses a significant threat to habitat for a number of threatened or endangered species. This is the case within Elkhorn Slough (Figure 3-9), which is the site of a large tidal wetland restoration project. This project will involve adding sediment to convert mudflats to more desirable salt marsh and reduce tidal prism along with associated erosion (Elkhorn Slough Tidal Wetland Project Team, 2012). This Plan will address the sediment management aspects of the restoration project.

Figure 3-9. Aerial photograph of the entrance to Moss Landing Harbor and the Elkhorn Slough BECA (background), dated October 2013. Source: Adelman and Adelman

There are also several coastal lagoons where human activities have disrupted natural sediment transport processes and contributed to excess sediment accumulation. This is the case at Waddell Creek and Scott Creek lagoons (Figure 3-10), where the construction of Highway 1 effectively isolated these lagoons from the open coast and reduced the natural transport of sediment to the open coast. As a result, the tidal prisms of these lagoons have been reduced with impacts on salinity regimes and other physical parameters that govern ecological function (ESA PWA and SWCA, 2012). Solutions to these problems will likely need to involve restoration of the connection between the lagoons and the open coast to a more natural state.

Figure 3-10. Aerial photograph of the Scott Creek Beach BECA and sediment impaired Scott Creek Lagoon, dated Sep 2010. The bridge and raised roadway constrict the mouth of Scott Creek and effectively isolate the lagoon from the open coast. Source: Adelman and Adelman.

4. REGIONAL SEDIMENT MANAGEMENT MEASURES

In the context of regional sediment management, there are a variety of measures that can be implemented to mitigate potential economic and environmental losses associated with imbalances in coastal sediments. These measures cover a wide range of actions including relocation of development from erosion hazard zones, beach nourishment, and construction of sediment retention structures.

Taken alone, individual actions might provide mitigation to an erosion problem at a particular location over a given time period. This can be the case with beach nourishment, where a fill episode will often only provide temporary erosion mitigation, absent any additional action (Patsch and Griggs, 2006). Therefore, it might be necessary to implement several measures, such as beach nourishment combined with a sediment retention structure, to better address the cause and impacts of erosion at a given BECA (Griggs, 2004). Likewise, the measures described in the next section are not necessarily intended to be stand-alone measures, but they might need to be combined at some of the BECAs and SICHs.

4.1 CONTEXT FOR FORMULATION OF REGIONAL SEDIMENT MANAGEMENT MEASURES

The development of this Plan involved examining coastal erosion in terms of overarching regional factors impacting the littoral cell sediment budget, and specific local conditions that contribute to erosion. Regional scale factors involve significant alterations to sediment supply and transport, which can be the result of both natural- and human-induced changes to the environment. Human-induced changes include impounding sediment behind dams, disrupting littoral transport by large coastal structures, and reducing sea cliff erosion caused by armoring. These factors are important considerations in the Santa Cruz Littoral Cell, where dams along the San Lorenzo and Pajaro Rivers have reduced sediment delivery and jetties at the entrance of Santa Cruz Harbor have disrupted littoral drift.

Recent research (e.g., Griggs et al., 2005) suggests that most significant regional-scale factor is the depletion of the Año Nuevo sand reserve, which supplied beaches south of Point Año with up to 50,000 cy of additional sand a year over the past several centuries. Without this supplemental sand, beaches south of Point Año Nuevo may be expected to narrow to reach equilibrium with the adjusted sediment supply (Patsch and Griggs, 2007). These beaches include a number of BECAs along the northern Monterey Bay shoreline, and the proposed erosion mitigation measures at each of these BECAs must be formulated within the context of a regional-scale reduction of sediment supply.

Local factors that may contribute to coastal erosion include orientation of the coastline, wave climate, presence or absence of features that can trap sediment, and armoring. These factors play a particularly important role along the shoreline of northern Monterey Bay, where wide beaches tend to form and persist along east-west oriented shorelines located updrift of littoral drift barriers. In contrast, sections of shoreline that are oriented north-south are subject to high rates of littoral drift, and those sections without any substantial littoral-drift barriers are characterized by narrow to non-existent beaches (Patsch and Griggs, 2006). As a result, sea cliffs in these areas are often directly exposed to wave attack and undermining, and this scenario is the primary cause of erosion concerns at a number of BECAs (e.g., East Cliff Drive, Depot Hill). Erosion mitigation measures at these locations will need to effectively create or retain a protective beach in an environment with high littoral drift rates and no natural features that can trap sand.

4.2 Description and Comparison of Regional Sediment Management Measures

4.2.1 No Action

This measure assumes that no new RSM measures will be implemented over the next 50 years. It does assume that existing sediment management measures (e.g., dredging of Santa Cruz Harbor and nourishment at Twin Lakes Beach) will continue over the planning horizon. Thus, this measure could be conceptualized as maintaining the status quo.

4.2.1.1 State of the coast in 50 years

To provide a baseline for discussing potential sediment management measures, it is necessary to envision the state of the coast in 50 years, absent any new sediment management measures. The two sea-level rise reports (PWA, 2009; and ESA PWA, 2014) provide a good starting point for understanding how coastal erosion hazard zones will migrate up and inland in response to several sea-level rise scenarios. Both reports envision a scenario where critical infrastructure will be increasingly exposed to inundation and wave attack over the next 50 years. The impacts of sea-level rise are expected to be particularly acute along the urbanized coast of northern Monterey Bay, where areas such as the Santa Cruz Beach Boardwalk, downtown Capitola, and the mouth of Aptos Creek will be subject to an increased coastal flooding risk by 2060 (ESA PWA, 2014).

The economic analysis of risk to infrastructure indicates that up to $1.1 Billion in damages could occur by 2050 (Section 7.5.3) if two-thirds of the parcels in the erosion hazard zone (per PWA, 2009) are lost to erosion. It is unlikely that this extent of damage will be allowed to occur, because both the public and private stakeholders are expected to continue or perhaps expand current erosion mitigation measures.

4.2.2 Managed Retreat and Restoration of Natural Environments

This measure encompasses a suite of sub-measures, all of which seek to restore some degree of natural sediment-related processes to a given coastal environment. These sub-measures can accomplish a number of objectives, including the reduction of the vulnerability of coastal infrastructure to erosion, and addressing the causes of excessive sediment accumulation.

4.2.2.1 Managed Retreat

This measure, which involves the relocation of vulnerable infrastructure away from the coastal-erosion hazard zone, is often undertaken when the cost of maintaining the infrastructure in question becomes prohibitive. There have been several well-documented cases of managed retreat in central California, including the removal of Stilwell Hall at the former Fort Ord site in 2004 (Figure 4-1) and removal of several structures from Pacifica State Beach (Figure 4-2). In addition to the removal of threatened structures, both of these cases of managed retreat also involved the removal of armoring that impeded natural sediment-transport processes.

Figure 4-1. Stilwell Hall in 2003 and the site after demolition in 2004. Source: Adelman and Adelman (2003 and 2004)

Figure 4-2. Pacifica State Beach before and after a managed-retreat project. Source: Adelman and Adelman (2013)

4.2.2.2 Beach and Marsh Restoration and Modification of Infrastructure

This measure, which involves actions intended to restore natural processes to a given coastal environment, is applicable to both BECAs and SICHs. Emerging research is demonstrating that restoration of coastal habitats can serve to reduce vulnerability of coastal infrastructure to erosion and increase the resilience of the coastline to future sea-level rise (2nd Nature, 2013). In the case of the Santa Cruz County coastline, Langridge et al. (2013) estimated that restoration of coastal wetlands will reduce the vulnerability of water system infrastructure by nearly 10%.

In addition to benefiting coastal infrastructure, measures that restore natural sediment-transport processes may serve to reduce or eliminate excessive sediment accumulation and associated ecological impacts. For example, there are a number of coastal lagoons in the Santa Cruz Littoral Cell that have been effectively separated from the open coast by infrastructure such as highways. Thus, restoration measures could include modifications to infrastructure, such as the removal of embankments and the extension of bridges at mouths of coastal lagoons, which will enable more natural sediment exchange between the sediment impaired lagoons and open coast (ESA PWA and SWCA Environmental Consultants, 2012).

4.2.3 Soft Engineering

Soft engineering measures, which typically involve the use of sediment to mitigate coastal erosion hazards, have become popular as harder (e.g., armoring) measures have fallen out favor over the past several decades (USACE, 2008). There are a variety of ways in which sediment placement can provide protective benefits to a given eroding shoreline, and this Plan will briefly describe two measures that have a reasonable possibility of working in the Santa Cruz Littoral Cell.

4.2.3.1 Beach Nourishment

This document defines beach nourishment as the direct placement of sand on a given beach or within the shallow waters of the surf zone for the purpose of reducing the likelihood of damaging erosion. Beach nourishment is a popular shoreline protection measure that is often selected because of constraints associated with other shoreline erosion mitigation measures (USACE, 2008). In addition, beach nourishment often occurs in conjunction with nearby navigation or construction projects that generate sand. This is the case at the two active beach nourishment operations in the Santa Cruz Littoral Cell, where sand dredged from the entrances of the Santa Cruz and Moss Landing Harbors are placed on nearby beaches (Figure 4-3; section 2.3.6).

Figure 4-3. Beach nourishment operations at Twin Lakes State Beach. Source: Moffatt & Nichol et al., (2011)

4.2.3.2 Nearshore Berm

This measure differs from direct beach nourishment in that sediment is placed in nearshore waters, often at depths of up to 30 or 40 feet (Figure 4-4). Nearshore berms can mitigate beach erosion by dissipating wave energy and supplying sediment to the littoral cell under accretionary conditions (USACE, 2008). The placement of sand in a nearshore berm may be an attractive option when there are operational constraints that preclude direct beach nourishment. This is the case at Ocean Beach in San Francisco, where sand has been placed at depths of 30 to 50 feet because of the lack of a pump-off capability for the dredge vessel (Barnard et al., 2009).

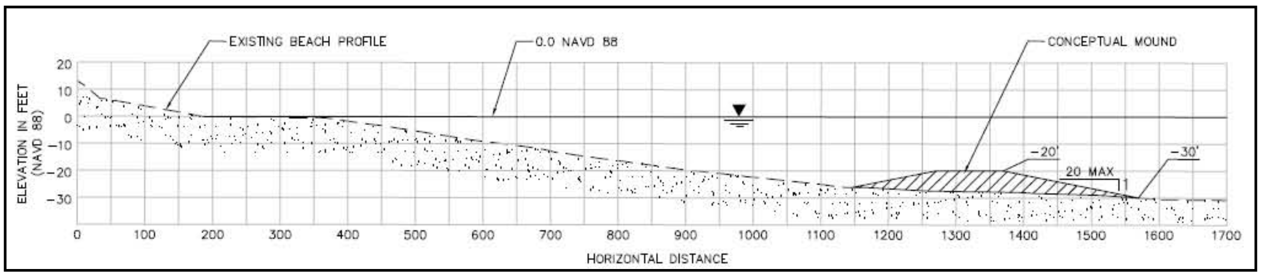


Figure 4-4. Nearshore berm configuration at Huntington Beach. Source: Beck et al. (2013)

4.2.4 Hard Engineering Structures

In contrast to the soft engineering measures, the hard engineering measures involve the use of rock, concrete or other hard material to mitigate coastal erosion. Hard engineering structures are typically designed to stabilize the shoreline position and generally do so through either retention of sediment or armoring (USACE, 2008). Of these two approaches, sediment retention is the more applicable in the context of regional sediment management, particularly in locations with relatively high littoral drift rates and no natural barriers to capture sand. However, armoring may be viewed as necessary by local interests, particularly in situations where relocating infrastructure will incur prohibitively high costs.

4.2.4.1 Submerged Sill and Perched Beach

This measure involves the construction of a submerged shore-parallel structure in shallow water to retain sediment to form a beach above the normal beach profile elevation (Figure 4-5). This measure has not been widely applied in the United States (USACE, 2008), but can have less-significant aesthetic impacts that most of the other hard engineering measures. But, there is considerable uncertainty regarding how well this measure will perform in a high wave-energy environment (ESA-PWA, 2012), and therefore this measure might only be practicable inside of a protected harbor.

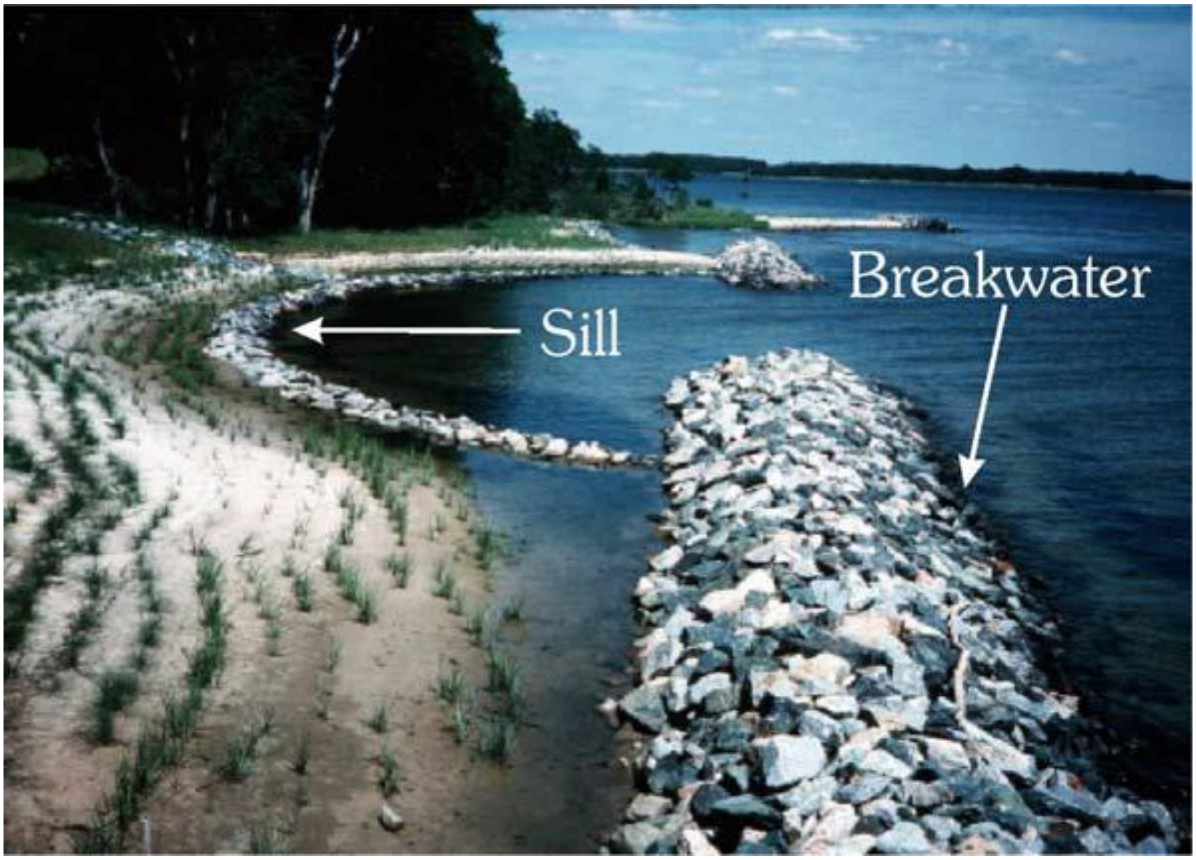


Figure 4-5. Example of a Submerged Sill along the Bank of the Choptank River, Talbot County, MD (Source: USACE, 2008)

4.2.4.2 Multipurpose Artificial Reef

A multipurpose artificial reef differs from a submerged sill in that the reef is placed farther offshore in somewhat deeper water, and is likely to provide unique recreational benefits (e.g., surfing) in addition to wave attenuation and erosion mitigation. Reefs may be constructed of a variety of materials, and USACE is currently working on a design of an experimental artificial reef, comprised of sand-filled geotextile containers, in Ventura County (ASR Limited, 2011; Figure 4-6). It should be noted the design of artificial reefs is a relatively new area of coastal engineering, and has not been widely practiced in the U.S. to date (USACE, 2008).

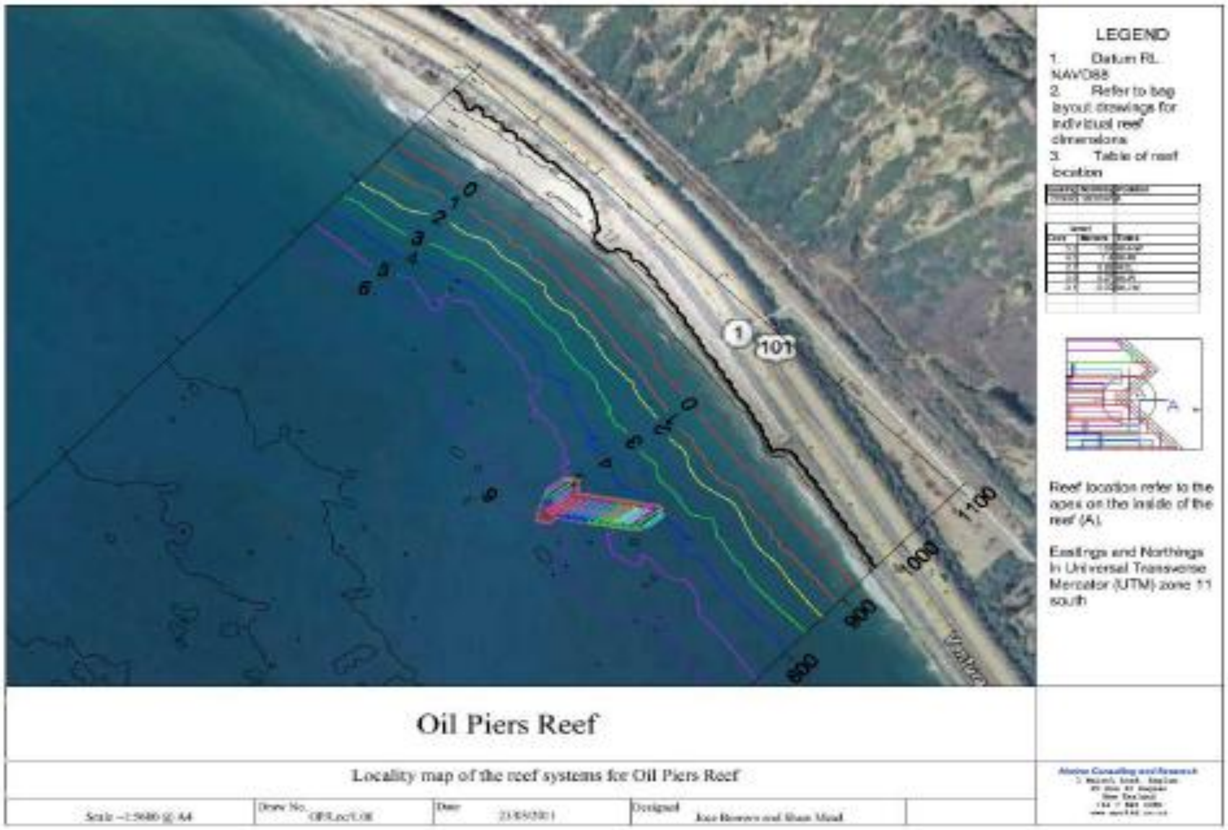


Figure 4-6. Schematic of proposed multipurpose artificial reef at Oil Piers in Ventura County, California (Source: ASR Ltd and USACE, 2011)

4.2.4.3 Jetties

Jetties are hardened shore-connected structures that are generally constructed perpendicular to shore, and are typically designed to confine stream or tidal flow to a selected channel (USACE, 2008). Jetties can serve a variety of functions including facilitation of navigation through harbor mouths (Figure 4-7) and stabilization of river mouths for flood risk management purposes. Jetties often affect alongshore transport of sediments and can contribute to erosion at downdrift beaches. Thus, potential erosion mitigation measures could include modification of a given set of jetties to allow for more efficient alongshore sediment transport.

Figure 4-7. Aerial view of the two jetties that stabilize the entrance to Santa Cruz Harbor. Source Adelman and Adelman (2013)

4.2.4.4 Groins

Groins are shore-connected structures that are designed to retain sand by disrupting alongshore sediment transport (USACE, 2008). Sand typically accumulates on the updrift side of a given groin, while beach erosion can increase over some distance downdrift of the structure. Groins can be particularly effective at retaining sand along shorelines subject to high littoral drift rates, such as the east-west oriented shoreline of northern Monterey Bay (Griggs, 2004). There is currently one functioning groin in the Santa Cruz Littoral Cell - the 250 foot long rubble-mound structure anchoring the east end of Capitola City Beach (Figure 4-8). This structure has experienced considerable degradation since construction in 1970, and the City of Capitola has identified rehabilitation of the structure as a priority under the City's Capital Improvement Program (Jesberg, pers. comm., 2013).

Figure 4-8. Aerial view of rubblemound groin at Capitola. Source: Adelman and Adelman (2010)

4.2.4.5 Cliff Stabilization and Seawalls

This measure involves the use of concrete, wood, or other hard material to armor and essentially fix the position of the shoreline. This measure is often implemented to protect coastal infrastructure and residential development, and approximately 15 miles of the Santa Cruz Littoral Cell shoreline are now armored with seawalls, revetments, and other hard structures (Figure 3-6. Although there are a number of concerns associated with armoring (Stamski, 2005; Dugan and Hubbard, 2010; Table 4-1), the practice still continues in the Santa Cruz Littoral Cell, particularly along the urbanized northern shore of Monterey Bay. The cliff stabilization project below East Cliff Drive provides an example of how this measure has been implemented in recent years (Figure 4-9). It was specifically formulated to address concerns regarding access, aesthetics, and environmental and recreational impacts (California Coastal Commission, 2007).

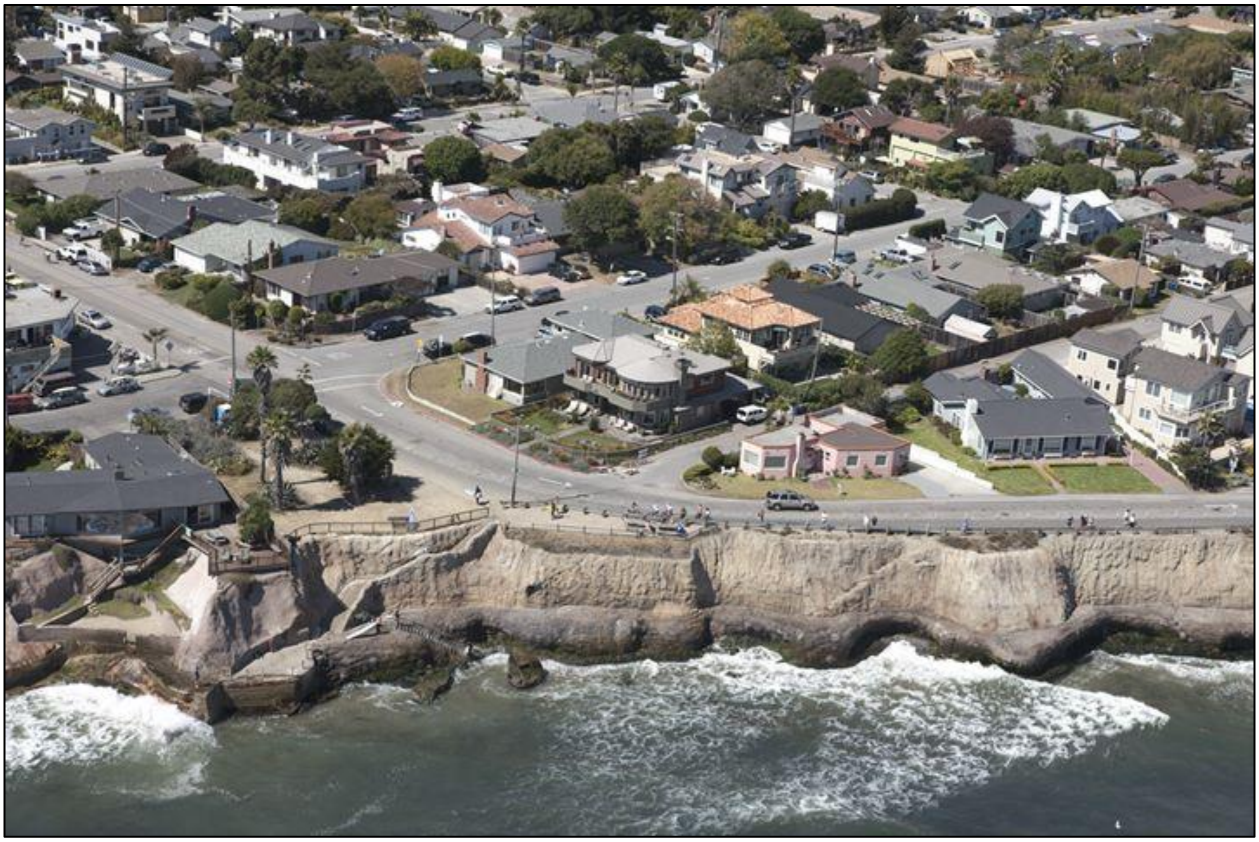


Figure 4-9. Aerial view of the recently completed East Cliff Drive Bluff Protection and Parkway Project. Source: Adelman and Adelman (2010)

4.3 Comparison of Regional Sediment Management Measures

The RSM measures described in the previous section only represent a starting point for formulating solutions to problems and BECAs and SICHs. Each of the sediment management measures described in the previous section has distinct advantages and disadvantages, and may only be practicable at certain locations due to a variety of physical, biological, and social factors. Table 4-1, which was modeled after outreach material developed for the San Francisco Littoral Cell CRSMP (ESA-PWA, 2012), is intended to provide a framework for comparing RSM measures.

Table 4-1: Comparison of advantages and disadvantages of RSM measures.

MEASURE	DESCRIPTION	ADVANTAGES	DISADVANTAGES
No Action	This option assumes that the "status quo" will continue for the next 50 years, often with local interests maintaining existing erosion-control measures.	1. Preferable course of action in areas without existing armoring or significant coastal infrastructure. 2. No cost associated with development of additional plans.	1. These measures often only provide temporary mitigation of erosion problems. 2. Measures generally do not provide a systematic approach for addressing beach erosion. 3. Uncertainty regarding future maintenance activities.
Managed Retreat	This option involves relocating development and infrastructure away from coastal erosion hazard zones.	1. Will maintain or increase beach width.[8] 2. Will increase access, safety, and recreational opportunities. 3. Will provide environmental benefits to species dependent on coastal environments.[8] 4. Consistent with the MBMNS Coastal Armoring Action Plan.[2] 5. Will eliminate or significantly reduce future costs associated with maintenance of vulnerable infrastructure.	1. Potential for prohibitively high land costs in areas with extensive infrastructure and development. 2. Potential for conflict with stakeholders.
Restoration of Beach and Marsh Environments and Modification of Infrastructure	This measure involves actions intended to restore natural processes to a given coastal environment, and applies to both BECAs and SICHs.	1. Will increase beach width (removal of armoring). 2. Will increase access, safety, and recreational opportunities (removal of armoring). 3. Will provide significant environmental benefits (restoration). 4. Will provide protective benefits to coastal infrastructure[9] 5. Consistent with MBMNS Coastal Armoring Action Plan.[2]	1. Perception of loss of shoreline protection. 2. High cost of obtaining coastal land for restoration. 3. Contingent on significant modification to existing infrastructure.

Measure	Description	Advantages	Disadvantages
Beach Nourishment	This option involves the direct placement of sand on the sub-aerial beach or in the surf zone.	1. Will increase beach width.[4] 2. Can provide beneficial sediment to downdrift beaches. [4] 3. Will likely provide recreational benefits.[4] 4. Can provide an attractive sand placement option for construction or dredging operations. 5. Minimal aesthetic impacts in comparison to armoring and other hard structures. 6. Potential environmental benefits for species favoring sandy environments.	1. Does not address the causes of erosion.[4] 2. High construction cost.[4] 3. Difficulty in identifying opportunistic sand sources. 4. May require subsequent nourishment phases, leading to high maintenance cost.[4] 5. May require additional measures, such as groins, to retain sand. 6. Potential safety issues associated with alteration of breaking wave characteristics.[8] 7. Potential regulatory issues involving the MBNMS.[2] 8. Environmental concerns involving turbidity and burial of organisms.
Nearshore Berm	This measure differs from direct beach nourishment in that sediment is placed in nearshore waters, often at depths of up to 30 or 40 feet.	1. Will reduce wave energy reaching the eroding shoreline and may increase beach width.[4] 2. Less operational complexity and cost than direct beach placement[4].	1. Uncertainty in effectiveness at increasing beach width[4]. 2. Potential regulatory issues involving MBNMS.[2] 3. Environmental concerns involving turbidity and burial of organisms.[10]
Perched Beach	This option involves utilizing a submerged sill to limit offshore sand transport, and thereby create a beach that is at a higher elevation than surrounding beaches.1	1. Will address underlying cause of erosion by reducing offshore sand transport.[4] 2. Will increase beach width.[4] 3. Will likely provide recreational benefits. 4. Should not require continual nourishment after initial charging with sand.[4] 5. At Princeton, less likelihood of regulatory issues involving the MBNMS.	1. High cost of construction.[8] 2. Uncertainty of performance, particularly in large-wave environments.[8] 3. Impacts to sandy habitat.[10] 4. Potential safety issues including steep drop off and change in breaking-wave characteristics.[4,8]

Measure	Description	Advantages	Disadvantages
Multipurpose Artificial Reef	This option involves the construction of a submerged offshore reef that is designed to reduce beach erosion and provide recreational benefits. These hard structures can induce accretion of sediment by altering the direction of wave approach, thereby reducing the rate of littoral drift and associated erosion.2	1. Will address underlying cause of erosion problem by reducing the rate of littoral drift.[7] 2. Will increase beach width.[8] 3. Does not require continual beach nourishment.[6] 4. Potential improvement of recreational opportunities (e.g., surfing, fishing).[6] 5. Minimal aesthetic impacts.[8]	1. High cost of construction.[7] 2. Uncertainty regarding performance.[6] 3. Uncertainty regarding maintenance cost.[6] 4. Habitat alteration [8] 5. Safety concerns. Unmarked underwater hazard. 6. Potential regulatory issues involving the MBNMS.[2]
Groin (s) and Jetties	This option involves construction one or more shore-perpendicular structures designed to retain beach sand. These structures may be particularly useful in environments with high littoral-drift rates and no existing barriers to this drift.	1. Will increase or maintain beach width.[8] 2. Should not require additional nourishment after initial placement of sand. 3. Will likely perform well along the east-west oriented coastline of northern Monterey Bay.[4]	1. High cost of construction. 2. Will require considerable monitoring and maintenance. 3. May induce erosion at down-coast beaches.[4] 4. Safety concerns, including formation of rip currents.[8] 5. Access concerns.[8] 6. Potential regulatory issues involving the MBNMS.[2,5]
Cliff Stabilization or Seawall	This option involves measures designed to stabilize sea cliffs that are subject to wave attack. Typical measures include construction of seawalls and stabilization with soil nail walls.	1. Will likely stop sea cliff erosion. 2. Can provide a systematic approach to protection, when applied over the entirety of a given problem area.[2] 3. Will protect cliff top infrastructure, including public amenities. 4. Can include features to improve public access, such as stairways.[3] 5. Can allow for removal of riprap and other undesirable armoring. 6. Has been recently implemented in the Plan area (East Cliff Drive Bluff Protection Project).	1. Will likely reduce sediment supply to local beaches.[2] 2. Can contribute to passive erosion and flanking, as adjacent unprotected cliffs continue to retreat.[2] 3. Potential visual impacts.[2,3] 4. Potential recreation concerns, such as impacts to surfing.[3]

Measure	Description	Advantages	Disadvantages
Note: This table was developed using a variety of source including [1]Griggs (2004), [2]Stamski (2005), [3]California Coastal Commission (2007), [4]USACE (2008), [5]NOAA (2008), [6]Borrero, et al. (2010), [7]ASR Limited (2011), [8]ESA PWA (2012), [9]Langridge et al. (2013), [10]SAIC (2012)			

4.4 Potential Sediment Sources

There are a number of natural and human-induced factors that have led to net sand deficits and erosion at BECAs scattered throughout the Santa Cruz Littoral Cell. Thus, there is considerable demand for sand at a number of locations throughout the littoral cell. There have been several localized efforts to develop plans for meeting sand demand at certain BECAs, but there has not been a region-wide effort to identify sand sources. As a result, this section details a preliminary effort to identify potential sand sources throughout the entire littoral cell with a focus on several of the more promising sand sources and stockpile locations.

Potential sand sources and stockpile locations were identified based on searches of existing literature and GIS databases, along with discussions with representatives from local governments and agencies involved in sediment generating activities (Figure 4-10 through Figure 4-15). This search for potential sand sources was wide ranging, and included a variety of potential sources such as harbors, offshore sand, and dams. The sand source and stockpile data were then organized into a GIS dataset, which was configured based on guidance in the SANDAG SCOUP Plan (Moffatt & Nichol, 2006). This GIS dataset, which identified approximately a dozen different types of sources, includes site descriptions, estimated quantities, ownership, and contact information.

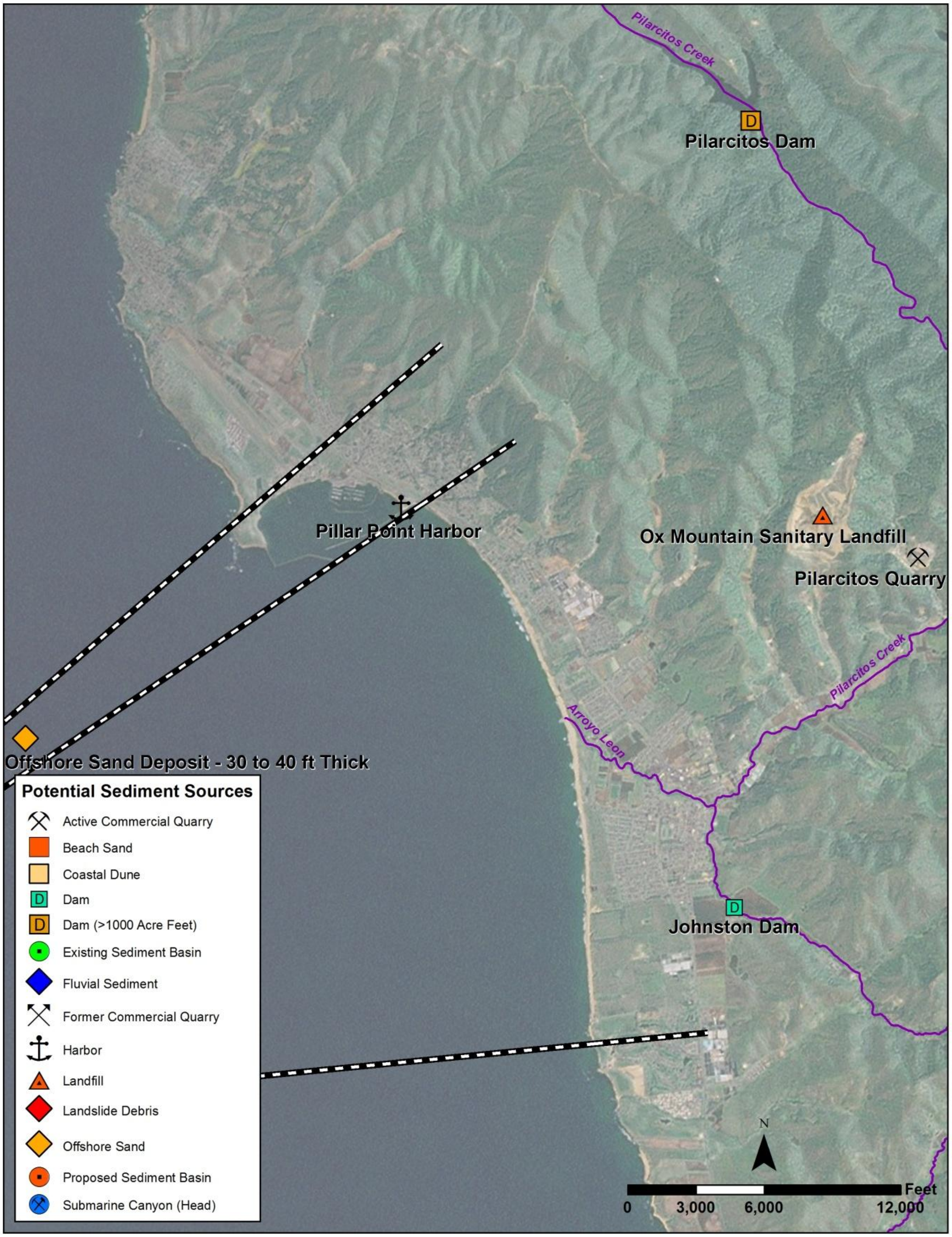


Figure 4-10. Potential sediment sources in Reaches 1 and 2

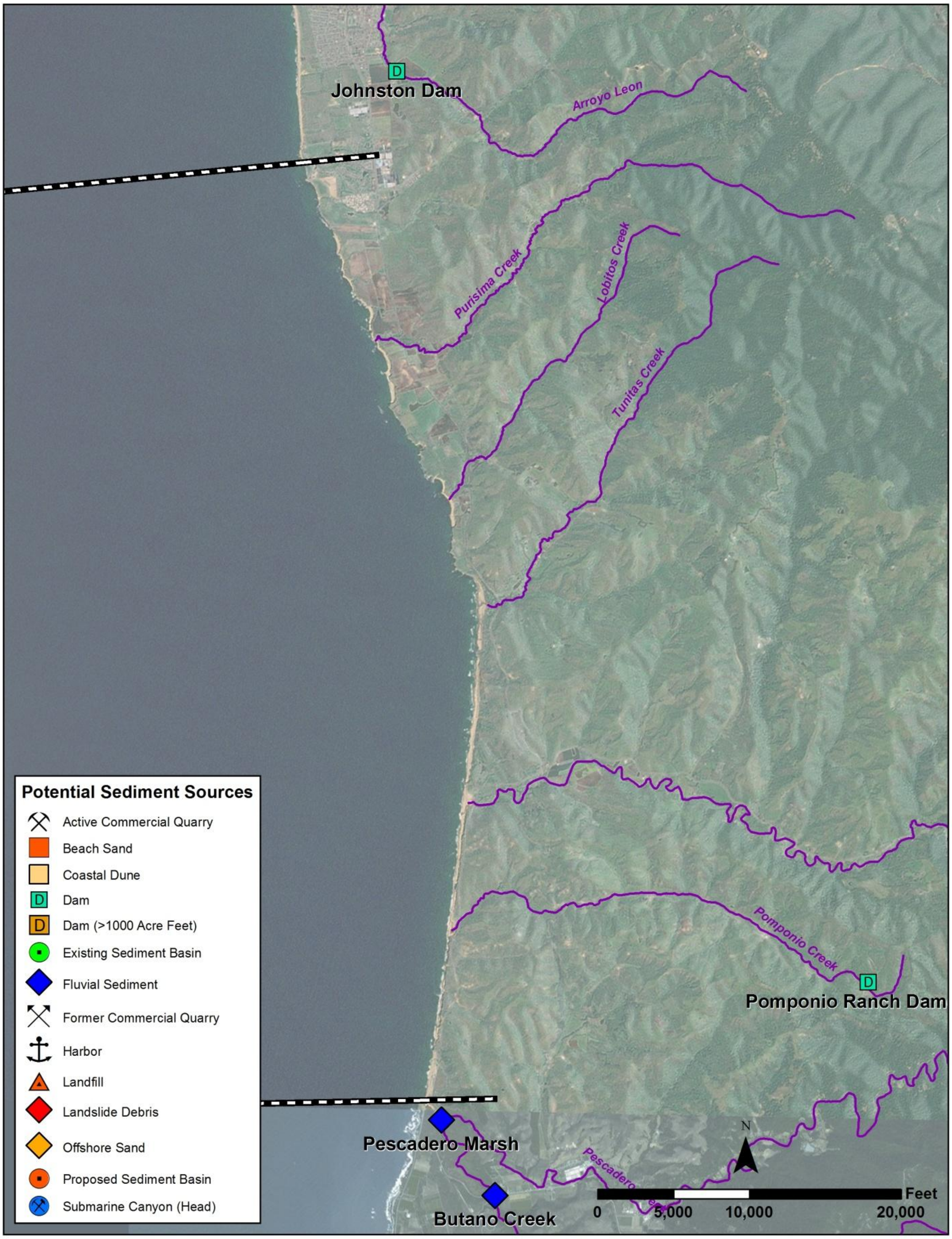


Figure 4-11. Potential sediment sources in Reach 3

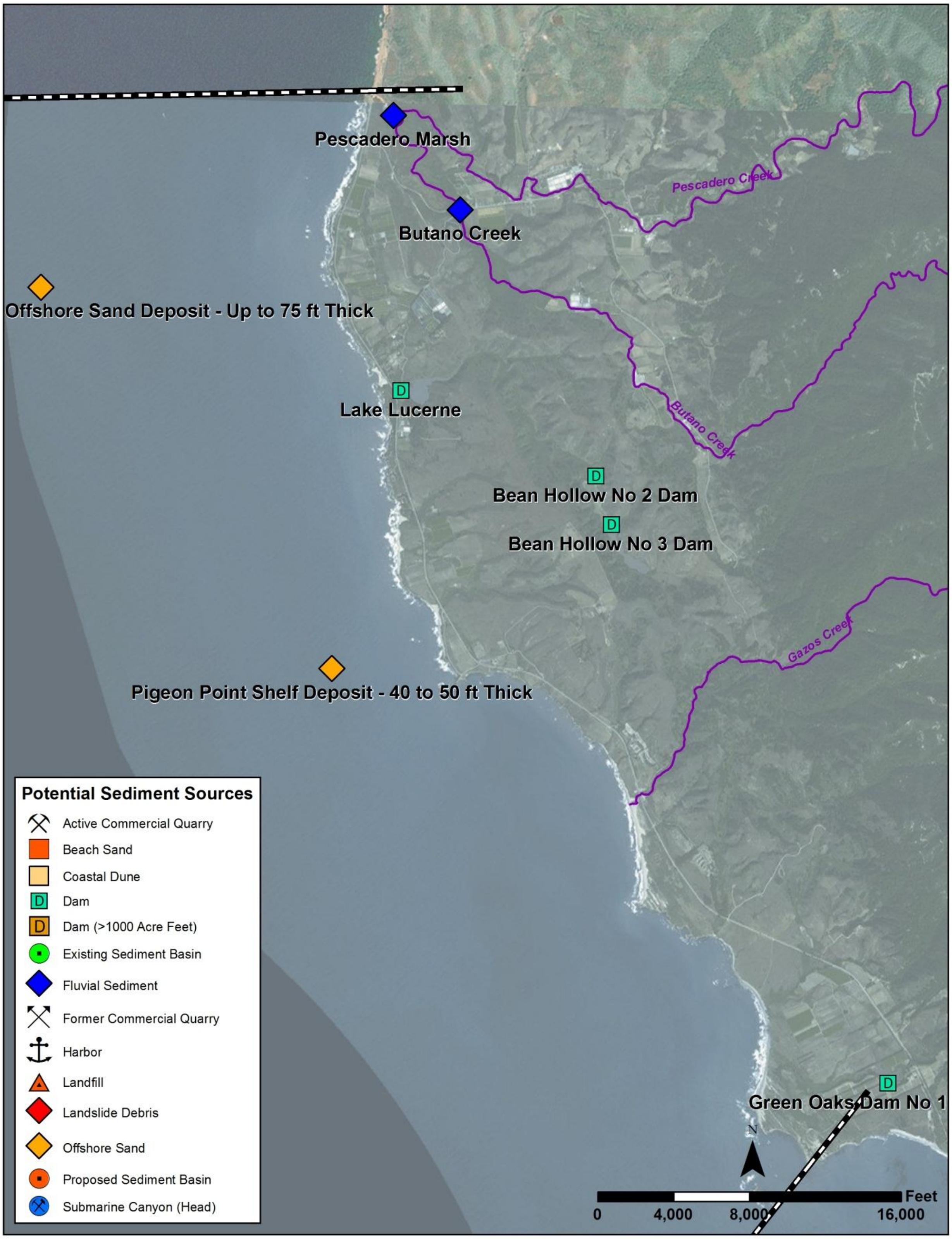


Figure 4-12. Potential sediment sources in Reach 4

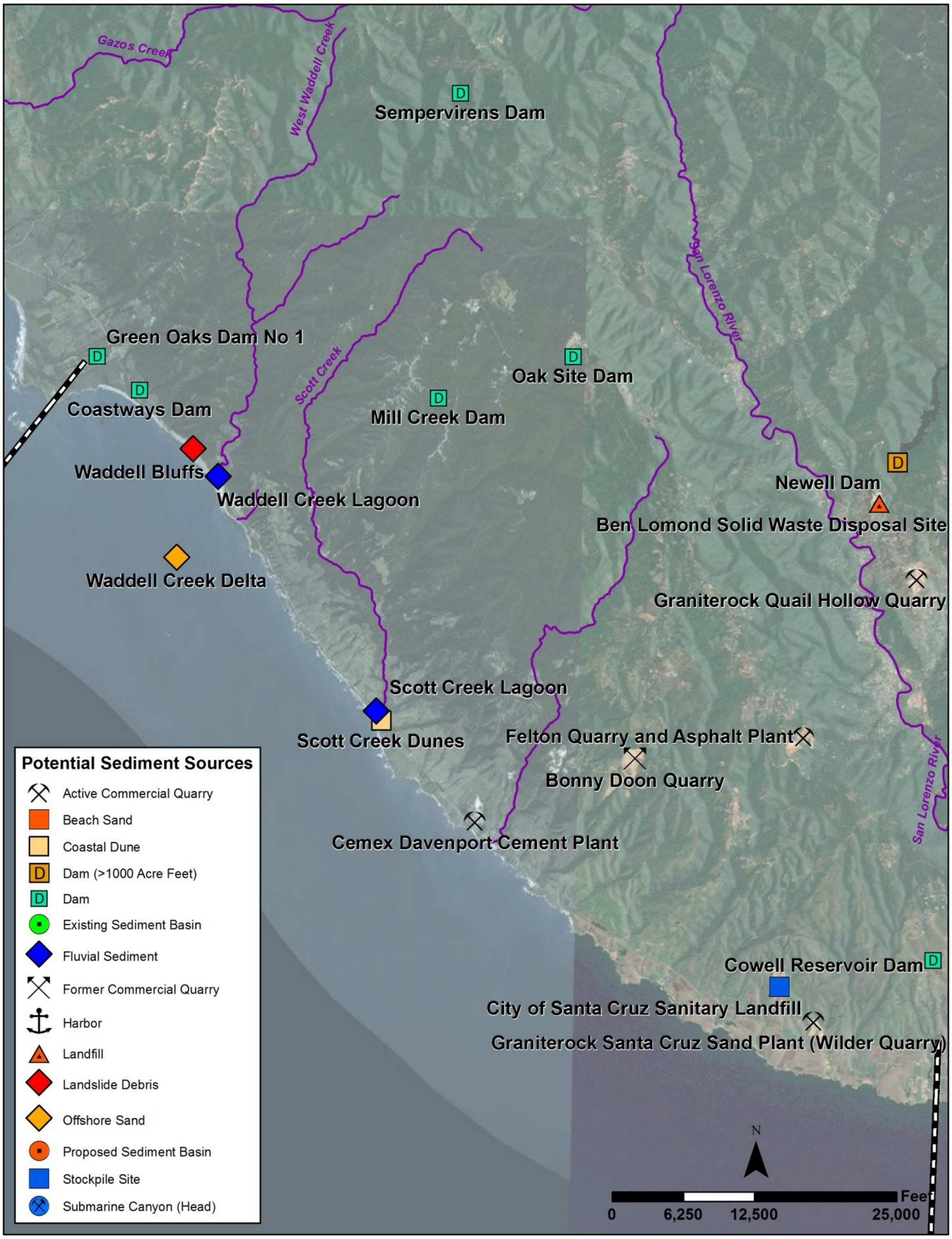


Figure 4-13. Potential sediment sources in Reach 5

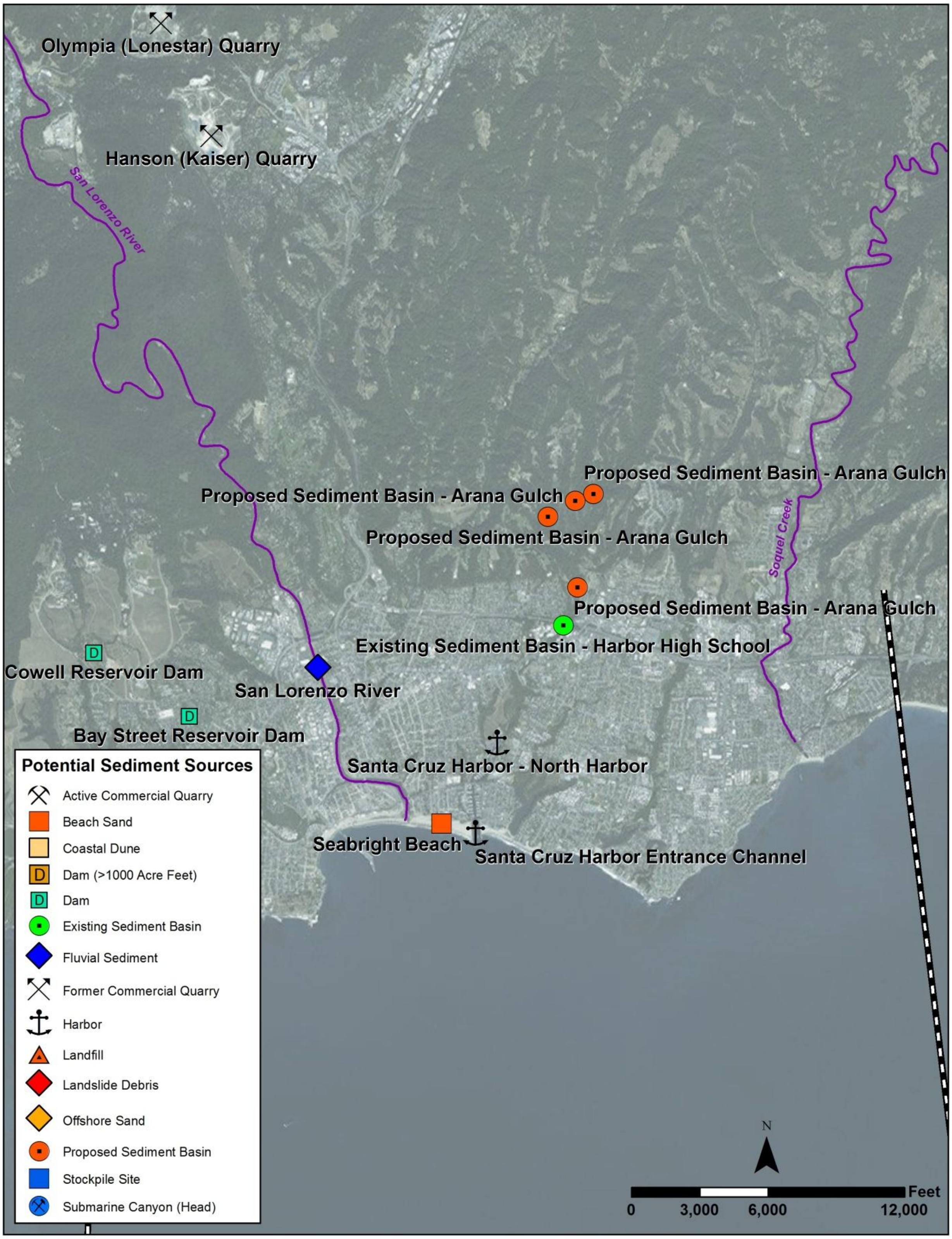


Figure 4-14. Potential sediment sources in Reach 6

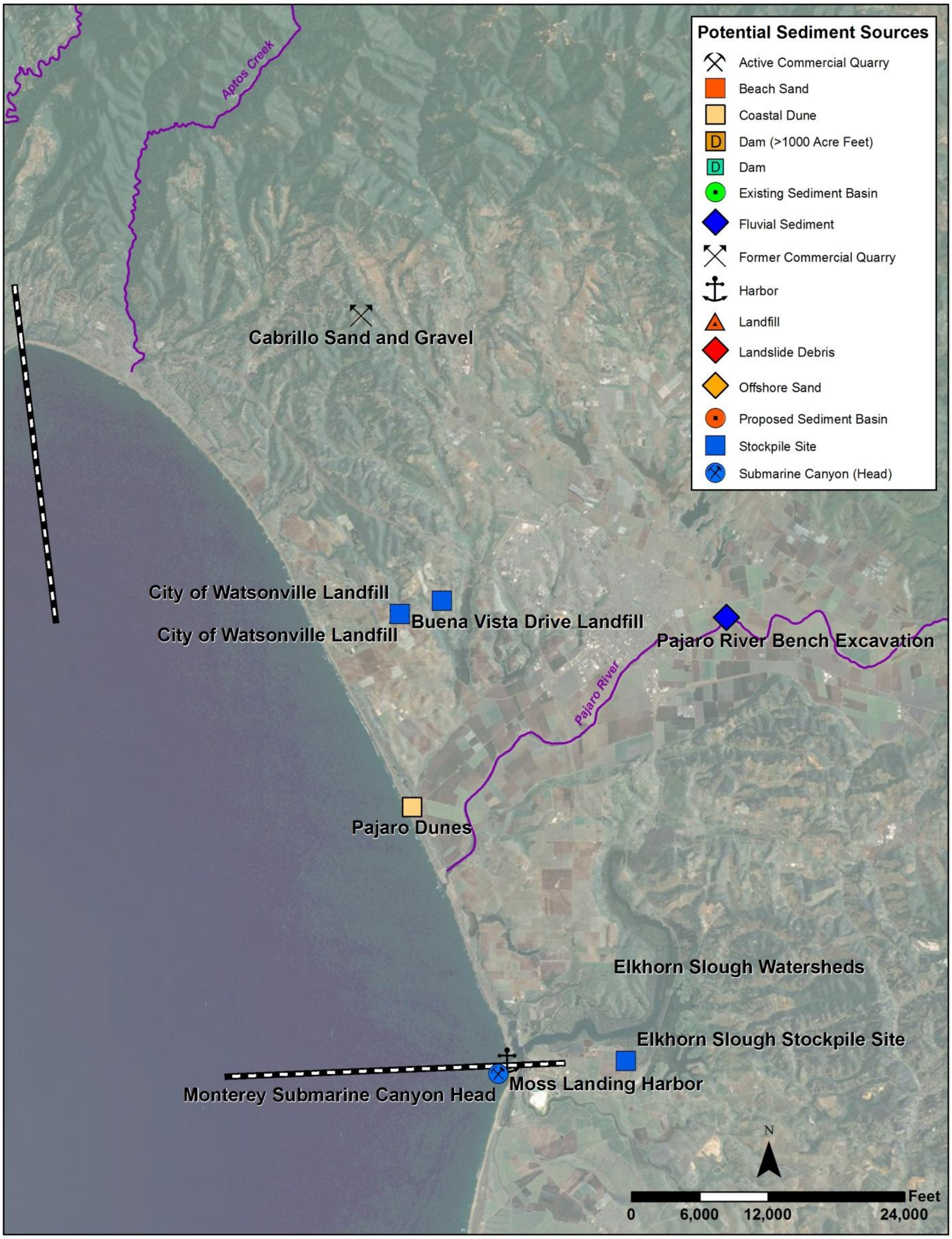


Figure 4-15. Potential sediment sources in Reach 7.

4.4.1 Harbors

There are three harbors in the Santa Cruz Littoral Cell (Figure 4-10, Figure 4-14, Figure 4-15), and all three owe their current level of functionality to the presence of large coastal navigation structures. These structures have significantly altered nearshore sediment transport, often resulting in shoaling of navigation channels that require routine dredging. In the case of Santa Cruz Harbor (section 2.5.9) routine dredging operations regularly bypass sand eastward to Twin Lakes State Beach. Sand is also routinely dredged from Moss Landing Harbor (section 2.3.7) and placed on the adjacent beach (South Spit) to the south. In both cases, the present dredging operations have optimized the beneficial use of sand on adjacent beaches and minimized the impacts of the coastal structures on natural sediment transport.

In contrast to the two harbors to the south, there are no routine dredging operations at Pillar Point Harbor, and approximately 200,000 cy of sand have accumulated on the harbor side of the East Breakwater. There has been considerable local interest in removing this sand and placing on the nearby eroding Surfer’s Beach (El Granada County Beach), and the San Mateo County Harbor District and USACE are currently evaluating the feasibility of this proposal (section 2.5.2). In the event that USACE is unable to undertake this project, there is the possibility that another agency could develop a pilot study of the impacts of sand placement Surfer’s Beach in coordination with the Monterey Bay National Marine Sanctuary. In any case, the sand impounded along in Pillar Point Harbor represents a valuable resource that could provide erosion mitigation at nearby BECAs.

4.4.2 Offshore Sand

Several other CRSMPs have identified offshore sand as a potentially valuable resource, particularly when the sand is located within several miles of shore (ESA-PWA, 2008; Moffat and Nichol et al., 2009). In the case of the Santa Cruz Littoral Cell, the USGS recently completed a series of detailed offshore geology maps as part of the California Seafloor and Coastal Mapping Program (Cochrane et al., 2014a-b; Cochrane et al., 2015a-d; and Dartnell et al., 2015). The maps have identified several potential offshore sources of sand, including relatively thick (30 to 80 feet) deposits located within a couple of miles of Pillar Point, Pescadero Point, Pigeon Point and the mouth of Waddell Creek (Figure 4-10, Figure 4-11, Figure 4-12, and Figure 4-13). While these deposits could prove to be rich sources of sand, removal for beach nourishment will face significant engineering, cost, and regulatory challenges (Section 6.3.1).

4.4.3 Beach Sand

Occasionally, excess sand accumulation on a given beach has posed a sediment management problem that necessitated removal of the sand. This is the case at Seabright Beach, where excessive sand impoundment along the west jetty of Santa Cruz Harbor has spread west around San Lorenzo Point and formed a sand bar that frequently blocks and alters the flow path of San Lorenzo River. It has been estimated that approximately 600,000 cy of sand accumulated on Seabright Beach within two years after harbor construction, with subsequent widening of Main Beach to the west in the following decades (Griggs, 2012). Currently, the seaward edge of Seabright Beach is nearly adjacent to the bend in west jetty, and the eastern section of the beach is over 600 feet wide (Google Earth, 2014). Thus, there is the potential to remove perhaps 200,000 to 300,000 cy of sand from Seabright Beach while still maintaining a fairly wide beach.

4.4.4 Sediment Impaired Coastal Habitats

There are several coastal lagoons where the construction of coastal infrastructure has contributed to excessive sediment accumulation and thereby impaired ecological function. In particular, there are two locations (Scott Creek and Waddell Creek) where there may be an opportunity to restore some degree of natural sediment transport as part of proposed bridge replacement projects (Figure 4-13; ESA-PWA and SWCA, 2012). This restoration process could involve modifications to infrastructure along with removal of a number of embankments, levees, to generate some sand. In addition, sediment could also be dredged from lagoons, to increase tidal prism and scour at the lagoon mouth. It is unknown, however, how much beach-quality sand may be generated by such restoration activities, given that only conceptual-level plans have been developed to date (ESA-PWA and SWCA, 2012).

4.4.5 Flood Risk Management Projects and Dams

There are a couple of cases where removal of excess sediment is necessary to restore hydraulic capacity to a given channel for flood risk management purposes. This is the case along the San Lorenzo River between Water Street and Highway 1, where sand has accumulated in the channel at a rate of up to 2,000 cy per year (Figure 4-14; Synder, pers. comm., 2014). As a result, the City of Santa Cruz and USACE are currently evaluating the feasibility of removing 50,000 cy of sediment of sediment from the channel (Dettle, pers. comm., 2014). In addition, the San Mateo County Resource Conservation District (SMRCD) has evaluated the removal of sediment from Butano Creek in the vicinity of the Pescadero Road Bridge for flood risk management purposes (Figure 4-11; Hammersmark et al., 2014).

Preliminary analysis suggests that up to 48,000 cy of sediment could be removed downstream of the bridge to the confluence with Pescadero Creek as part of an integrated approach that includes reduction in upland sediment inputs and reconnection of floodplains (cbec and Stillwater Sciences, 2014).

Sediment often impounds behind dams, and there has been considerable research into the impacts of dams on coastal sediment budgets. With respect to the Santa Cruz Littoral Cell, Slagel and Griggs (2008) estimated that approximately 770,000 cy of sand have accumulated behind Newell Dam, which forms the Loch Lomond Reservoir on one of the major tributaries of the San Lorenzo River (Figure 4-14). But, recent surveys show that the current sediment rate inside the reservoir is relatively slow (McPherson et al., 2011). The City of Santa Cruz does not have any plans to remove sediment from the reservoir (Rivera, pers. comm., 2014).

In addition, there are a number of small dams in the coastal watersheds of the Santa Cruz Littoral Cell. Most of them are privately owned, and coordination with the owners of the dams is beyond the scope of this plan. Thus, it is unlikely that any dams within the Santa Cruz Littoral Cell Plan area could be viable sediment sources.

4.4.6 Major Construction Projects

Large construction projects have the potential to generate considerable quantities of sediment, particularly in the case of large transportation and infrastructure projects that require significant excavation. As of this writing, the Santa Cruz Regional Transportation Commission (SCRTC) does not foresee any major sediment-generating construction projects being undertaken over the next several years (Pushnik, pers. comm., 2013).

4.4.7 Stockpile Sites

In addition to identifying sediment sources, it is also critical to identify sites where sand could be stockpiled if the timing of sand generation and beach placement is not ideal. A preliminary search indicates that there are several potential stockpile sites in the southern section of the littoral cell, including two publically owned landfill facilities (Figure 4-14; Figure 4-15). In addition, the Elkhorn Slough Tidal Wetland Project has identified a parcel which can serve as a long-term stockpile site for restoration activities (Figure 4-15; Fountain, pers. comm., 2014). Identifying stockpile sites in the northern section of the cell has been more of a challenge, with a representative from the SMRCD indicating that there are no active, currently available, viable stockpile sites in the Pescadero area (Kogan, pers. comm., 2014).

5. BIOLOGICAL RESOURCES

The Santa Cruz Littoral Cell includes part of the MBNMS and several managed areas and protected habitats including state marine conservation areas, marine reserves, state parks and beaches, national parks, and ecologically significant habitats. It is also host to a variety of species, including more than twenty cetaceans (whales, dolphins and porpoises), six species of pinnipeds (seals and sea lions), otters, several species of fish, and resident birds. Being located on the Pacific flyway, it serves as a temporary home to several migratory birds.

Coastal sediment management options, such as beach nourishment and the construction of sediment retention structures, have the potential to affect habitats and species in the littoral cell in a variety of ways. In addition, removing sand from aquatic and upland sources also has the potential to adversely affect biological resources in the vicinity. Many of the biological and natural resources in the littoral cell are protected by various federal and state environmental laws and regulations. As such, compliance with these environmental laws and regulations is required prior to undertaking sediment management activities. Section 6 provides details on laws and regulations governing resources in the littoral cell.

Figure 5-1 through Figure 5-6 provide details of the habitats within each reach, including: the shore type (i.e., sand beach, rocky shore, hardened or constructed shorelines); managed and protected areas (e.g., state marine conservation areas and reserves, state parks, national parks, and state beaches); coastal rivers and streams; kelp canopies; benthic contours; and critical habitat. These figures are referenced throughout this section when discussing the various habitats and species present in the littoral cell.

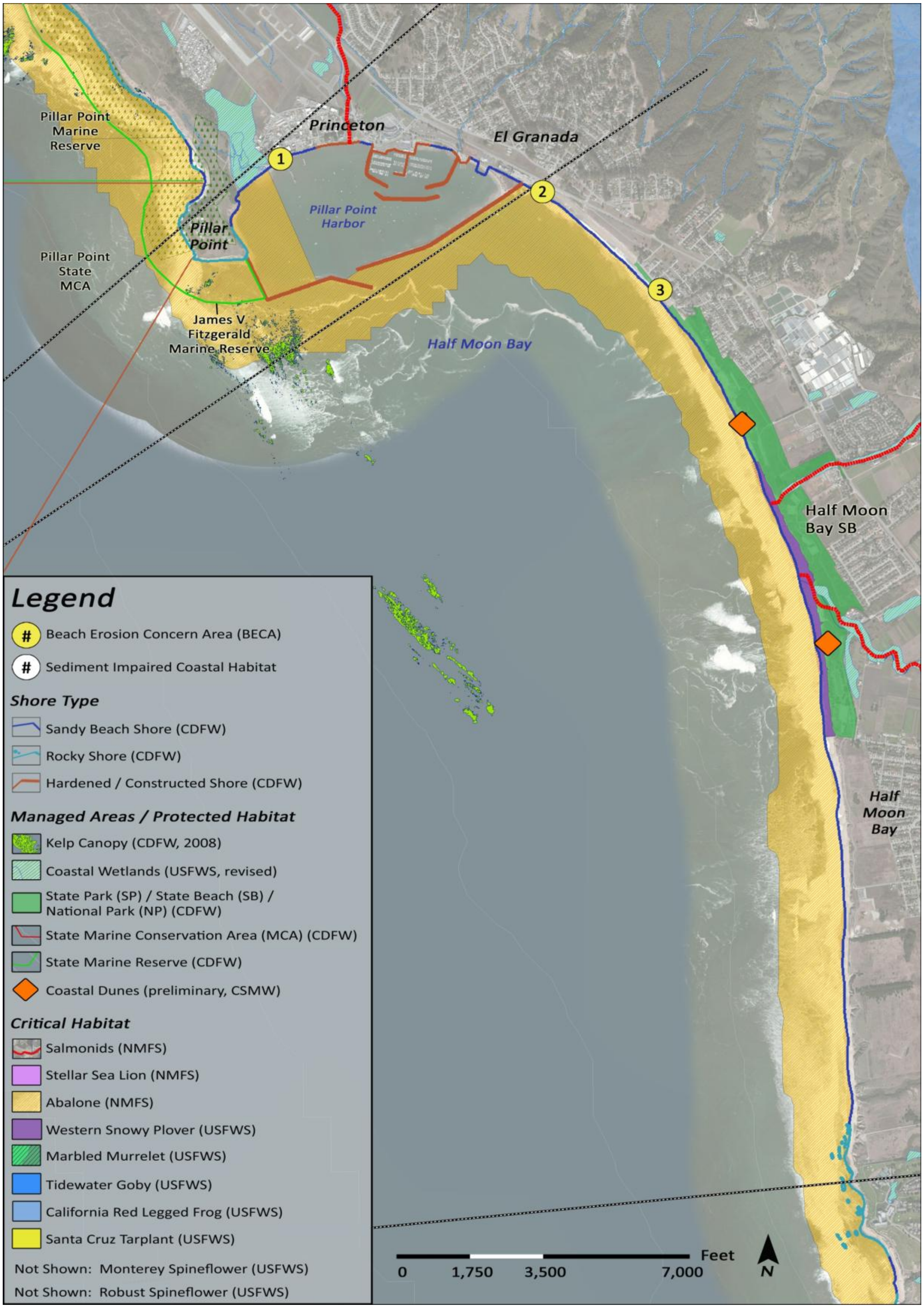


Figure 5-1. Biological Resources of Reaches 1 and 2

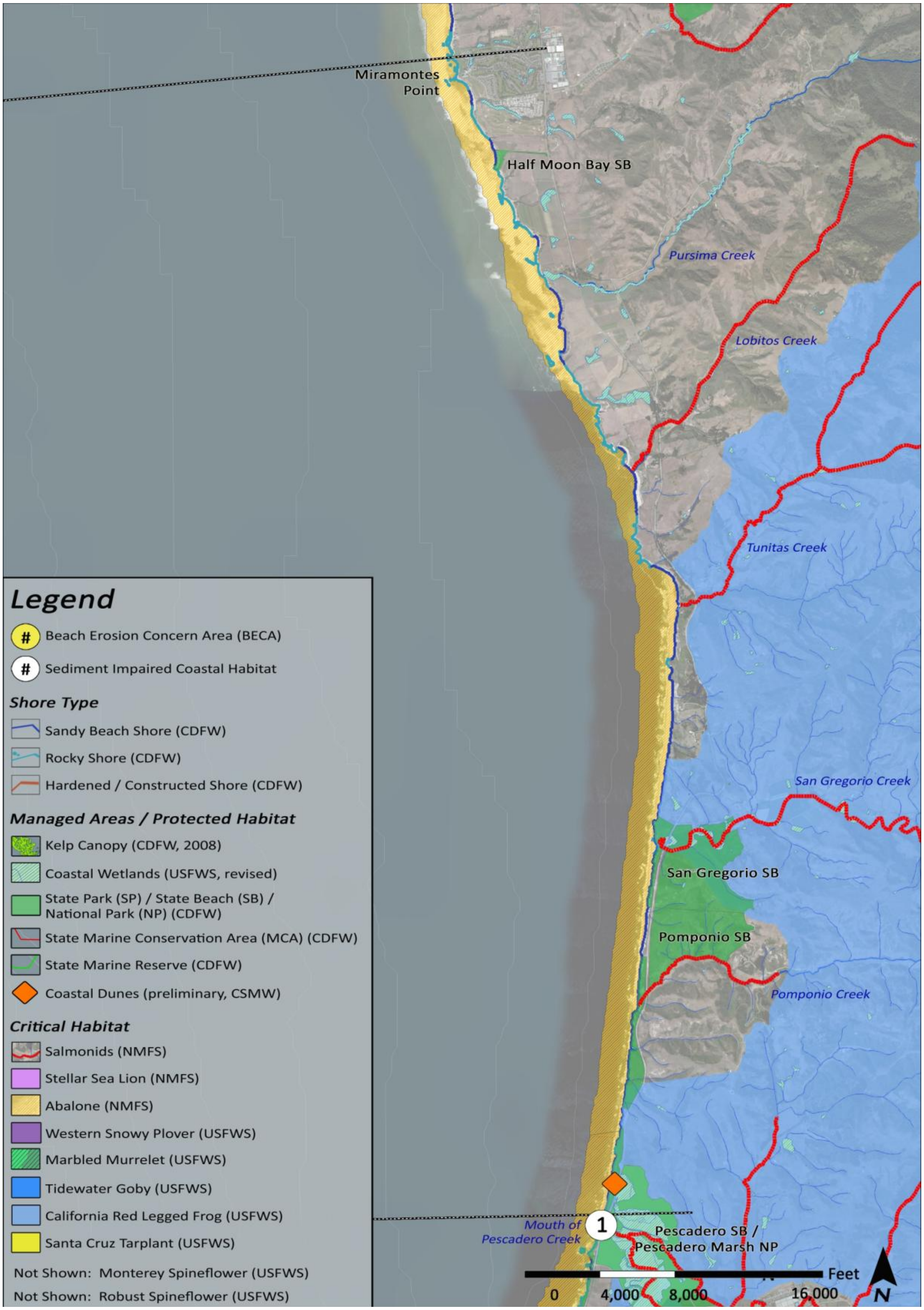


Figure 5-2. Biological resources of Reach 3

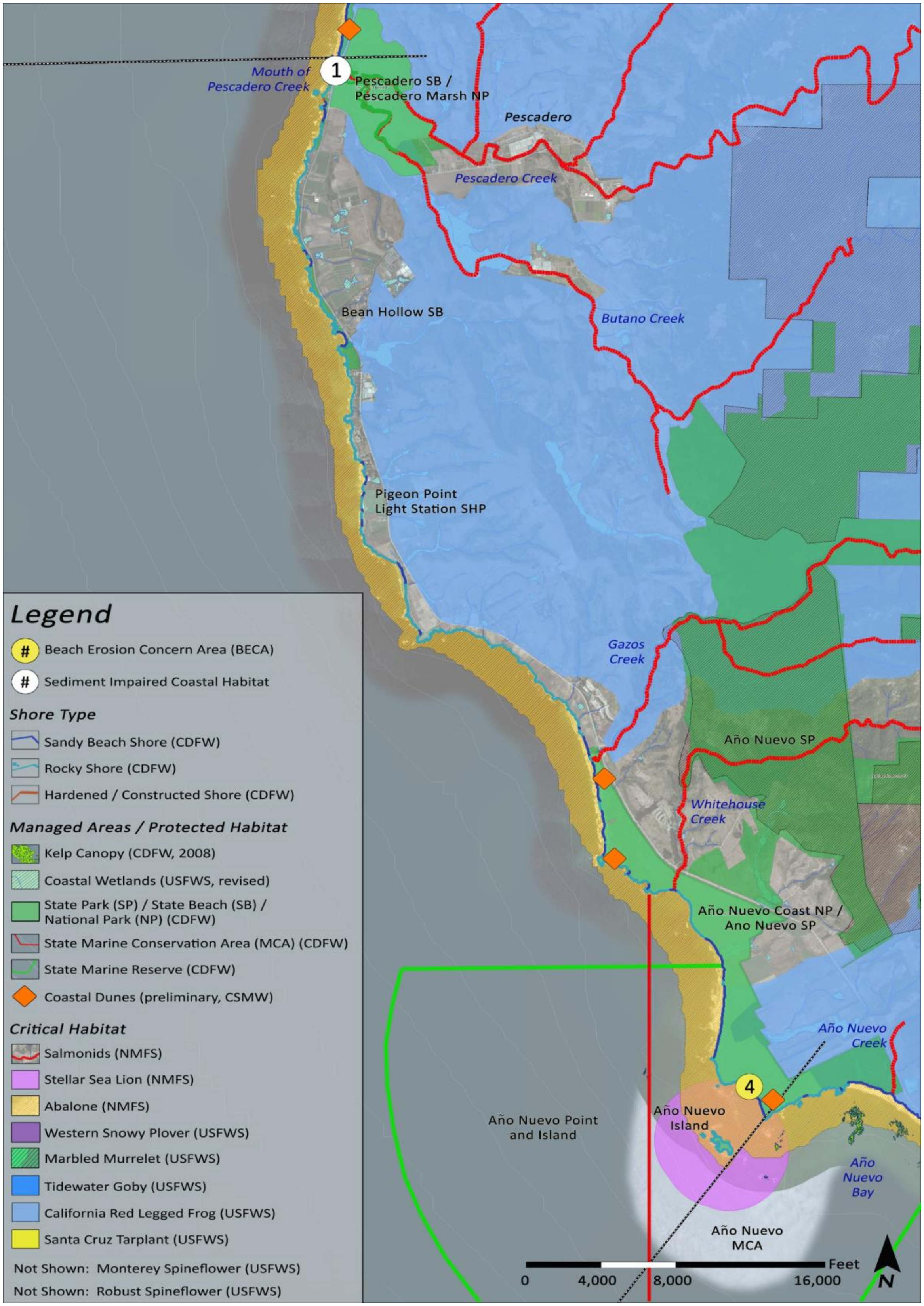


Figure 5-3. Biological resources of Reach 4. Note that the white areas around Point Año Nuevo are reflection from low clouds in the background overhead imagery.

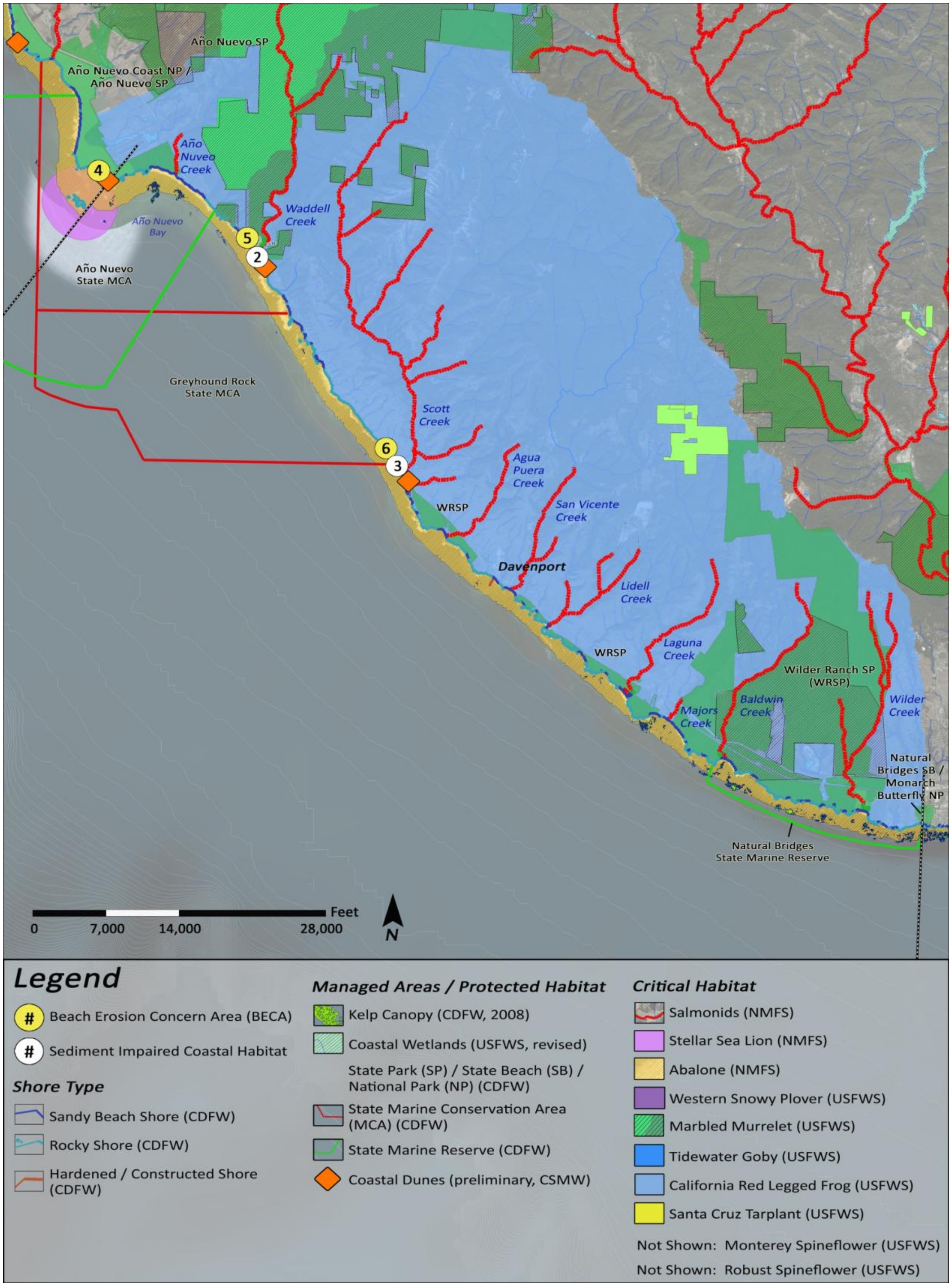

Año Nuevo SP
Año Nuevo Coast NP / Año Nuevo SP
Año Nuevo Creek
Año Nuevo Bay
Waddell Creek
Año Nuevo State MCA
Greyhound Rock State MCA
Scott Creek
Agua Puera Creek
San Vicente Creek
WRSP
Davenport
Lidell Creek
Laguna Creek
WRSP
Wilder Ranch SP (WRSP)
Majors Creek
Baldwin Creek
Wilder Creek
Natural Bridges SB / Monarch Butterfly NP
Natural Bridges State Marine Reserve
Feet
0
7,000
14,000
28,000
N
Legend
Beach Erosion Concern Area (BECA)
Sediment Impaired Coastal Habitat
Shore Type
Sandy Beach Shore (CDFW)
Rocky Shore (CDFW)
Hardened / Constructed Shore (CDFW)
Managed Areas / Protected Habitat
Kelp Canopy (CDFW, 2008)
Coastal Wetlands (USFWS, revised)
State Park (SP) / State Beach (SB) / National Park (NP) (CDFW)
State Marine Conservation Area (MCA) (CDFW)
State Marine Reserve (CDFW)
Coastal Dunes (preliminary, CSMW)
Critical Habitat
Salmonids (NMFS)
Stellar Sea Lion (NMFS)
Abalone (NMFS)
Western Snowy Plover (USFWS)
Marbled Murrelet (USFWS)
Tidewater Goby (USFWS)
California Red Legged Frog (USFWS)
Santa Cruz Tarplant (USFWS)
Not Shown: Monterey Spineflower (USFWS)
Not Shown: Robust Spineflower (USFWS)

Figure 5-4. Biological resources of Reach 5

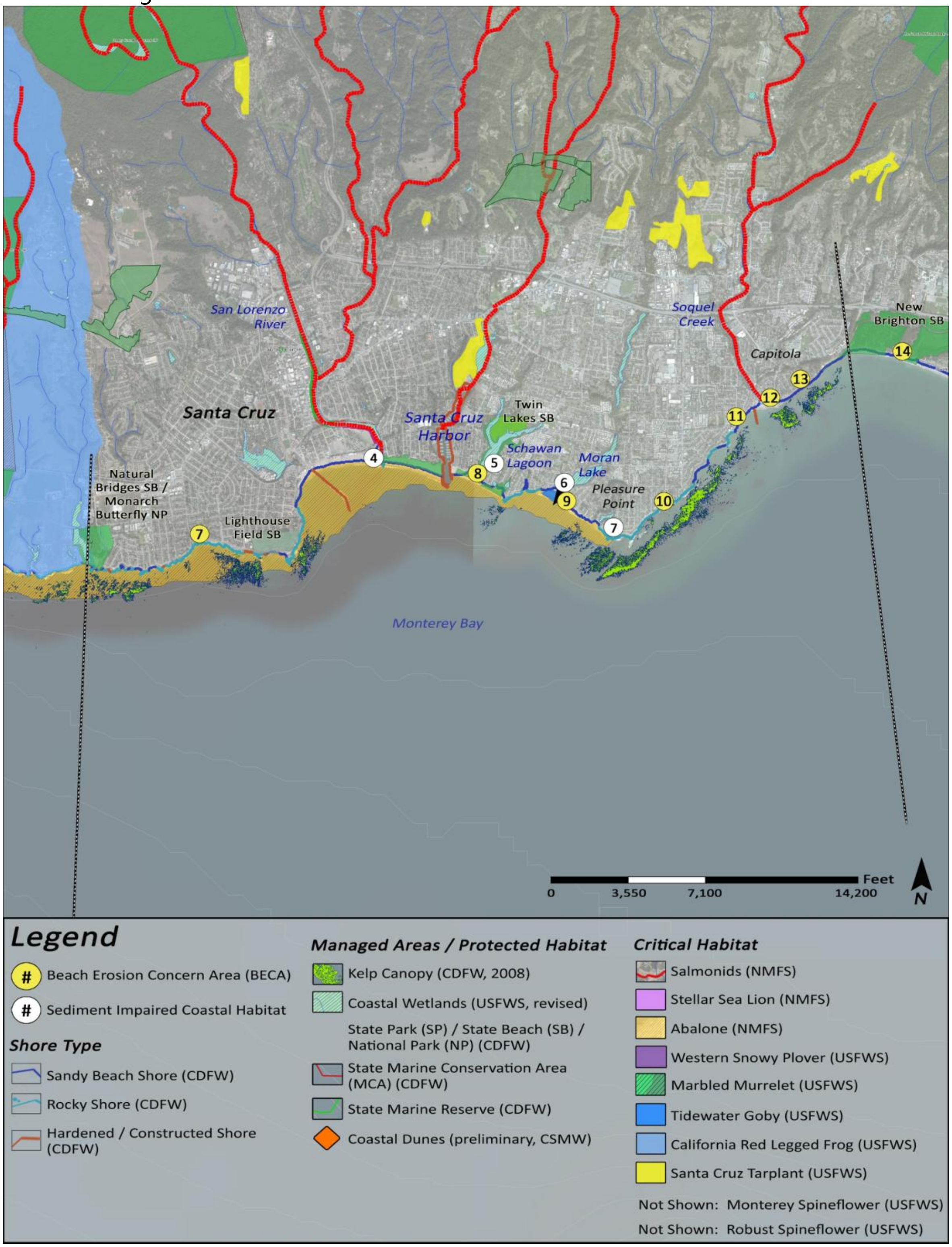


Figure 5-5. Biological Resources of Reach 6

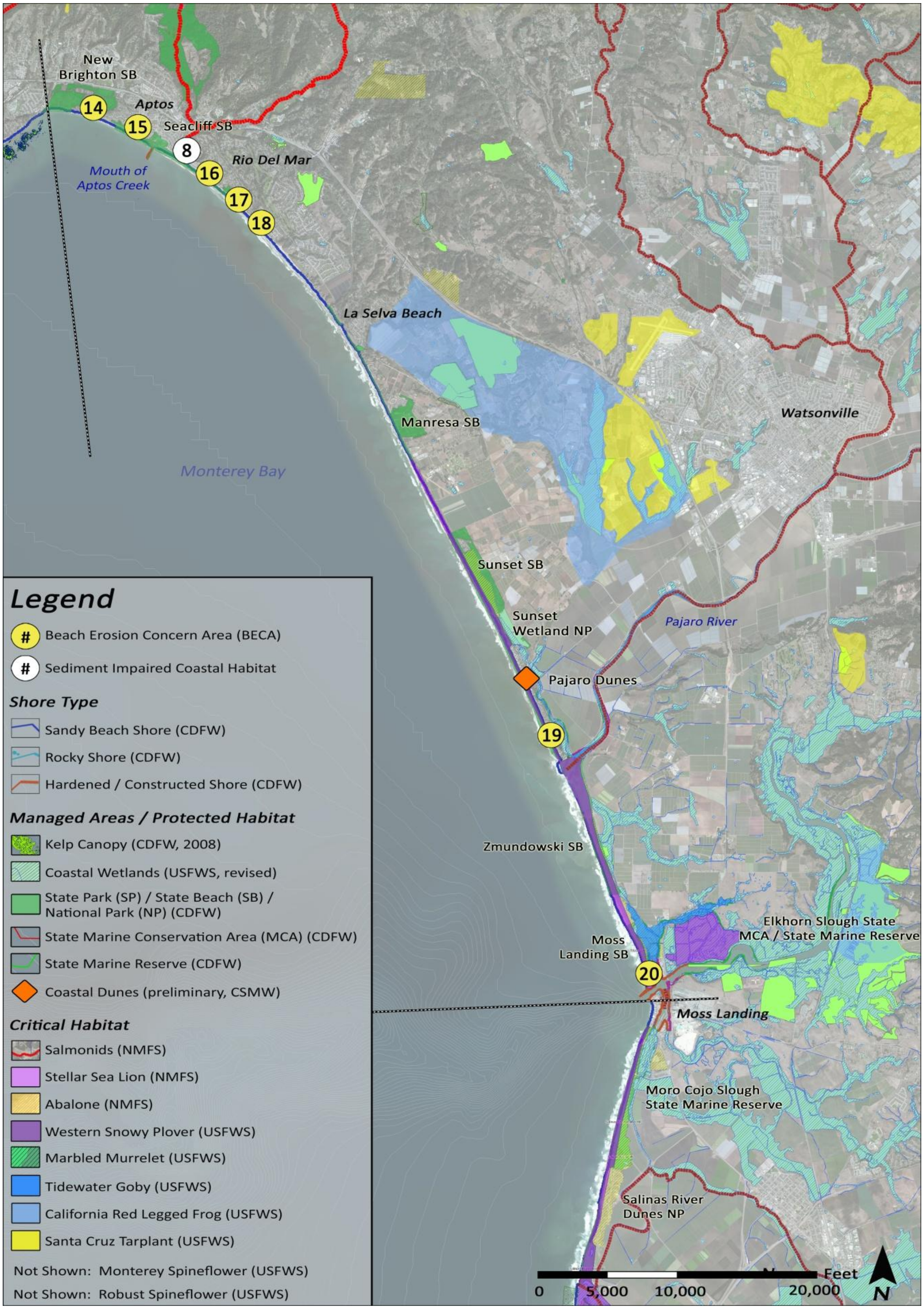


Figure 5-6. Biological Resources of Reach 7

5.1 HABITATS OF THE SANTA CRUZ LITTORAL CELL

Many common and special status species occupy the several different habitats in the Santa Cruz Littoral Cell. And, many of these habitats are ecologically important. These include submarine canyons, estuaries, rocky shores and outcrops, and coastal wetlands.[1] The bays, estuaries, and sloughs are important rearing habitat for steelhead, coho salmon, and tidewater goby. Several birds nest in adjacent coastal dune and sandy beach habitats. Many marine mammals are present year-round or temporarily migrating through the offshore, deep-water habitats. Many of these habitats are protected by various environmental laws, including, but not limited to, the federal Clean Water Act, Coastal Zone Management Act, Endangered Species Act, and Magnuson-Stevens Fishery Conservation and Management Act; and the state Porter-Cologne Act, Endangered Species Act, and California Coastal Act.

5.1.1 Sandy Beaches, Coastal Dunes, and Strands

Sandy beaches, which are in a zone that extends between MHHW and MLLW, include both intertidal foreshore and the dry backshore areas. This habitat is dynamic with constantly shifting sands resulting from wave action, tidal forces, and longshore transport. Sandy beaches are characterized by lower productivity when compared to adjacent intertidal habitat (NOAA, 1992). Beaches with sufficient sand support a variety of resource uses and recreational values, including sunbathing, wading, surfing, and swimming. Furthermore, these areas may support recreational clamming and fishing.

Sandy beaches provide primary habitat for invertebrates; forage, resting, and nesting habitat for birds, including the threatened western snowy plover; and spawning habitat for California grunion, which spawn between March and September. Macrophytic wrack (e.g., algae, kelp, and seagrasses that have washed ashore) provides nutrients for invertebrates and a secondary foraging base for birds, such as gulls and plovers. Snowy plovers nest on sandy beaches within the littoral cell, and their critical habitat is present along Half Moon Bay State Beach (Reach 2, Figure 5-1), along the shoreline in northern Santa Cruz County (Reach 5, Figure 5-4), and along the Monterey Bay shoreline from approximately Manresa State Beach south to Moss Landing Harbor (Reach 7, Figure 5-6). In addition, harbor seals and northern elephant seals are known to haul out on coastal beaches.

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[1] The USGS has produced seafloor character and potential habitat maps along the coast of the littoral cell that extend from approximately 10m depth to the boundary of State waters. Project proponents may find this information useful with regards to environmental impacts of possible offshore sand resources

Coastal sand dunes are terrestrial habitat dominated by vegetated and unvegetated sandy mounds. Dunes are formed from wind blowing sand landward (aeolian transport) with the sand accumulating in drifts and becoming stabilized by vegetation. These habitats are typically present in areas landward of the extreme high water line where rocky shores are not dominant. The beach backshore, which occurs landward of MHW, may transition to dune habitat. Coastal dune and strand habitat may support several of species of plants, insects, reptiles, birds, and mammals (SAIC, 2007), including several special status species.

Coastal strands are the vegetation that grows on the beach backshore or foredune areas. Coastal strand vegetation is adapted to areas affected by strong winds, waves, and salt spray. Typically, vegetation diversity in these areas is rather low, but increases landward. In the littoral cell, there are only a few species of dominant plants. Non-native vegetation further reduces the plant diversity of coastal strands in the littoral cell. Non-native and invasive vegetation includes European beachgrass (*Ammophila arenaria*) and iceplant species (*Carprobrutus* spp. and *Mesembryantheum* spp.), pampas grass (*Cortaderia sellonana*), and ripgut brome (*Broums diandrus*). Special status plants associated with coastal dune and strand habitat that may be the present in the littoral cell include robust spineflower (*Chorizanthe robusta*), Tidestrom's lupine (*Lupinus tidestromii*), and beach layia (*Layia carnosa*). Native coastal strand habitat is considered rare in California.

Sand dunes provide shoreline stability, protection from winter storms, and contribute sand to the coastal zone. Coast dunes and strands are particularly vulnerable to human impact, including beach recreation, beach grooming, development, and hardened shoreline protection. In addition, dune erosion resulting from wind and waves can adversely affect this habitat.

In the littoral cell, sandy beaches account for most of the shoreline in Reaches 1, 2, and 7; and approximately half or less of the shoreline in Reaches 3, 4, 5, and 6. Sand dunes are present at Half Moon Bay State Beach (Reach 2, Figure 5-1), Pescadero State Beach and Pescadero Marsh State Park (Reach 3, Figure 5-2), Año Nuevo State Park (Reaches 4 and 5, Figure 5-3 and Figure 5-4) near the mouths of Waddell and Scott Creeks (Reach 5, Figure 5-5), and just north of the mouth of the Pajaro River (Pajaro Dunes, Reach 7, Figure 5-6).

5.1.2 Coastal Rivers, Creeks, Sloughs, and Lagoons

There are several rivers and creek mouths in the littoral cell, many of which serve as critical habitat for salmonids and tidewater goby. The mouths of rivers and creeks form estuaries and adjacent wetland habitat where salmonids rear and gobies are present during all life stages. At times, some rivers and creeks may be cut off from the ocean by sand bars. Other rivers and creeks, such as San Gregorio Creek; Butano and Pescadero Creeks, which form Pescadero Marsh; Waddell Creek; San Lorenzo River; Soquel Creek; Aptos Creek; and the Pajaro River (along with Watsonville Slough) form larger estuaries and marshes. At the southern end of the littoral cell, the Old Salinas River, Elkhorn Slough, and Moro Cojo Slough flow into the Moss Landing Harbor area creating the protected Elkhorn Slough Marine Conservation Area and State Marine Reserve. Table 5-1provides an overview of the rivers, creeks, sloughs, and lagoons (from north to south) that flow into the ocean within the littoral cell.

Rivers, creeks, sloughs, and lagoons occur in all eight of the SICHs identified in the littoral cell (Figure 5-1 through Figure 5-6). The SICHs include Pescadero Marsh (which includes Butano and Pescadero Creeks), Waddell Creek, Scott Creek, San Lorenzo River, Schwan Lagoon, Corcoran Lagoon, Moran Lake, and Aptos Creek. These areas are discussed in Section 5.2.1.

Table 5-1: Coastal rivers, creeks, sloughs, and lagoons

Reach	Name	Figure	SICH #	Notes [1]
1	Denniston Creek	Figure 5-1	--	
	Deer Creek	Not shown	--	
2	Frenchmans Creek	Figure 5-1	--	Upper reaches (not shown in Figure 5-1) are California red-legged frog critical habitat
	Pilarcitos Creek	Figure 5-1	--	Upper reaches (not shown in Figure 5-1) are California red-legged frog critical habitat
3	Purisima Creek	Figure 5-2	--	
	Lobitos Creek	Figure 5-2	--	
	Tunitas Creek	Figure 5-2	--	California red-legged frog critical habitat
	San Gregorio Creek	Figure 5-2	--	Tidewater goby critical habitat California red-legged frog critical habitat
	Pomponio Creek	Figure 5-2	--	Tidewater goby critical habitat Portions of creek are California red-legged frog critical habitat

Reach	Name	Figure	SICH #	Notes [1]
4	Butano and Pescadero Creeks (flow into Pescadero Marsh)	Figure 5-2 and Figure 5-3	1: Pescadero Marsh	Tidewater goby critical habitat Pescadero Marsh is red-legged frog critical habitat
	Bean Hollow Creek (Flows through Bean Hollow State Beach)	Not Shown.	--	Tidewater goby critical habitat
	Arroyo De Los Frijoles	Figure 5-3	--	Tidewater goby critical habitat
	Gazos Creek	Figure 5-3	--	California red-legged frog critical habitat
	Whitehouse Creek	Figure 5-3	--	Portions are California red-legged frog critical habitat
	Cascade Creek (flows through Año Nuevo State Park	Not shown	--	California red-legged frog critical habitat
	Green Oaks Creek (flows through Año Nuevo State Park	Not shown	--	California red-legged frog critical habitat
5	Año Nuevo Creek	Figure 5-3 and Figure 5-4	--	California red-legged frog critical habitat
	Finney Creek	Not shown	--	California red-legged frog critical habitat
	Elliot Creek	Not shown	--	California red-legged frog critical habitat
	Waddell Creek	Figure 5-4	2: Waddell Creek	Tidewater goby critical habitat California red-legged frog critical habitat Waddell Creek beach is western snowy plover critical habitat
	Scott Creek	Figure 5-4	3: Scott Creek	Tidewater goby critical habitat California red-legged frog critical habitat Scott Creek beach is western snowy plover critical habitat
	Molino Creek	Not shown	--	California red-legged frog critical habitat

Reach	Name	Figure	SICH #	Notes [1]
	Agua Puera Creek	Figure 5-4	--	California red-legged frog critical habitat
	San Vicente Creek	Figure 5-4	--	California red-legged frog critical habitat
	Liddell Creek	Figure 5-4	--	California red-legged frog critical habitat
	Laguna Creek	Figure 5-4	--	Tidewater goby critical habitat California red-legged frog critical habitat
	Majors Creek	Figure 5-4	--	California red-legged frog critical habitat
	Baldwin Creek	Figure 5-4	--	Tidewater goby critical habitat California red-legged frog critical habitat
	Wilder Creek	Figure 5-4		Tidewater goby critical habitat California red-legged frog critical habitat Wilder Creek beach is western snowy plover critical habitat.
6	San Lorenzo River	Figure 5-5	4: San Lorenzo River	
	Schwan Lagoon	Figure 5-5	5: Schwan Lagoon	
	Corcoran Lagoon	Figure 5-5	6: Corcoran Lagoon	Tidewater goby critical habitat
	Moran Lake	Figure 5-5	7: Moran Lake	
	Soquel Creek	Figure 5-5	--	
7	Aptos Creek	Figure 5-6	8: Aptos Creek	Tidewater goby critical habitat
	Pajaro River	Figure 5-6	--	Tidewater goby critical habitat
	Bennett Slough	Figure 5-6	--	Tidewater goby critical habitat

Reach	Name	Figure	SICH #	Notes [1]
	Elkhorn Slough	Figure 5-6	--	Mudflats are western snowy plover critical habitat White tailed kite nest in this area Red-legged frog critical habitat May be critical habitat for Monterey spineflower Southern sea otters utilize the slough
	Old Salinas River (immediately south of the littoral cell)	Figure 5-6	--	

[1] All creeks are considered salmonid critical habitat.

5.1.3 Coastal Wetlands

Coastal wetlands include all lands within the coastal zone that are periodically or permanently covered with shallow water. Coastal wetlands include saltwater marshes, freshwater marshes, brackish marshes, swamps, mudflats, and fens. In the littoral cell, wetlands are typically present near the mouth of rivers and sloughs, and adjacent to estuaries. Wetlands are present within each reach of the littoral cell. Several State Park managed areas encompass large wetland areas, including Pescadero State Beach (Reaches 3 and 4, Figure 5-2 and Figure 5-3); Twin Lakes State Beach (Reach 6, Figure 5-5), and Elkhorn Slough State Marine Conservation Area and State Marine Reserve (Reach 7, Figure 5-6).

5.1.4 Estuaries

Estuaries are some of the most productive habitats in the world. They provide critical habitat for some life stages of several plants, fish, shellfish, and other organisms. Bays, sloughs, and associated wetlands, which provide a variety of habitats – e.g., open water, mudflats, eelgrass beds, marshes, salt flats, and pannes – may support thousands of species of plants, invertebrates, fish, amphibians, reptiles, birds, and mammals (CDFG, 2001; Coastal Conservancy, 2001; as cited in SAIC, 2007). These habitats are considered important nurseries for marine fish, nesting and foraging areas for resident and migratory birds, and critical habitat for several threatened and endangered species, including tidewater goby and salmonids. Estuaries also provide spawning and rearing habitat for several commercially important species, such as herring, halibut, and Dungeness crab.

Estuaries support a variety of recreational (bird watching, educational activities, hiking, boating, fishing), commercial (commercial fishing landings, mariculture, shipping), and military (homeport) uses (SAIC, 2007). Mouths of creeks, esteros, lagoons, rivers, and sloughs provide ecologically important connections between watersheds and the coastal zone. Estuary mouths also serve as inlets that bring tidal exchange to coastal wetlands and as outlets for storm water runoff, nutrients, and sediment supply to the coastline. Invertebrates inhabit inlet sediments, anadromous and marine fish may transit inlets to reach estuarine and riverine spawning and foraging areas, and shorebirds and fish-eating birds forage within inlet areas (SAIC, 2007). The largest estuarine habitat in the littoral cell lies at the southern end of the cell along Monterey Bay and the adjacent Elkhorn Slough (Reach 7, Figure 5-6).

5.1.5 Inlet Embayments

Coastal inlet embayments typically form estuaries, which provide some of the most ecologically productive and heavily used recreational areas in the state. Coastal ports, harbors, and marinas are often located in quiescent sections s of larger bays and along natural indentations of the coastline of California. These areas have a relatively deep-water connection to the ocean and provide more protected habitats than the open ocean because of headlands, structural breakwaters, and distance from the open ocean (SAIC, 2007). These protected embayments support hundreds of species, including a variety of invertebrates, fish, aquatic vegetation, fish-eating birds and waterfowl, and transient occurrence of marine mammals (CCC, 1987; Allen, 1999; MEC, 2000b; Thompson et al., 2000 as cited in SAIC, 2007).

The littoral cell has only three harbors and marinas – Pillar Point Harbor, Santa Cruz Harbor, and Moss Landing Harbor. Pillar Point Harbor is located in the very northern portion of the littoral cell (Reach 1, Figure 5-1). The embayment is formed by a natural outcrop on the west, Pillar Point, and man-made breakwaters to the south. Santa Cruz Harbor is located in Monterey Bay (Reach 6, Figure 5-5). Santa Cruz Harbor includes inland marina and docking facilities on a natural creek. Moss Landing Harbor is located in the middle of Monterey Bay at the mouth of Elkhorn Slough (Reach 7, Figure 5-6).

5.1.6 Littoral Habitats

Littoral habitats are found in the nearshore waters off the continental shelf, from the high water mark (typically MHW) to a depth of approximately 660 feet. Littoral habitats include the supralittoral or spray zone, which is just above the high water mark; eulittoral or intertidal zone, which is regularly inundated, and the sublittoral zone, which extends from the eulittoral zone to the continental shelf.

5.1.7 Sublittoral Habitats

Sublittoral habitats include the nearshore waters from the intertidal zone to a depth of approximately 660 feet. Much of the sea floor in this area comprises unconsolidated mud and sand with some areas of hard bottom and rocky outcrops near the shore. Hard-bottom seafloor is found in the region of Half Moon Bay and Santa Cruz and areas along the shore. The sublittoral zone comprises most of the aquatic habitat in the Santa Cruz Littoral Cell.

Species composition and diversity of marine resources associated with soft substrates differ with sediment type, which often varies according to depth and energy gradients. The nearshore zone of the sublittoral zone is relatively shallow, and waves and currents interact with the sandy bottom causing sands to shift with coarser sediments settling closer to shore. Fewer species of invertebrates live in sandy sediments in the shallow energetic nearshore zone than in the finer sandy to mixed sediments offshore, probably because of greater sediment stability offshore (Oliver et al., 1980; Thompson et al., 1997, as cited in SAIC, 2007). The area is occupied by small, mobile, deposit-feeding crustaceans (Sanctuary Integrated Monitoring Network [SIMoN]).

The deeper areas of the sublittoral zone experience less wave action, resulting in finer sediments settling on the seafloor. This area is characterized by more stable, fine sands and sediment with a significant amount of mud. The benthic communities are composed of polychaete worms and other sessile and suspension feeding organisms. Benthic fish are also more abundant in the deeper sublittoral zones with finer sediments, compared to the shallower areas with coarser sands.

Pelagic organisms found in this habitat include several species of plankton and zooplankton, squid, octopus, salmon, albacore, rockfishes, mackerel, anchovy, and several marine mammals. California sea lions, harbor porpoise, sea otters, and several species of whales are often observed in this area (NOAA, 1992). Important fisheries are associated with soft bottom habitats (e.g., Dungeness crab, halibut, Washington clam), but generally yield less overall commercial catch value than hard bottom or pelagic fisheries (CDFG, 2001, as cited in SAIC, 2007). Marine birds also feed in this habitat.

5.1.8 Intertidal Zone

The intertidal zone, also known as the foreshore, is the area that is regularly inundated during high tides and exposed during low tides. The intertidal zone is either rocky or sandy, both of which abound in the littoral cell. The size of the intertidal zone is not fixed; rather, it varies with tidal range and the slope of the shore, and steep shorelines generally have a smaller range of intertidal rocky habitat.

5.1.8.1 Sandy Intertidal Zone

Sandy intertidal zones are characterized by soft bottom sands, shells, and occasionally cobble in the area between the highest and lowest tides. Sandy intertidal zones provide important habitat for various organisms living under the surface of the sand, including clams, crabs, and other invertebrates. This habitat also serves as an important feeding ground for invertebrates and shore birds.

5.1.8.2 Rocky Intertidal Zone

Rocky intertidal habitat occurs on rocky substrate between the lowest and highest tidal water levels. Rocky substrate habitats are capable of supporting hundreds of species of plants, invertebrates, and fish (Pequenat, 1964; Abbott et al., 1980; as cited in SAIC, 2007). The most productive reef habitats are characterized by a variety of substrate relief and vegetation that provide important shelter and living space functions. In contrast, sand-scoured, low-lying reef and cobble substrate support little marine life (Ambrose et al., 1989; MEC 2000a, SAIC 2006 as cited in SAIC 2007). Organisms inhabiting this habitat include: red, brown and green algae; sessile invertebrates such as mussels, barnacles and anemones; mobile grazers and predators, including crabs, amphipods, littorine snails, limpets, sea stars, sea urchins, and abalone. Tidepool fish include the striped surfperch, tidepool sculpin, tidepool snailfish, and cabezon. In the littoral zone area, rocky intertidal habitat is critical habitat for black abalone.

The physical habitat is very dynamic, with tides constantly changing the water level and waves continuously breaking on and washing over the organisms and substrate. Organisms inhabiting rocky tidal zones are exposed to air and inundated by sea water daily. When the tide is in and waves are crashing down, stationary organisms can be dislodged and removed from their rocky homes. When the tide is out, organisms desiccate (dry out) and are more visible to predators. The organisms present in this habitat are able to withstand the periodic desiccation, high temperature and light, low salinities, and strong wave action typical of this habitat (NOAA 1992).

Mobile animals prevent desiccation by finding tide pools, vegetation, or crevices in rocks to reside until the tide comes back in. Non-mobile organisms anchor tightly to the rocks and either close their shell structures or find other ways to prevent desiccation. Mussels close their shells during low tide and sea anemones fold inward to prevent drying out and to protect against predation.

Rocky tidal habitat is further characterized by zonation, which is defined by the amount of time rocks are exposed to air and water. Zones include the splash zone, upper intertidal, mid-intertidal, and lower intertidal. Zonation is determined by wave action and tidal range, physical tolerances, larval settlement, organism behaviors, intra- and interspecies competition, and predation and algal grazing. Each zone is associated with different water-air exposure ratios and species composition:

Splash zone: The splash zone – or supratidal zone – is the most upland zone. It is typically only splashed by waves, and organisms are rarely fully inundated. Organisms present in the splash zone are typically cyanobacteria and barnacles.

Upper tidal zone: The upper tidal zone is exposed to air most of the time, and species inhabiting this area have adapted unique life histories to survive. Barnacles are the most abundant species in this zone. Competition for space is typical in this zone.

Mid-intertidal zone: The mid-intertidal zone is densely populated. Mussels are the most abundant species, forming large beds anchored to the rock and adjacent mussels. Other species that may be present in tide pools in this area include sea stars, crabs, urchins, anemones, and other organisms. Competition for space is common in this zone, particularly between barnacles and mussels.

Lower intertidal zone: The lower intertidal zone is exposed to air only during the lowest ebb tides (i.e., spring tides), and organisms must be able to withstand continuous wave force. This zone is characterized by having the most species richness of all rocky intertidal zones. Green anemone, purple sea urchins, crabs, sea stars, abalone, and other invertebrates are commonly found in this zone. Seaweed and surf grass is also present in this zone.

Well-developed, rocky intertidal habitats also support recreational activities such as tide pooling and fishing and diving. Hard-bottom species (e.g., California lobster, rock crab, sea urchins, octopus, sea cucumber, sheephead) account for the high value of commercial landings in these habitats as well (CDFG 2001, as cited in SAIC 2007).

5.1.9 Rocky Subtidal

Rocky subtidal habitat is a highly productive, diversely populated habitat. It is home to several species of rockfish, algae, crustaceans, mollusks, and other marine organisms. Rocky subtidal areas, which provide habitat for white and black abalone, serve as important abalone critical habitat. Much of the rocky subtidal habitat in the littoral cell is characterized by dense kelp forests, comprised of giant kelp (*Macrocytstis pyrifera*) and bull kelp (*Nereocystis pyrifera*).

5.1.10 Kelp Forest, Eelgrass and Surfgrass

Three submerged aquatic vegetation (SAV) habitats of special interest in California coastal waters are: kelp forests and beds, surfgrass beds, and eelgrass meadows (SAIC, 2007). The SAV habitats provide important sources of organic matter, substrate, shelter, and nursery functions for many species (SAIC 2007). Often, hard-bottom surfgrass (Phyllospadix spp.) and kelp-bed habitats are located inshore and offshore of each other, respectively, on the same reef system (SAIC 2007). Eelgrass grows in soft bottom habitat. More species of invertebrates and fish are typically associated with SAV than non-vegetated habitats (Fonseca et al., 1991; Hoffman, 1996; MEC, 2000b; as cited in SAIC, 2007).

Surfgrass is typically found between the intertidal zone and waters approximately 16 feet deep; however, it can grow in waters up to 50 feet deep. Surfgrass beds are highly productive areas supporting invertebrates and many species of algae (SiMON). They also provide nursery habitat for commercially important California spiny lobster, shelter for a variety of invertebrates and fish, and forage habitat for birds (Stewart and Meyers, 1980; DeMartini, 1981; as cited in SAIC, 2007). Surfgrass beds are found throughout the littoral zone in areas of rocky shores and outcrops.

Kelp beds grow in waters just beyond the breaker zone to depths of about 100 feet. They support hundreds of species of invertebrates and fish, many of which are prey for marine mammals (Foster and Schiel, 1985; as cited in SAIC, 2007). Kelp forests provide critical habitat for encrusting animals such as sponges, bryozoans, and tunicates, as well as for juvenile fish, mollusks such as abalone, algae, and other invertebrates. Kelp forests are the primary foraging area for southern sea otters. Fish associated with kelp beds include greenling, lingcod, bocaccio, and many species of surfperches and rockfish. Gray whales have been reported to feed near kelp forests and to seek refuge in them from predatory killer whales (Baldridge, 1972 as cited in NOAA, 1992). Kelp also provides a food resource for fish and for grazing and detritus feeding invertebrates, such as isopods and sea urchins.

Predators, such as sea stars and sea otters, are also active there. Harbor seals are also commonly associated with kelp forests in this area (NOAA, 1992).

Two species of kelp grow in the littoral zone – giant kelp (Macrocytstis pyrifera) and bull kelp (Nereocystis pyrifera). Kelp beds are present in the nearshore waters throughout the littoral cell. They are documented in Half Moon Bay (Reaches 1 and 2, Figure 5-1), Año Nuevo Bay and in waters off the shore in Reach 5 (Figure 5-4), and in Monterey Bay (Reaches 6 and 7; Figure 5-5 and Figure 5-6).

Eelgrass meadows occur on soft substrates in protected coastal areas, mainly embayments, but also may occur in the nearshore where suitable conditions exist (SAIC, 2007). In this littoral cell, eelgrass beds are documented in Elkhorn Slough (Reach 7, Figure 5-6).

5.1.11 Canyon and Deepwater Habitats

The Monterey Submarine Canyon is the largest submarine canyon along the North American coast. The approximately 676-square-nautical-mile canyon (NOAA, 1992) lies in the center of Monterey Bay and partially in the southern part of the littoral cell in Reaches 6 and 7. The canyon complex includes several canyons located along the continental shelf and extends west into the Pacific Ocean. The Soquel Canyon branches off of the Monterey Canyon just northwest of the head of the canyon and is also located in Monterey Bay. The Soquel Canyon and surrounding waters make up the approximately 14,200 acre Soquel Canyon State Marine Conservation Area, located approximately 7 miles south of Santa Cruz and 8 miles west of Moss Landing. Much of the sand carried by longshore currents ends up in the submarine canyons each year (SIMoN).

The canyon floor and the waters over the canyon provide a unique habitat that extends from the shallow waters of the continental shelf to the deep sea. Although the diverse habitat of the canyon supports a wide diversity of organisms, most organisms are not unique to the canyon, being found at similar depths outside of the canyon (SIMoN). Several fish and invertebrates are known to congregate in the canyon heads and on its walls, and rocky outcrops are colonized by several invertebrates, including feather stars, corals, tunicates, and rock fishes. Soft sediments on the canyon floor also support a diverse community of invertebrates and fishes (SIMoN). Upwelling in the area supports most of the primary productivity for the entire Monterey Bay. The canyon edge serves as a feeding area for endangered blue and fin whales, Pacific white-sided dolphins, northern right whale dolphins, Risso's dolphins, Dall's porpoise, and possibly the blue shark (NOAA, 1992).

The Monterey Submarine Canyon is susceptible to increased marine debris and contaminant loads because plastics, abandoned fishing gear, and contaminated sediment can concentrate in the deep waters. Increased contaminated sediment loads also increase bioaccumulation risk in aquatic organisms inhabiting the canyon (SIMoN).

5.2 Managed areas

There are several state- and federal-managed areas in the littoral cell – State Marine Conservation Areas, State Marine Reserves, State Beaches, and State Parks. The BECAs or SICHs identified in this document may be present in some of these managed areas. In addition, future sediment management activities not identified herein may become part of the regional sediment management plan in the Santa Cruz littoral cell. Activities conducted in managed areas may require additional permissions (e.g., environmental approvals or permits). This section discusses the state-managed areas. Local (i.e., regional, county, or city managed areas) are not identified herein. Section 6.3.1 discusses federally-managed areas (primarily the Monterey Bay National Marine Sanctuary). Project planners should consult with regional or local governments to ensure that all environmental approvals are obtained prior to conducting sediment management activities in locally-managed areas. They can use Section 6 as a starting point.

5.2.1 State Marine Conservation Areas and Reserves

There are several State Marine Conservation Areas and Reserves in the littoral cell (Table 5-2), which is located entirely within the NOAA-managed MBNMS. Many of these managed areas are home to special status species, such as marine mammals and ESA-protected fish. They also harbor important habitats protected by other state and federal environmental statutes. Marine protected areas are similar to state parks; they help protect and restore marine organisms. In some conservation areas and reserves, many activities are restricted. Other areas may allow some recreation or fishing. In the most restrictive protected areas, the taking of any species is prohibited.

Table 5-2: State Marine Conservation Areas and Reserves

Reach	State Marine Conservation Areas and Reserves	Figure	BECA	Notes
1 – 7	Monterey Bay National Marine Sanctuary (MBNMS)	Figure 5-1 to Figure 5-6	--	Entire littoral cell is within the MBNMS. All sediment management activities conducted in the sanctuary will require approval from the MBNMS.

Reach	State Marine Conservation Areas and Reserves	Figure	BECA	Notes
1	Pillar Point State Marine Conservation Area	Figure 5-1	--	Take of all living marine resources is prohibited; except for recreational take of pelagic fish, Dungeness crab, and squid.
1	James V. Fitzgerald Marine Reserve	Figure 5-1	--	Includes 5.5 miles of coastline along the park. Considered an area of special biological significance, which is a state water quality protection area.
4 and 5	Año Nuevo Point and Island and Año Nuevo State Marine Conservation Area	Figure 5-2 & Figure 5-3	BECA 4: Año Nuevo State Reserve	Area includes waters from the mean high tide line to 200 feet shoreward. All species are protected in this area. Only hand harvesting of giant kelp is allowed. Several pinnipeds use the island and beaches as haul outs and rookeries.
4 and 5	Greyhound Rock State Marine Conservation Area	Figure 5-2 & Figure 5-3	--	Area includes waters from the MHT line to three nautical miles offshore. Recreational and commercial fishing of giant kelp (by hand), salmon, and market squid. Recreational hook and line fishing of other fin fish is also allowed. All other species are protected.
5	Natural Bridges State Marine Reserve	Figure 5-4	--	Includes waters from the MHT line to a distance of 200 feet seaward. No fishing or other collection of organisms is allowed.
7	Elkhorn Slough State Marine Conservation Area National Estuarine Research Center	Figure 5-6	BECA 20: Moss Landing / Elkhorn Slough	Elkhorn Slough has ongoing and proposed restoration projects. Only recreational hook and line fishing of fin fish and clamming is allowed. Take of all other species is prohibited.
7	Elkhorn Slough State Marine Reserve	Figure 5-6	BECA 20: Moss Landing / Elkhorn Slough	Take of any species is prohibited.
7	Soquel Canyon State Marine Conservation Area	Not shown (offshore)	--	Includes 14,200 acres located 8 miles west of Moss Landing and 7 miles south of Santa Cruz. Only recreational and commercial fishing of pelagic finfish is allowed.

5.2.2 State Parks and State Beaches

The littoral cell is home to several state beaches and parks (Table 5-3), and the California Department of Parks and Recreation has jurisdiction over activities conducted within them.

Table 5-3: State Parks and State Beaches

Reach	Name	Figure	BECA or SICH	Notes
2	Half Moon Bay State Beach	Figure 5-1	--	Western snowy plover critical habitat is present in this area.
3	San Gregorio State Beach	Figure 5-2	--	San Gregorio Creek is tidewater goby critical habitat California red-legged frog critical habitat
3	Pomponio State Beach	Figure 5-2	--	Tidewater goby critical habitat
3 and 4	Pescadero State Beach / Pescadero Marsh Natural Reserve	Figure 5-2	SICH 1: Pescadero Marsh	Tidewater goby critical habitat Pescadero Marsh is red-legged frog critical habitat
4	Bean Hollow State Beach	Figure 5-3	--	Bean Hollow Creek is tidewater goby critical habitat
4	Pigeon Point Light Station State Historic Park	Figure 5-3	--	
4	Año Nuevo State Park	Figure 5-3 & Figure 5-4	BECA 4: Año Nuevo State Reserve	Marbled murrelet critical habitat California red-legged frog critical habitat Waddle creek runs through this park and is tidewater goby critical habitat. Pinniped haul out and rookery area
5	Wilder Ranch State Park	Figure 5-4	--	Wilder Creek beach is western snowy plover critical habitat Marbled murrelet critical habitat California red-legged frog critical habitat
5 and 6	Natural Bridges State Beach	Figure 5-4 & Figure 5-5	--	Monarch butterflies habitat Western edge California red-legged frog habitat
6	Lighthouse Field State Beach	Figure 5-5	--	
6	Twin Lakes State Beach	Figure 5-5	BECA 8: Twin Lakes State Beach	Santa Cruz tarplant critical habitat
7	New Brighton State Beach	Figure 5-5 & Figure 5-6	BECA 14: Pot Belly Beach – New Brighton State Beach	--
7	Seacliff State Beach	Figure 5-6	BECA 15: Seacliff State Beach – North BECA 16: Seacliff State Beach – South	--

Reach	Name	Figure	BECA or SICH	Notes
7	Manresa State Beach	Figure 5-6	--	Monterey spineflower critical habitat
7	Sunset State Beach /	Figure 5-6	--	Western snowy plover critical habitat Robust spineflower critical habitat
7	Pajaro Dunes	Figure 5-6	--	Western snowy plover critical habitat
7	Zmundowski State Beach	Figure 5-6	--	Western snowy plover critical habitat Monterey spineflower critical habitat
7	Moss Landing State Beach	Figure 5-6	--	Western snowy plover critical habitat Pinniped haul out area

5.3 Fish and Wildlife of the Littoral Cell

The Santa Cruz littoral cell is located in one of the most diverse biological areas along the California Coast. The coastal waters are known for their biological richness and unique habitats, and most of the coastline is rugged and natural. The waters of the littoral cell are used by more than 30 species of marine mammals, many of which are resident; 130 species of seabirds; more than 500 species of fish; and countless invertebrates.

Common seabirds present in the littoral cell include loons (common, Pacific, red-throated, and yellow-billed); grebes (Clark's, western, and others); albatross (black-footed, laysan, and short-tailed); several species of shearwaters; petrels; American white and California brown pelicans; cormorants (Brandt's, double-crested, and pelagic); herons and egrets; rails; coots; plovers; sparrows; and several other birds[2] (MBNMS 2014). Many seabirds nest on the islands off the coast of the littoral cell, including Año Nuevo Island.

Common fish in the littoral cell include grunion; black and Pacific hagfish; various sharks; skates (big skate, California, sandpaper, and others); white sturgeon; eels; American shad; Pacific herring; threadfin shad; Pacific sardine; smelt (surf, whitebait, night); several species of rockfish; sablefish; kelp and rock greenlings; lingcod; sculpins; poiachers; snailfish; and several other species[3] (Burton and Lea 2013).

5.3.1 Laws and Regulations Governing Special Status Species

The littoral cell is home to several special status species. This section discusses the organisms present in the littoral cell. It begins with an overview of the laws and regulations

[2] For a list of birds in the littoral cell, see MBNMS seabirds and shorebirds. Available at: http://montereybay.noaa.gov/sitechar/birtab1.html.

[3] For a complete list of fish, see Burton and Lee (2013). Available at: http://montereybay.noaa.gov/research/techreports/mbnms_fishes_checklist.pdf

governing special status species and provides details of the special status species present in the littoral cell.

The Santa Cruz littoral cell and adjacent upland areas provides habitat for several special status species, including federal and state ESA-protected species, marine mammals, California Department of Fish and Wildlife (CDFW) fully protected (FP) species, and essential fish habitat. Prior to conducting sediment management activities, project planners may need to consult with and obtain permits from the United States Fish and Wildlife Service (USFWS), National Marine Fishery Service (NMFS), or the CDFW. This section provides a brief overview of the various statues and regulations protecting special status species. Section 5.3.1.7 provides details regarding laws and regulations governing special status species.

5.3.1.1 Federal Endangered Species Act (16 U.S.C. § 1531 et seq.)

These species include federally threatened (FT), endangered (FE), critical habitat (CH), and proposed critical habitat (PCH), including: California least tern (*Sterna antillarum browni* [FE, CH]), marbled murrelet (*Brachyramphus marmoratus marmoratus* [FT]), western snowy plover (*Caradrius alexandrines nivosus* [FT, PCH]), South-Central Coast California steelhead (*Oncorhynchus mykiss* [FE, PCH]), tidewater goby (*Eucyclogobius newberryi* [FE]), Southern sea otter (*Enhydra lutris nereis* [FT]), green sturgeon (FT, CH), blue whales (FE), fin whales (FE), and humpback whales (FE).

All or portions of the littoral cell are considered critical habitat for some threatened and endangered species. Critical habitat receives protection under the federal ESA through prohibition against destruction or adverse modification. The ESA defines critical habitat as specific areas within the geographical area, occupied by the species at the time of listing, that contain the physical or biological features essential to conservation of the species, and that may require special management considerations or protection. Critical habitat also includes specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. Primary constituent elements of critical habitat include the specific physical and biological features essential to conservation. The federal ESA defines a primary constituent element as a physical or biological feature essential to the conservation of a species for which its designated or proposed critical habitat is based on (50 CFR § 424.12(b)). Primary constituent elements include space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and habitats that are protected from disturbance or are representative of the species historic geographic and ecological distribution.

A detailed discussion of critical habitat present in the littoral cell is provided for each species for which critical habitat is designated. Only a brief discussion is provided for species with designated critical habitat that is not within the boundaries of the littoral cell.

Prior to conducting sediment management activities, project planners must consult with the USFWS or NMFS or both to ensure that the activity will not jeopardize the continued existence of threatened or endangered species, or adversely modify critical habitat. Those agencies may issue a biological opinion and incidental take statement for sediment management activities. Additionally, reasonable and prudent measures may be included in the biological opinion to further avoid or minimize impacts to listed species.

5.3.1.2 Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. § 1361 et seq)

Species protected under the MMPA that use the littoral cell include: pinnipeds such as Pacific harbor seals, northern elephant seals, California sea lions, stellar sea lions, and northern fur seals; cetaceans may also pass through the Monterey Bay area, including blue whales, fin whales, humpback whales, right whales, and sperm whales; and fissipeds such as California sea otters and southern sea otters. Prior to conducting sediment management activities, project planners must consult with the NMFS to ensure that the proposed action will not adversely affect marine mammals. The NMFS may issue an incidental take permit for these activities.

5.3.1.3 Magnuson-Stevens Fishery Conservation and Management Act Amendments of 1996 (16 U.S.C. § 1801 et seq)—Essential Fish Habitat (EFH)

The MSFCMA defines EFH to be "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Furthermore, waters are defined as "aquatic areas and their associated physical, chemical, and biological properties that are used by fish," and may include areas historically used by fish. Substrate is defined as "sediment, hard bottom, structures underlying the waters, and associated biological communities"; necessary means "the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem"; and spawning, breeding, feeding or growth to maturity covers the full life cycle of a species.

The MSFCMA also requires NOAA Fisheries to designate a Habitat Area of Particular Concern (HAPC) for each species. HAPCs are subsets of EFH that are rare, particularly susceptible to human-induced degradation, ecologically important, or are located in an environmentally stressed area. The HAPCs are not afforded additional protection beyond that of the EFH; however, federal projects with potential adverse impacts on HAPCs will be given more scrutiny during the consultation process.

The Santa Cruz littoral cell is located within an area designated as EFH for three Fishery Management Plans (FMPs): the Pacific Coast Salmon, the Coastal Pelagics, and Pacific Groundfish. Many of the 87 species protected under this law are known to occur in the area. In addition, the Monterey Canyon is listed as an area of interest. Areas of interest are discrete areas that are of special interest because of their unique geological and ecological characteristics.

Pacific Salmonid Fishery Management Plan: The current Pacific Salmon FMP provides management protection for the coast-wide aggregate of natural and hatchery salmon species within the EEZ that are fished off the coasts of Washington, Oregon, and California. These species include Chinook, coho, pink (only in odd-numbered years), and all salmon protected under the ESA. Steelhead are not protected under the FMP. The Pacific Salmon FMP also contains requirements and recommendations for the EFH for the managed salmon species. The EFH includes marine waters within the EEZ, and estuarine and freshwater habitat within Washington, Oregon, California, and Idaho. The action area is within designated EFH for Pacific salmon species. Coho salmon are the only Pacific Salmon FMP salmonid that exists in the littoral cell.

Pacific Groundfish Fishery Management Plan: The Pacific Coast Groundfish FMP provides protection for 83 groundfish species throughout the Pacific Coast of the United States, most of which are found in the littoral cell. Because groundfish species are widely dispersed during certain life stages, EFH for groundfish species is correspondingly large. Therefore, EFH for Pacific Coast Groundfish includes: the entire Exclusive Economic Zone (EEZ) and all the waters from MHHW to the upriver extent of saltwater intrusion in river mouths along the coasts of Washington, Oregon, and California. The Pacific Coast Groundfish FMP describes seven composite units that comprise pacific groundfish EFH: estuarine, rocky shelf, non-rocky shelf, canyon, continental slope/basin, neritic zone, and oceanic zone.

The overall extent of groundfish EFH includes all water and substrate in depths that are less than or equal to 11,500 feet to MHHW or the upriver extent of saltwater intrusion (upstream area and landward where waters have salinities less than 0.5 parts per thousand), seamounts in depths greater than 11,500 feet, and areas designated as HAPCs (for Pacific groundfish, HAPCs include estuary, sea grass, kelp canopy, and rocky habitats).

Coastal Pelagic Fishery Management Plan: The Coastal Pelagic FMP provides protection for commercial pelagic species, including four finfish: Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*); market squid (*Loligo opalescens*); and various species of krill and euphausiids. All of these species are present in the littoral cell.

The EFH for the finfish species and squid is based on a thermal range bordered by the geographical area where these species occur at any life stage. It includes all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington, offshore to the limits of the EEZ and above the thermocline where sea surface temperatures range between 50 and 78 degrees Fahrenheit. The EFH for krill extends the length of the West Coast from the shoreline to the 6,000 foot isobath and a depth of 1,300 feet (NMFS, 2011a).

5.3.1.4 Migratory Bird Treaty Act of 1918 (16 U.S.C. §§ 703-712)

The Migratory Bird Treaty Act (MBTA) established a federal prohibition to "…pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess…at any time, or in any manner, any migratory bird…or any part, nest, or egg of such bird." (16 U.S.C. 703). The littoral cell is on the Pacific Flyway. Several migratory birds migrate through the littoral cell, stopping to feed, roost, and even nest. Prior to conducting sediment management activities, project planners should contact the USFWS to discuss migratory birds in the project area and ensure that the project would not adversely affect migratory birds.

5.3.1.5 California Endangered Species Act

The California Endangered Species Act (CESA) protects all native species of fish, amphibians, reptiles, birds, mammals, invertebrates, and plants - as well their habitats - threatened with extinction or in significant decline. Several species protected under the CESA are also protected under the federal ESA. The CESA makes it unlawful to harm or take (defined in Fish and Game Code section 86) listed species without an incidental take permit or consistency determination with a federal ESA biological opinion and incidental take statement. Furthermore, the CESA requires 'full mitigation' for take of any listed species. Prior to conducting sediment management activities, project planners should coordinate with the CDFW on potential impacts to state-listed species and obtain the appropriate approvals.

5.3.1.6 CSFW Fully Protected (FP) Species

California provides additional protection for fully protected species under FGC sections 3511, 4700, 5050, and 5515. Each of these sections prohibits take or possession at any time of fully protected species. Six fully protected species are present in the littoral cell – the Santa Cruz long-toed salamander, California brown pelican, California least tern, white-tailed kite, southern sea otter, and northern elephant seal. The CDFW is not able to issue a CESA incidental take permit or consistency determination if a project will result in the take of a fully protected species. Prior to conducting sediment management activities, project planners should work with the CDFW to ensure that fully protected species are not affected by project activities.

5.3.1.7 Special Status Species

The littoral cell is habitat for several special status species, including species protected under state and federal ESAs, protected marine mammals, migratory birds, and other state protections, such as fully protected species or species protected under various California Fish and Game (CFG) codes. This section identifies the special status species that have the potential to be affected by sediment management activities in the littoral cell. Details regarding the listing status and species range, life history, habitat use in the littoral cell, and other information for species that have the potential to be affected by regional sediment activities are provided in Appendix A. Species which may be present in the littoral cell, but are not expected to be affected by sediment management activities are only briefly discussed.

The listing status of each special status species described in this section is provided in the discussion section of the respective species in Appendix A; the acronyms used to identify the listing status are shown in Table 5-4. Special status species are also summarized in Table 5-5.

Table 5-4: Acronyms Used to Describe Status of Species

Special Status Designation	Law Protecting Species	Acronym
Federal threatened	Federal ESA	FT
Federal endangered	Federal ESA	FE
Critical habitat	Federal ESA	CH
Protected marine mammal	Federal MMPA	MMPA

Special Status Designation	Law Protecting Species	Acronym
Essential fish habitat (EFH)	Magnuson-Stevens Fishery Conservation and Management Act	EFH
State threatened	California ESA	ST
State endangered	California ESA	SE
State fully protected	California ESA	FP
State species of special concern	California ESA	SSC
Migratory birds	Migratory Bird Treaty Act	MBTA

Table 5-5: Special Status Species in the Santa Cruz Littoral Cell

Common Name	Scientific Name	Federal	State	Federal Register	Presence Within Littoral Cell	Potential Effects
				Fish		
Tidewater goby	*Eucyclogobius newberry*	FE, CH	--	Listing: 59 FR 5494 (1994) CH: 65 FR 69693 (2000) Revised CH: 78 FR 8745 (2013)	CH includes portions of Monterey, San Mateo, and Santa Cruz counties.	Dredging and aquatic placement activities may affect tidewater goby and its CH.
Southern DPS green sturgeon	*Acipenser medirostris*	FT, CH	SSC	Listing: 71 FR 17757 (2006) CH: 74 FR 52300 (2009)	CH includes all coastal marine waters marine waters and bays and estuaries from Vancouver Island, British Columbia, to Monterey Bay, California. Coastal marine waters, bays and estuaries within the littoral cell are critical habitat.	Dredging and aquatic placement activities may affect green sturgeon and its CH.

Common Name	Scientific Name	Federal	State	Federal Register	Presence Within Littoral Cell	Potential Effects
Central California Coast coho salmon ESU	*Oncorhynchus kisutch*	FE, CH	SE	Listing (T): 61 FR 56138 (1996) Reclassified (E): 71 FR 834 (2005) CH: 64 FR 24049 (1999) Range expansion: 77 FR 19552 (2012)	CH includes all water, substrate and adjacent riparian zones of all accessible river reaches and estuarine habitat from Punta Gorda in northern California to the San Lorenzo River, which empties into Monterey Bay at Santa Cruz. In 2012, the NMFS expanded the range of Central California Coast coho to include Aptos and Soquel creeks (both empty into Monterey Bay).	Dredging and aquatic placement activities may affect coho salmon and its CH.
Central California coastal steelhead ESU	*Oncorhynchus mykiss*	FT, CH	--	Listing: 62 FR 43937 (1997) CH: 65 FR 7764 (2000)	CH includes all accessible river reaches and estuarine areas accessible from the Russian River to Aptos Creek (inclusive).	Dredging and aquatic placement activities may affect steelhead and its CH.
South Central California coastal steelhead ESU	*Oncorhynchus mykiss*	FT, CH	--	Listing: 62 FR 43937 (1997) CH: 65 FR 7764 (2000)	CH includes all accessible river reaches and coastal river basins from the Pajaro River (inclusive), Santa Cruz County, south to the Santa Maria River.	Dredging and aquatic placement activities may affect steelhead and its CH.
Pacific Salmonid EFH	--	EFH	--	--	Littoral cell is within Pacific Salmonid EFH.	Dredging and aquatic placement activities may affect Pacific salmonid EFH.
Pacific Groundfish EFH	--	EFH	--	--	Littoral cell is within Pacific Groundfish EFH. Many of the 87 species protected under this law are known to occur in the area.	Dredging and aquatic placement activities may affect Pacific groundfish EFH.
Coastal Pelagic EFH	--	EFH	--	--	Littoral cell is within Coastal Pelagic EFH.	Dredging and aquatic placement activities may affect coastal pelagic EFH.
				Marine Invertebrates		
Black abalone	*Halitoes cracherodii*	FE, CH	--	CH: 76 FR 66806 (2011)	CH present in the littoral cell.	Dredging and aquatic placement activities may affect black abalone and its CH.

Common Name	Scientific Name	Federal	State	Federal Register	Presence Within Littoral Cell	Potential Effects
				Marine Amphibians		
Leatherback turtle	*Dermochelys coriacea*	FE, CH	--	Listing: 35 FR 8491 (1970) CH: 77 FR 4170 (2012)	U.S. West Coast CH designated in January 2012. Critical habitat includes the California Coast from Point Arena to Point Arguello. The littoral cell is within this critical habitat.	Dredging and other activities within the littoral cell may affect critical habitat and turtles.
				Marine Mammals		
Guadalupe fur seal	*Arctocephalus townsendi*	FT, MMPA	FP	Listing: 50 FR 51252 (1985)	Littoral cell is within range; but, seals are generally south of the project area.	Not likely, seals are generally south of the littoral cell.
Northern elephant seal	*Mirounga angustirostris*	MMPA	FP	--	Present in the littoral cell, particularly at Año Nuevo Island.	Fully protected species. The CDFW will not approve projects which adversely affect northern elephant seals.
Southern sea otter	*Enhydra lutris nereis*	FT, MMPA	FP	Listing: 42 FR 2965 (Proposed for delisting)	Sea otters are present in Monterey Bay and other areas within the littoral cell.	Dredging activities and other activities may affect Southern sea otters.
Stellar sea lion	*Euetopias jubatus*	MMPA	--	Delisted: 78 FR 66140 (2013) Listing (T): 42 FR 2965 (1977) CH: 58 FR 45269 (1993)	Haul out site: Año Nuevo Island rookery (previously designated as CH).	Dredging activities and other activities that may occur near haul out sites may affect stellar sea lion.
California sea lion	*Zalophus californianus*	MMPA	--	--	California sea lions are present in the littoral cell. Haul out areas are located present in the littoral cell.	Dredging activities and other activities that may occur near haul out sites.
Pacific harbor seal	*Phoca vitulina*	MMPA	--	--	Pacific harbor seals are present in the littoral cell. Haul out areas are located present in the littoral cell.	Dredging activities and other activities that may occur near haul out sites.
Killer whale, Southern Resident DPS	*Orcinus orca*	FE, CH MMPA	--	Listing: 70 FR 69903 (2005) CH: 71 FR 69054 (2006) (Under review for delisting)	Range from Alaska to Central California Coast, including Monterey Bay. CH is located in Alaska and Washington; does not include the project area.	Dredging noise may affect whales that enter Monterey Bay or other areas close to dredging activities.

Common Name	Scientific Name	Federal	State	Federal Register	Presence Within Littoral Cell	Potential Effects
Humpback whale, North Pacific	*Megaptera novaeangliae*	FE, MMPA	--	Listing: 35 FR 18319 (1970) Delisting finding: 78 FR 53391 (2013) (Under review for delisting)	Present April through December. Known to enter Monterey Bay.	Dredging noise may affect whales that enter Monterey Bay or other areas close to dredging activities.
Blue whale	*Balaenoptera musculus*	FE, MMPA	--	Listing: 35 FR 18319 (1970)	Observed in the Monterey Bay area; present June through October	Impacts are not likely.
Fin whale	*Balaenoptera physalus*	FE, MMPA	--	Listing: 35 FR 18319 (1970)	Occasionally encountered in summer and fall off the Central California Coast.	Coastal development, including dredging, cited as potential low adverse effects (NMFS 2010). However, not likely to be in areas where actions would occur.
Killer whale, transient and offshore	*Orcinus orca*	MMPA		--	Present year-round. Offshore killer whales usually occur 9 miles or more offshore, but also visit coastal waters and occasionally enter protected inshore waters. Transient killer whales tend to stay closer to the shore. The littoral cell is in the range of the transient and offshore killer whales. Killer whales are known to enter Monterey Bay.	Dredging noise may affect whales that enter Monterey Bay or other areas close to dredging activities.
Eastern North Pacific Gray whale (California stock)	*Eschrichtius robustus*	MMPA	--	Listed (E): 35 FR 18319 (1970) Delisted: 59 FR 31094 (1994)	Inhabits coastal inshore waters. May be present in the littoral cell December – May.	Impacts are not likely.
Minke whale	*Balaenoptera acutorostrata*	MMPA	--	--	Inhabits both coastal/inshore and oceanic/offshore areas. Can be found offshore of the littoral cell area year round; observed during summer and fall.	Impacts are not likely.
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	MMPA	--	--	Observed within the littoral cell.	Impacts are not likely.

Common Name	Scientific Name	Federal	State	Federal Register	Presence Within Littoral Cell	Potential Effects
Risso's dolphin	*Grampus griseus*	MMPA	--	--	Observed within the littoral cell.	Impacts are not likely.
Northern dolphin	*Lissodelphis borealis*	MMPA	--	--	Observed within the littoral cell.	Impacts are not likely.
Long-beaked dolphin	*Delphinus capensis*	MMPA	--	--	Observed within the littoral cell.	Impacts are not likely.
Short-beaked dolphin	*Delphinus delphis*	MMPA	--		Observed within the littoral cell.	Impacts are not likely.
Dall's porpoise	*Phocoenoides dalli*	MMPA	--	--	Observed within the littoral cell.	Impacts are not likely.
Bottlenose dolphin	*Tursiops truncatus*	MMPA	--	--	Observed within the littoral cell.	Impacts are not likely.
Harbor porpoise	*Phocoena phocoena*	MMPA	--	--	Observed within the littoral cell.	Impacts are not likely.
				Birds		
Western snowy plover	*Charadrius alexandrines nivosus*	FT, CH	--	Listing: 58 FR 12864 CH: 64 FR 68508 Revised CH: 77 FR 36728	Critical habitat is present along the coast in San Mateo, Santa Cruz, and Monterey Bay counties. Known nesting areas within the littoral cell.	Beach nourishment is likely to affect nesting snowy plovers.
Marbled murrelet	*Brachyramphus marmoratus*	FT, CH	E	Listing: 57 FR 45328 CH: 61 FR 26257 Revised CH: 76 FR 61599	Critical habitat is present in the Half Moon Bay and Santa Cruz areas.	Dredging and beach nourishment activities may affect foraging murrelets.
California least tern	*Sternula Antillarum browni*	FE	E, FP	Listing: 35 FR 16047	Historic nesting in along the coast of the littoral cell. Current nesting sites appear to be north and south of the cell.	Fully protected species. The CDFW will not approve projects which adversely affect California least tern.
California brown pelican	*Pelecanus occidentalis californicus*	--	FP	Delisting: 74 FR 5944 (Federal and state delisted; however, fully protected by the CDFW. FP species cannot be adversely affected)	Present within the littoral cell.	Fully protected species. The CDFW will not approve projects which adversely affect California brown pelicans.

Common Name	Scientific Name	Federal	State	Federal Register	Presence Within Littoral Cell	Potential Effects
White-tailed kite	*Elanus leucurus*	--	FP	--	Present in Elkhorn Slough and other aquatic and upland areas within the littoral cell.	Fully protected species. The CDFW will not approve projects which adversely affect white-tailed kites.
				Insects		
Smith's blue butterfly	*Euphilotes enoptes smithi*	FE	--	Listing: 41 FR 22041	Inhabits coastal sand dunes in Monterey County. Largest populations found along Monterey Bay between the Salinas River and Del Ray Creek.	Sediment management activities in coastal dune habitat where butterflies are present.
Mertle's silverspot butterfly	*Speyeria zerene myrtleae*	FE	--	Listing: 57 FR 27848	Inhabits coastal dunes and bluffs. Historic range from Sonoma County south to Point Año Nuevo in San Mateo County; however, known populations at Point Reyes National Sea Shore. Half Moon Bay and Año Nuevo State Park were identified as potential recovery areas (USFWS 1998, http://ecos.fws.gov/docs/recovery_plan/980930d.pdf).	Sediment management activities in coastal dune habitat where butterflies are present.
				Amphibians		
California tiger salamander, central population	*Ambystoma californiense*	FT, CH	ST	Listing: 69 FR 47212 CH: 70 FR 49380	Critical habitat around Monterey Bay (Central Coast Region).	Sediment management activities in tiger salamander habitat. Possible impacts to CH.
California red-legged frog	*Rana draytonii*	FT, CH	--	Listing: 61 FR 25813 CH: 66 FR 14626 Revised CH: 75 FR 12816	Critical habitat present in the littoral cell in San Mateo and Santa Cruz counties.	Sediment management activities in frog habitat. Possible impacts to CH.
Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*	FE	SE, FP	Listing: 32 FR 4001	Inhabits coastal areas of Santa Cruz and Monterey counties.	Fully protected species. The CDFW will not approve projects which adversely affect Santa Cruz long-toed salamander.

Common Name	Scientific Name	Federal	State	Federal Register	Presence Within Littoral Cell	Potential Effects
				Plants		
Robust spineflower	*Chorizanthe robusta var. robusta*	FE, CH	--	Listing: 59 FR 5499 CH: 67 FR 36822	Inhabits sand dune areas. Known from only 10 sites in coastal and near-coastal areas of Santa Cruz, Monterey, and Marin Counties, California.	
Monterey spineflower	*Chorizanthe pungens var. pungens*	FE, CH	--	Listing: 59 FR 5499 CH: 73 FR 1525	Monterey spineflower occurs on sand soils in active dunes, interior fossil dunes in the littoral cell. Three units of critical habitat are within the littoral cell.	
Santa Cruz tarplant	*Holocarpha macradenia*	FT, CH	SE	Listing: 65 FR 14898 CH: 67 FR 63968	Coastal prairies on marine terraces. Santa Cruz and northern Monterey County.	

Source:

California Natural Diversity Data Base. Accessed December 2014.

USFWS Species Generator. Quadrangle maps: Montara Mountain, Half Moon Bay, San Gregorio, Pigeon Point, Franklin Point, Año Nuevo, Davenport, Santa Cruz, Soquel, Moss Landing, Marina, Monterey, San Mateo, Redwood Point, Woodside, Palo Alto, La Honda, Mindeog Hills, Big Basin, Castle Rock Ridge, Felton, Laurel, Loma Prieta, Watsonville West, Watsonville East, Prundale, Salinas. Accessed December 2014.

Noted Federal Registers.

Table 5-6 identifies the designated critical habitats associated with each BECA or Sediment Impaired Coastal Habitat Area. A detailed discussion of the listing status and species range, life history, habitat use in the littoral cell, and other information for species that have the potential to be affected by regional sediment activities (those listed in Table 5-5) is provided in Appendix A. Species which may be present in the littoral cell, but are not expected to be affected by sediment management activities are only briefly discussed.

Table 5-6: Designated Critical Habitat Associated with BECAs and SICH Areas

Reach	BECA or SICH	Figure	Name	Critical Habitats[1]	Notes
1	BECA 1	Figure 5-1	Princeton - Pillar Point Harbor	- Nearby Denniston Creek is CCC steelhead ESU CH - Black Abalone[2] CH is located in a portion of Pillar Point Harbor	
2	BECA 2	Figure 5-1	El Granada County Beach	- Black Abalone[2] CH	

Reach	BECA or SICH	Figure	Name	Critical Habitats[1]	Notes
	BECA 3	Figure 5-1	Half Moon Bay – Mirada Road	- Black Abalone[2] CH	
3		Figure 5-2	No BECAs or SICHs in reach		
4	SICH 1	Figure 5-2 and Figure 5-3	Pescadero Marsh	-Tidewater goby CH; red-legged frog CH - Pescadero and Butano Creeks are CCC steelhead ESU CH and CCC coho salmon ESU CH - Black Abalone[2] CH at the coastal end of the marsh.	
	BECA 4	Figure 5-3 and Figure 5-4	Año Nuevo State Reserve	- Black Abalone[2] CH; Steller Sea Lion CH; California red-legged frog CH	- Part of Año Nuevo State Marine Conservation Area (Table 5-2) and Año Nuevo State Park (Table 5-3) - The greater Año Nuevo State Park region includes Marbled murrelet CH (although distant from BECA 4) and has been identified as a potential recovery area for Mertle's silver spot butterfly (USFWS 1998,http://ecos.fws.gov/docs/recovery_plan/980930d.pdf) - Several Pinnipeds use the beaches as haul out and/or rookery areas
5	BECA 5	Figure 5-4	Waddell Bluffs	- Black Abalone[2] CH; Marbled murrelet CH; California red-legged frog CH	- Waddell Creek and Waddell Creek Beach are approximately 0.5 miles down the coast and contain additional critical habitats (see SICH 2)
	SICH 2	Figure 5-4	Waddell Creek	- Tidewater goby CH; CCC steelhead ESU CH; CCC coho salmon ESU CH; Marbled murrelet CH; California red-legged frog CH - Waddell Creek beach is western snowy plover CH - Black Abalone[2] CH along the nearby coastline	

Reach	BECA or SICH	Figure	Name	Critical Habitats[1]	Notes
	BECA 6	Figure 5-4	Scott Creek Beach	- Black Abalone[2] CH; Western snowy plover CH; California red-legged frog CH - Directly adjacent to Scott Creek which contains additional CH (see SICH 3)	
	SICH 3	Figure 5-4	Scott Creek	- Tidewater goby CH; CCC steelhead ESU CH; CCC coho salmon ESU CH; California red-legged frog CH - Runs though Scott Creek beach which contains additional CH (see BECA 6)	
6	BECA 7	Figure 5-5	West Cliff Drive	- Black Abalone[2] CH	
	SICH 4	Figure 5-5	San Lorenzo River	- CCC steelhead ESU CH; CCC coho salmon ESU CH - Black Abalone[2] CH at the coastal end of the river	
	BECA 8	Figure 5-5	Twin Lakes State Beach	- Black Abalone[2] CH - Santa Cruz tarplant CH is located to the immediate north of Schwan Lagoon at Twin Lakes State Beach	
	SICH 5	Figure 5-5	Schwan Lagoon	- Santa Cruz tarplant CH to the immediate north	
	SICH 6	Figure 5-5	Corcoran Lagoon	- Tidewater goby CH - Black Abalone[2] CH along the adjacent coastline	
	BECA 9	Figure 5-5	Del Mar Beach –Corcoran Lagoon and Moran Lake	- Tidewater goby CH; Black Abalone[2] CH	
	SICH 7	Figure 5-5	Moran Lake	- Adjacent to the southern end of designated Black Abalone[2] CH	
	BECA 10	Figure 5-5	East Cliff Drive – 37th Ave to Larch Lane	--	

Reach	BECA or SICH	Figure	Name	Critical Habitats[1]	Notes
	BECA 11	Figure 5-5	East Cliff Drive – Capitola	--	
	BECA 12	Figure 5-5	Capitola Beach and Esplanade	- Adjacent Soquel creek is CCC steelhead ESU CH	
	BECA 13	Figure 5-5	Depot Hill	--	
7	BECA 14	Figure 5-5 and Figure 5-6	Pot Belly Beach – New Brighton State Beach	--	
	BECA 15	Figure 5-6	Seacliff State Beach - North	--	
	SICH 8	Figure 5-6	Aptos Creek	- Tidewater goby critical habitat; CCC steelhead ESU CH	
	BECA 16	Figure 5-6	Seacliff State Beach - South	--	
	BECA 17	Figure 5-6	Rio Del Mar – Beach Drive	--	
	BECA 18	Figure 5-6	Rio Del Mar – Via Gaviota	--	
	BECA 19	Figure 5-6	Pajaro Dunes	- Western Snowy Plover CH - The Pajaro River directly adjacent down coast (0.5 miles) is Tidewater Goby and South-Central California Coastal Steelhead ESU CH	
	BECA 20	Figure 5-6	Moss Landing and Elkhorn Slough	- Elkhorn Slough is South-Central California Coastal Steelhead ESU CH - Adjacent to Tidewater Goby, Western Snowy Plover and Monterey Spineflower CH at Moss Landing State Beach	- Part of Elkhorn Slough State Marine Conservation Area and Elkhorn Slough State Marine Reserve (Table 5-2)

Reach	BECA or SICH	Figure	Name	Critical Habitats[1]	Notes

Notes:

[1] Marine habitat in the entire littoral cell falls within Leatherback turtle critical habitat, which stretches along the California Coast from Point Arena to Pont Arguello. The marine areas of the entire littoral cell are also within green sturgeon critical habitat, which extends from Monterey Bay, California North and East.

[2] Black Abalone critical habitat is present in reaches 1-5 and the northern portion of reach 6 in the littoral cell. This includes rocky intertidal and subtidal habitat, and all waters from mean higher high water to a depth of 20 feet.

6. REGULATORY AND POLICY CONSIDERATIONS

6.1 SECTION OVERVIEW

This section describes the regulatory compliance process for implementing RSM projects in the Santa Cruz Littoral Cell. It also provides an overview of the roles and responsibilities of federal and state agencies that would be involved in review and permitting of various potential RSM measures.

The information provided here is a general overview of applicable laws, regulations, and agencies rather than a detailed roadmap of the regulatory and permitting process. The CSMW's *Beach Restoration Regulatory Guide* (BRRG) (EIC, 2006) is a recommended resource that contains more comprehensive and specific information on the permitting process and relevant state and federal regulatory requirements for implementation of beach nourishment projects in California. As part of the *California Coastal Sediment Master Plan*, the BRRG was developed to provide an analysis of relevant policies, procedures, and regulations and to assist coastal planners and managers in navigating the regulatory compliance process for beach restoration projects. The BRRG can be found online at: http://dbw.ca.gov/csmw/PDF/BBRG_Final.pdf.

6.2 AN OVERVIEW OF THE REGULATORY COMPLIANCE PROCESS FOR RSM PROJECTS

Although the precise requirements and process would vary based on the specifics of each project, regulatory compliance can generally be broken down into two major components or processes: 1) Environmental Review and 2) Permitting. These processes along with the applicable laws and regulations and roles and responsibilities of various agencies are summarized in this section. The BRRG (EIC, 2006) should be referred to for more specific guidance on the requirements and necessary steps in carrying out the environmental review and permitting processes for beach-restoration projects.

6.2.1 Environmental Review Process

Environmental review consists primarily of compliance with the *National Environmental Policy Act* (NEPA) and the *California Environmental Quality Act* (CEQA), but also with several other state and federal laws. Environmental review is typically completed or nearly completed prior to embarking on the permitting process, since the information developed during this phase will be used by permitting agencies in reviewing the project and making permit decisions. Environmental review and permitting should be viewed as part of an iterative process, and coordination between the permit applicant and regulatory agencies should begin early and reoccur often to ensure that the environmental review documentation will provide the information necessary to satisfy the needs of the permitting and review agencies.

Implementation of RSM measures will require preparation of NEPA or CEQA documentation or both. Compliance with CEQA is required for all projects that necessitate approval or financing by the state or local government or participation by state government. NEPA compliance is required by projects that are sponsored by a federal entity. NEPA and CEQA each require preparation of different documents. CEQA documentation would include a *Negative Declaration* (ND), a *Mitigated Negative Declaration* (MND), or an *Environmental Impact Report* (EIR). Acceptable NEPA documentation could consist of an *Environmental Assessment* (EA) with a *Finding of No Significant Impact* (FONSI) or a more comprehensive *Environmental Impact Statement* (EIS). Compliance with CEQA and NEPA each entails undergoing a specific process and series of implementation requirements (e.g., public notification) and steps to ultimately arrive at a determination of potential environmental impacts associated with a proposed project. A NEPA compliance process flowchart is provided in Figure 6-1 and a CEQA flowchart in Figure 6-2. For additional information, both the NEPA and CEQA compliance processes are both discussed in detail in the BRRG (EIC, 2006). In certain cases environmental review would consist of compliance with both NEPA and CEQA. Although there are many similarities in the implementation of NEPA and CEQA, there are some key differences that are important to understand (Table 6-1).

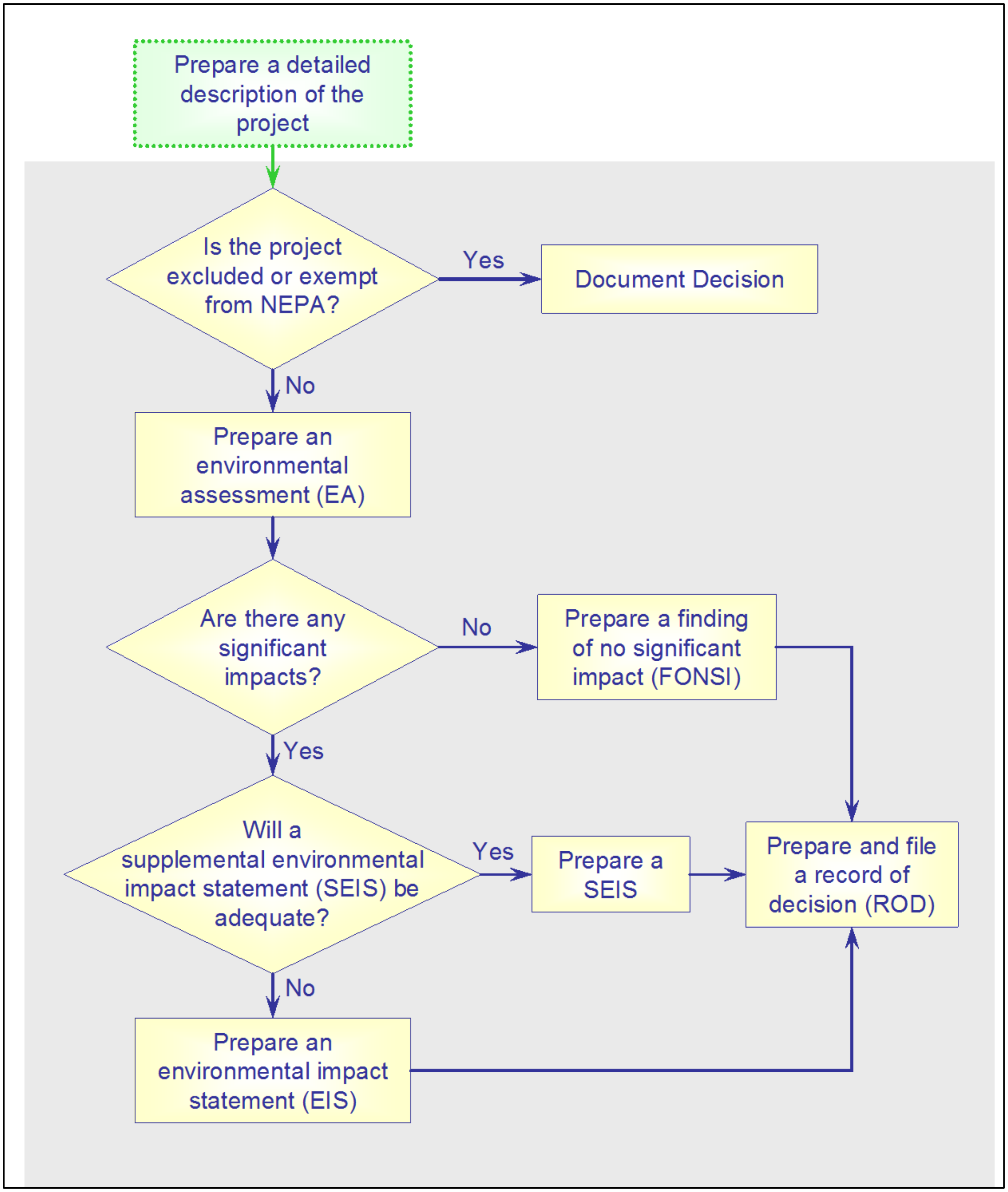
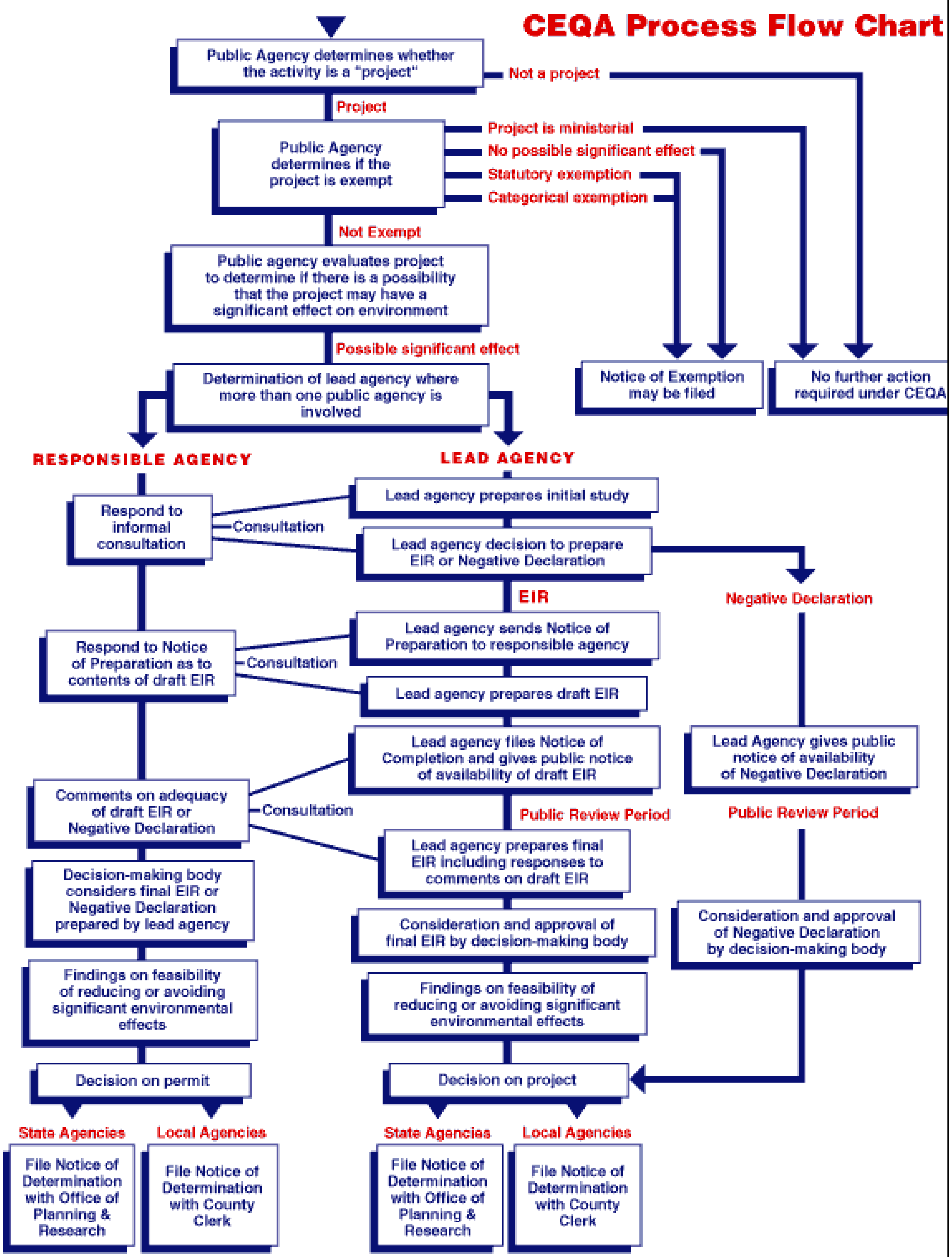


Figure 6-1. NEPA compliance flowchart



Source: http://ceres.ca.gov/images/CEQA_process_chart.gif

Figure 6-2. CEQA compliance flowchart

Table 6-1: Major differences between NEPA and CEQA

NEPA	CEQA
Agencies do not have to mitigate impacts	Agencies must mitigate impacts when feasible
Public noticing is not required for a FONSI (USACE does circulate a public notice to start the EA/Individual Permit process)	Public noticing required for negative declarations
Federal register notification required for draft EIS	Public noticing required for draft EIRs
Federal register notification required for final EIS	Public noticing not required for final EIRs
No time limits for preparation of environmental documents	Permit Streamlining Act applies for publicly-funded projects
No statute of limitation	Some statutes of limitation
ROD must only address why the decision was made, and a ROD is not required for EA/FONSI	ROD (findings) must explain whether each impact has been mitigated and, if not, why
Alternatives must be analyzed to a similar level of detail	Alternatives do not have to be analyzed to a similar level of detail as the proposed project
Environmental impact analyses must include an evaluation of reasonably foreseeable indirect and cumulative impacts	Environmental impact analyses do not have to include speculative impacts
Document must include integration of other federal environmental laws	Document does not have to include integration of other federal environmental laws but should identify relevant state and local ordinances

Source: Beach Restoration Regulatory Guide (EIC, 2006)

6.2.2 Agencies and Local Jurisdictions Involved in Review and Permitting of RSM Measures

This section summarizes the relevant federal, state and local agencies and municipalities. Specific roles and responsibilities of these agencies, as they pertain to Coastal RSM projects, are described in more detail in Sections 6.2.3 and 6.3. There are numerous state and federal regulatory agencies that would potentially be involved in reviewing various RSM measures identified in this plan. Which regulations apply and what agencies are responsible for review or approval will vary from project to project.

Federal agencies involved in conducting, reviewing or approving and permitting potential RSM projects identified in this plan include: USACE, the MBNMS and GFNMS, and the MMS. The USEPA and USACE are the two main agencies involved in regulating discharges of fill and dredged material. But, numerous other federal agencies are also involved in review of proposed beach nourishment projects and must provide approval before permits can be issued. Any RSM project proposed within the boundaries of the

MBNMS, which encompasses the entire Santa Cruz Littoral Cell region, will require sanctuary review and approval.

State agencies involved in conducting, reviewing, or approving potential RSM projects recommended in this plan include: the CCC, CSLC, SCC, CGS, DPR, and DBW. The agencies with primary regulatory responsibility over shoreline protective structures are the CCC and CSLC. The SCC and DBW are both involved with funding shoreline maintenance projects and generation of data; the DPR is involved as a land manager; and the CGS is the state agency with responsibility for identifying geologic hazards.

Local municipalities and agencies could also be involved in implementing RSM measures as well as permitting and review of projects. The local jurisdictions existing within the boundaries of the Santa Cruz Littoral Cell include: the Counties of Monterey, Santa Cruz, and San Mateo; the Cities of Capitola, Santa Cruz and Half Moon Bay; Moss Landing Harbor District, Santa Cruz Port District (Santa Cruz Harbor); and San Mateo County Harbor District (Pillar Point Harbor); and several local and regional agencies, special districts, and other relevant entities.

6.2.3 Relevant Laws and Regulations

Depending on the type of project being proposed, the location of the affected area, and the scale of the project, there is a wide range of state, federal and local laws and regulations that could apply to the implementation of RSM projects, such as beach nourishment or sand-retention structures (Table 6-2).

The primary federal laws that shoreline preservation projects must comply with are the *Clean Water Act* (CWA), *National Environmental Policy Act* (NEPA), *Coastal Zone Management Act* (CZMA), and *Rivers and Harbors Act* (RHA). The primary state laws and regulations include the *California Environmental Quality Act* (CEQA), the *California Coastal Act* (CCA), the *California Endangered Species Act* (CESA), the *California Ocean Plan* (COP), *California Department of Fish and Wildlife Code*, *California Public Resources Code*, and the *Porter-Cologne Water Quality Control Act* (PCWQCA).

Table 6-2: Relevant regulations affecting beach restoration projects

POLICY/REGULATION	REQUIREMENT	PERMITTING/APPROVAL AGENCY
	Federal	
NEPA	Compliance	Lead NEPA Agency
CZMA	CCD	CCC

RHA	Section 10 Permit	USACE
CWA	Title V Operating Permit	CARB
CWA	Section 401 Certification or Waiver (401 Permit)	RWQCBs
CWA	Section 402 NPDES Permit (NPDES Permit)	RWQCBs
CWA	Section 404 Permit (404 Permit)	USACE
ESA*	Section 7 Consultation	USFWS or NMFS
NHPA*	Section 106 Approval	SHPO
FWCAQ*	CAR	USACE
MSFCMA*	Assessment of Impacts to EFH	NMFS
OCS	Lease Agreement for Utilization of Outer Continental Shelf Sand	MMS
	State	
CEQA	Compliance	Lead CEQA Agency
CCA	CDP	CCC
PCWQCA	CompliancePermits under CWA Sections 401, 402, and 404	SWRCB and RWQCBs
California State Lands Public Resources Code	Lease Agreement for Utilization of Sovereign Lands	CSLC
California Public Resources Code Section 1600	SAA	CDFW
CESA	Section 2081(b) Incidental Take Permit (State)Section 2081.1 Consistency Determination (State and Federal)	CDFW
WQCPs, COP	Consistency Compliance	RWQCBs+
CAA	Title V Operating Permit	APCDs and AQMDs

* Review and compliance is usually triggered through the initial CWA Section 404 permitting process by USACE.+ The SWRCB has lead responsibility when a project involves jurisdiction by more than one RWQCB.

6.3 Federal Agencies Involved in Permitting and Review of RSM Projects

6.3.1 MBNMS

A detailed description of the MBNMS and its potential role in reviewing and permitting RSM projects is provided here because it has permitting authority over RSM projects implemented within its boundaries (which includes the entire Santa Cruz Littoral Cell except for within Moss Landing, Santa Cruz, and Pillar Point Harbors) and because the agency is not included in the BRRG regulatory analysis. Designated in 1992, the MBNMS is a federally protected marine area offshore of California's central coast. Stretching from Marin to Cambria, it encompasses a shoreline length of 276 miles and 4,601 square nautical miles of ocean, extending an average distance of 30 miles offshore.

The mission of the MBNMS, to understand and protect the ecosystem and cultural resources of central California, is carried out through resource protection, research, education, and public use. As such, it addresses a wide range of resource protection issues within its boundaries, and reduces or prevents detrimental human impacts on sanctuary resources through collaborative partner efforts, regulations and permits, emergency response, enforcement and education.

The MBNMS was designated in accordance with the *National Marine Sanctuaries Act* (NMSA) and is managed under the authority of the Act. Under the NMSA, the MBNMS has the ability to grant permits for prohibited activities and enforce its regulations, provided that the activities meet certain criteria such as having, at most, short-term and negligible adverse effects on sanctuary resources and qualities (15 CFR Section 922.133). The primary regulations governing management of the MBNMS are described in the United States Code of Federal Regulations, Title 15, Part 922.

The MBNMS enforces thirteen federal regulatory prohibitions designed to preserve and protect the natural and cultural resources and qualities of the ocean and estuarine areas within its boundaries. Depending upon the nature of the project, there are six of these prohibitions that could pertain to potential RSM measures, and thus trigger the need for MBNMS review and permitting. These are summarized below:

1) Drilling into, dredging, or otherwise altering the submerged lands of the sanctuary; or constructing, placing, or abandoning any structure, material, or other matter on or in the submerged lands of the sanctuary (with the exception of several activities, such as boat anchoring and harbor maintenance projects).

2) Discharging or depositing, from within or into the sanctuary, any material or other matter (with the exception of several activities, such as dredged material disposal at designated sites).

3) Discharging or depositing, from beyond the boundary of the sanctuary, any material or other matter that subsequently enters the sanctuary and injures a sanctuary resource or quality (with the exception of several activities unlikely to be applicable to the measures evaluated in this RSM Plan).

4) Taking (disturbing or injuring) any marine mammal, sea turtle, or bird within or above the sanctuary, except as authorized by the MMPA, ESA, or MBTA (regardless of intent).

5) Possessing, moving, removing or injuring a sanctuary historical resource, or attempting such actions.

6) Introducing or otherwise releasing from within or into the sanctuary an introduced species (with the exception of striped bass and some shellfish species approved for aquaculture).

Authorizations may be issued under special circumstances for activities otherwise prohibited by MBNMS regulations if: an activity has been authorized by a valid lease, permit, license, approval or other authorization issued after the effective date of MBNMS designation by any federal, state, or local authority; the Superintendent finds that the activity will not harm sanctuary resources and qualities, and; the applicant complies with all applicable regulations and any specific conditions or terms specified by the Superintendent. An authorization may be issued in conjunction with a valid lease, permit, license, approval or other authorization issued by any federal, state, or local authority of competent jurisdiction. In cases where projects require a CCC CDP (or another relevant permit issued by a state or federal agency), MBNMS staff could review and potentially authorize that permit.

RSM or coastal protection measures that would require MBNMS review and approval include any proposed seawall or revetment structure placed below the mean high tide line; beach nourishment project where sediment is placed within MBNMS boundaries, or where sediment subsequently enters the MBNMS and causes negative impacts; any project dredging sand from elsewhere (offshore, etc); or any project that involves placement of a structure or equipment on or into the submerged lands of the sanctuary (i.e. submerged breakwaters, perched beaches, groins, emergent breakwaters, and possible seawalls or revetments).

In addition to MBNMS's permitting and regulatory authority over certain RSM projects, the sanctuary participates in a variety of collaborative planning and adaptive management initiatives to address shoreline protection issues through non-regulatory means. The MBNMS Coastal Armoring Action Plan, for example, has several activities that relate to beach nourishment, opportunistic use of dredged material, and identifying alternatives to coastal armoring structures:

> *Activity 2.8: Pursue Pilot Program for Alternatives to Coastal Armoring*
> *Based on the scientific and needs assessment, MBNMS will pursue a pilot program to investigate environmentally sound alternatives to coastal armoring, and develop and implement monitoring*

protocols for the program. Alternatives will include but not be limited to: preventative measures, planned retreat, beach nourishment, and structural responses such as groins or breakwaters.

MBNMS will convene interagency working groups to identify and help design sub-region specific design alternatives for the coastal erosion responses identified in Activity 2.1.

Considerations will include:
A. Identifying the suite of preventative measures such as restricting activities that contribute to erosion, predevelopment conditioning of projects and the necessary legal measures or relocation of structures such as road realignment or development demolition, or enhanced vegetation of exposed, erosion prone areas.

B. Identifying hard structures that may preempt erosion or help retain sand on beaches. Types of structures may include groins (narrow wooden or concrete constructions that extend from a shore into the sea to protect a beach from erosion), offshore seawalls, breakwater, or submerged structures such as artificial reefs that dissipate wave energy prior to reaching the shoreline. All hard structures would alter the seabed and therefore trigger review by MBNMS as a prohibited activity.

C. Identifying appropriate sources of beach quality material and one or more locations for one or more pilot demonstration projects that might receive an MBNMS scientific research permit (and other necessary agency permits) to test and develop appropriate sand supply and beach nourishment program options. MBNMS will develop a coordinating mechanism with the California Coastal Sediment Management Workgroup to promote the exchange of information and ideas. If appropriate sources of sand and potentially beneficial nourishment sites can be identified, the pilot study or studies would develop specific research objectives and study methodologies. Criteria for "success" will also be developed. The criteria could include minimal environmental impacts, recreational access, shoreline protection and habitat benefits, the potential for using maintained nourishment to avoid or mitigate for shoreline armoring, and other identifiable overall benefits to MBNMS resources.

At the conclusion of this/these demonstration pilot project(s), the agency working group will evaluate the desirability of, and necessary steps for, continuing such a program involving beach nourishment within MBNMS boundaries. If the sand supply project is to continue, this evaluation will also examine whether revision of MBNMS regulations may be warranted, if a beneficial program might continue via MBNMS permit or authorization in concert with other regulatory agencies.

The MBNMS Harbors and Dredge Disposal Action Plan also includes language that is relevant to this RSM Plan*:*

Activity 5.1: Evaluate Potential Beneficial Usage of Dredged Materials
MBNMS will work with partners to examine the potential beneficial uses for dredged material. Recognizing that littoral sand is a MBNMS resource for various habitat, recreation, access and shoreline protection reasons, MBNMS and other agencies should identify if, when and where beach nourishment is appropriate. As discussed in the Coastal Armoring Action Plan, MBNMS may identify the criteria and

data needed to make that determination, including an evaluation of sand transport and science needs and pursuit of a comprehensive research strategy. In addition, MBNMS will work with partners to assess individual and cumulative impacts to sand transport and shoreline dynamics due to existing harbors and artificial groins within the MBNMS. Studies should estimate the quantity of sand and sand-generating beach material that is trapped by such structures and assess means to bypass such material and replicate natural processes to the degree feasible. If investigations indicate that employment of additional beach nourishment sites using clean dredged harbor material would be possible and appropriate, MBNMS may examine whether revision of MBNMS regulations may be warranted; or if a beneficial program might occur via MBNMS permit or authorization in concert with other agencies.

6.3.2 USACE

The USACE has regulatory authority over activities involving waters of the U.S. pursuant to *Section 404 of the Clean Water Act* and *Section 10 of the Rivers and Harbor Act.* This includes the regulation of any development or structure that may cause obstructions to U.S. navigable waters, or placement of fill or dredged material (which is defined generally to include any structure that is built). Under Section 404 there are two types of applicable permits that are required: for larger-scale projects with the potential to cause significant impacts, an individual permit is typically required; for activities with minimal potential environmental impacts a general permit is usually required.

The USACE is the chief decision-making agency for beach nourishment projects. For USACE to approve a project, the proponent must demonstrate that the proposed project is the "least environmentally damaging practicable alternative." Additionally, under Section 404 permitting, either an *Environmental Assessment* (EA) or an *Environmental Impact Statement* (EIS) is required for beach nourishment projects. The USACE disposal-related regulations are located at 33CFR 320-330 and 33 CFR 335-338. For more information on USACE policies, procedures, and regulations refer to the *CSMW's Beach Restoration Regulatory Guide* (EIC, 2006).

6.3.3 NMFS

The NMFS is the federal agency responsible for managing, protecting, and conserving living marine resources and their habitat throughout the *Exclusive Economic Zone* (typically, waters between 3 and 200 miles offshore). It becomes involved with projects by the way of providing consultation pursuant to Sections 7 and 10 of the ESA, which governs potential impacts of various activities to species and habitats that are either federally listed or proposed for listing. The NMFS would also review some project proposals for their potential impacts to EFH under the MSFMCA. Pursuant to the MMPA, NMFS is also responsible for protection of most marine mammal species found in the Santa Cruz Littoral

Cell region, with the exception of the southern sea otter (*Enhydra lutris)*, which is under the jurisdiction of the USFWS.

With respect to the implementation of potential RSM and coastal protection measures, the main activities that require NMFS review would be construction impacts on subsurface hard substrate or impacts related to the discharge of materials such as through beach nourishment projects.

6.3.4 U.S. Coast Guard (USCG)

The USCG is charged with ensuring safety and security along the U.S. coastline with respect to navigation, management of waterways, and protection of natural resources. The USCG typically is involved with reviewing proposals for structures to be located underwater to ensure that they do not interfere with navigation or present other hazards. Potential USCG involvement with shoreline restoration and protection projects would involve consulting with USACE as required under Section 404 of the *Clean Water Act* and Section 10 of the Rivers and Harbors Act.

6.3.5 USFWS

Similar to NOAA Fisheries, the USFWS plays a consultative role under Sections 7 and 10 of the ESA, as well as the MMPA. Pursuant to the ESA, the lead agency responsible for environmental review of a proposed project is required to determine whether or not any species listed as either threatened or endangered under the ESA are present in the Plan area and to determine whether the project will cause any potentially significant impacts on that species.

The USFWS and NOAA Fisheries both are guided by the same set of regulations under the ESA; however each agency is exclusively responsible for different listed species. The USFWS has jurisdiction over terrestrial animals and sea otters, whereas NOAA Fisheries is responsible for the remaining listed marine animals and all other marine mammals. If the lead agency responsible for the project were a federal agency, then a Section 7 consultation would occur. Otherwise the project proponent would need to complete a *Habitat Conservation Plan* (HCP) and submit it to the USFWS for review and approval.

6.3.6 MMS

The primary responsibility of the MMS is to regulate mineral exploration and development on the outer continental shelf pursuant to the Outer Continental Shelf (OCS)

Lands Act (43 U.S.C. 1331, et. seq.). The MMS would be involved in beach nourishment projects where the source of sand is located in federal waters on the OCS. State and local governments and other federal agencies negotiate directly with the MMS when OCS sand is needed for projects, such as beach nourishment, that benefit the public.

6.4 State Agencies Involved in Permitting and Review of RSM Projects

6.4.1 CCC

The CCC, in collaboration with local counties and cities, is the primary state agency responsible for planning and regulating the use of land and water within California's Coastal Zone, in accordance with the specific policies of the CCA and consistent with the CZMA.

Any proposed RSM projects located within the coastal zone must be reviewed for consistency with the CCA and would require a *Coastal Development Permit*, which involves stringent review of the project by CCC staff. In addition to development within the state's coastal zone, the CCC also has jurisdiction over projects requiring federal permits or approval in federal waters.

The CCC was established to assist local governments in implementing local coastal planning and regulatory powers by adopting *Local Coastal Programs* (LCPs). An LCP consists of one or more *Land Use Plans* (LUP) with goals and regulatory policies as well as a set of *Implementing Ordinances*. The CCA requires local jurisdictions to prepare and submit an LCP; once the CCC approves the LCP then that local jurisdiction has coastal permitting authority. The CCC, however, holds permitting authority over Sovereign Lands, which are submerged lands seaward of the MHT line and those not in within the LCP area. As of the writing of this report, within the Santa Cruz Littoral Cell region the counties of Santa Cruz and San Mateo and the cities of Capitola, Santa Cruz and Half Moon Bay all have approved LCPs and therefore permitting authority.

Any projects located on sovereign lands below the MHT line are within CCC appeal jurisdiction (as are lands between the ocean and the first public road). Therefore in many cases, two permits may be necessary – one from the local jurisdiction with a certified LCP and one from the CCC. Most of the RSM measures being evaluated in this plan, including beach nourishment, would require CCC approval and a permit from the local jurisdiction with an approved LCP.

All structures in the coastal zone require CCC approval pursuant to CCA *Section 30106,* which regulates coastal development. The definition of development in the CCA is very broad and would encompass many potential coastal protection and restoration measures including beach nourishment, beach dewatering devices, submerged breakwaters, perched beaches, seawalls or revetments, groins, and emergent breakwaters.

The CCC is also mandated to protect views as well as to maintain public access and enhance recreational opportunities. Consequently, projects that have potentially significant visual impacts (e.g. groins or emergent breakwaters), or public safety or access issues would be reviewed subject to relevant policies of the CCA.

6.4.2 CSLC

The CSLC was established in 1938 with authority detailed in Division 6 of the California Public Resources Code. It manages nearly 4 million acres of Sovereign Lands underlying California's navigable and tidal waterways, which include over 120 rivers, streams, and sloughs; tidal navigable bays and lagoons; and submerged lands along the entire coastline of the state between the MHT line and three nautical miles offshore.

Any proposed project with infrastructure that would encroach onto CSLC lands, such as a coastal protective structure, would require a General Lease from the CSLC. For beach nourishment borrow sites located on CSLC lands, a Mineral Extraction Lease may also be required.

6.4.3 Central Coast and San Francisco RWQCBs

It is the responsibility of the RWQCBs to preserve and enhance the quality of the state's waters through the development of Water Quality Control Plans (Basin Plans) and the issuance of Waste Discharge Requirements (WDRs), which are required by the California Water Code. In the Santa Cruz Littoral Cell region, WDRs for land and surface water discharges are issued and enforced by either the Central Coast RWQCB for the sections of coast north of approximately Pescadero State Beach or the San Francisco RWQCB for the area to the south of Pescadero State Beach. The WDRs issued by the RWQCBs, are subject to review by the State Water Board, but do not need the State Water Board's approval before becoming effective.

Any projects requiring a *Clean Water Act Section 404* permit from USACE will require *Section 401 Water Quality Certification* by the Regional Water Boards. Therefore, beach nourishment projects require the project sponsor to obtain a water quality certification from the corresponding RWQCB to be issued a permit.

Additionally, the RWQCB requires all construction projects with the potential to disturb one or more acres of land to obtain a General Permit for Storm Water Discharges from Construction Activity. The Storm Water Permit requires the development and implementation of a *Storm Water Pollution Prevention Plan* (SWPPP). The SWPPP identifies Best Management Practices (BMPs) for reducing or eliminating pollutants in runoff that discharges into waterways and storm drains.

6.4.4 CDFW

The CDFW maintains the California list of threatened and endangered species. Under the CESA it is illegal to take any species that are listed under CESA as endangered and threatened. Take is defined roughly as any activity resulting directly in direct mortality, permanent or temporary loss of occupied habitat that would result in mortality, or disruption in reproduction to one or more individuals of the species, or avoidance of the habitat resulting in the same as above. The CDFW may evaluate a proposed project's potential to negatively affect species listed as either endangered or threatened in the state. In certain cases, an Incidental Take Permit may also be required. The CDFW often becomes involved in proposed projects through reviewing and commenting on EIRs or EISs.

6.4.5 DPR

The DPR is responsible for the management and protection of natural and cultural resources and facilitating outdoor recreational opportunities within the 270 State Park units. State Parks in the Santa Cruz Littoral Cell region include Sunset State Beach, Manresa State Beach, Seacliff State Beach, New Brighton State Beach, Twin Lakes State Beach, Lighthouse Field State Beach, Natural Bridges State Beach, Wilder Ranch State Park, Coast Dairies State Park, Big Basin Redwoods State Park, Bean Hollow State Beach, Año Nuevo State Park, Pescadero State Beach, Pomponio State Beach, San Gregorio State Beach, and Half Moon Bay State Beach.

Any project located on or affecting state parkland would require approval by DPR in the form of an Encroachment Permit. In addition to the agency's permitting authority, DPR has several policies regarding coastal erosion and development that are relevant to this RSM Plan. The following excerpt from the Policy on Coastal Erosion from the *DPR Operations Manual - Chapter 3 - Natural Resources* – (updated September 2004) provides guidance regarding coastal erosion and development within parks:

0307.3.2.1 Coastal Development Siting Policy

It is the policy of the Department that natural coastal processes (such as wave erosion, beach deposition, dune formation, lagoon formation, and sea cliff retreat) should be allowed to continue without interference. The Department shall not construct permanent new structures and coastal facilities in areas subject to ocean wave erosion, sea cliff retreat, and unstable cliffs. New structures and facilities located in areas known to be subject to ocean wave erosion, sea cliff retreat, or unstable bluffs shall be expendable or movable. Structural protection and re-protection of existing developments is appropriate only when:

a. The cost of protection over time is commensurate with the value of the development to be protected, and
b. It can be shown that the protection will not negatively affect the beach or the near-shore environment.

Where existing developments must be protected in the short run to achieve park management objectives, including high-density visitor use, the Department should use the most natural-appearing method feasible, while minimizing impacts outside the threatened area. Any shoreline manipulation measures proposed to protect cultural resources may be approved only after an analysis of the significance of the cultural resource and the degree to which proposed measures would impact natural resources and processes, so that an informed decision can be made through an assessment of alternatives and long term costs.

6.4.6 DBW

The DBW was established in 1957 upon enactment of legislation that established a state boating agency dedicated to all aspects of recreational boating and a special fund (Harbors and Watercraft Revolving Fund) to fund the division's activities. The DBW is responsible for planning, developing, and improving facilities on state-owned and state-managed properties, including those on State Parks and State Water Project properties. It also provides funding so that local agencies can renew deteriorated facilities or develop new public access. In addition, the DBW is heavily involved in furthering environmentally sound boating practices through its clean and green programs. Also, it is involved in research on climate change and wave prediction as they relate to navigation and coastal protection (Source: http://www.dbw.ca.gov/AboutUs.aspx).

The DBW is the California agency with responsibility for studying and reporting beach erosion issues in the state, and for developing measures to stabilize the shoreline pursuant to *Article 2.5* of the *Harbors and Navigation Code*. And following the passage of the Public *Beach Restoration Act* (1999) responsibility for allocating funds for beach restoration projects.

The DBW reviews certain projects that have the potential to present a hazard to boaters, potentially including certain RSM and coastal protection measures evaluated in this plan, such as groins or submerged breakwaters. Although the DBW is not involved in projects from a regulatory standpoint, the agency plays the primary role in funding local projects and providing technical information.

7. ECONOMIC CONSIDERATIONS

7.1 INTRODUCTION

The San Mateo and Santa Cruz County coastlines are famous for their rugged, natural beauty. Nature watchers, surfers, and hikers come from near and far for the unique recreational opportunities offered by this stretch of California's coast. The cooler climate and lack of development near many of the beaches are in stark contrast to the warm, crowded beaches of southern California. Most of the coastline in the Santa Cruz Littoral Cell is undeveloped, and only a relatively small percentage of the coastline has any significant infrastructure at risk from erosion. Coastal storms, however, have caused property damages to homes, businesses, parks, and public infrastructure located along the coast in these two counties. Although the timing, frequency, and magnitude of future damaging storms are unknowable, their future occurrence is a virtual certainty. Future sea level rise will only increase the risk to coastal communities from coastal storms as well as long-term erosion.

Beach nourishment is one of the ways to reduce the risk posed by coastal storms and more gradual long-term erosive forces. Beach nourishment can also preserve or enhance the total economic value associated with coastal recreation opportunities, as well as help preserve, or expand important coastal habitat.

This economic analysis is intended to preliminarily describe the economic value at risk from coastal erosion in the Santa Cruz Littoral Cell. Because of scope and budget limitations, this evaluation relies on existing information, so no new surveys or property assessments have been conducted. The evaluation quantifies values and impacts where possible using available existing data, and otherwise reports in qualitative terms. This evaluation can be used to inform the public and decision-makers as to types of value at risk, and may help prioritize the region's beaches for nourishment (and other types of project) funding. More detailed future analyses will be needed to determine the cost, the effectiveness, and the efficiency of measures to reduce the risk from coastal storms and erosion to recreational resources, property, and infrastructure. More work is needed before an alternatives analysis or benefit-cost analysis can be completed.

In summary, this evaluation aims to do the following:

- Inventory the coastal recreational resources in the Plan area that are vulnerable to future erosion.

- Describe the marketed and non-marketed values associated with beach attendance in the Plan area.
- Identify the property and infrastructure at risk from future coastal erosion.
- Identify the locations where the overall economic risk from coastal erosion is greatest.
- Describe the additional work required to complete a more-detailed, complete economic analysis of RSM measures in the Plan area.

This report has benefited from a review of the RSM Plans that have already been completed for other parts of the California coast. An effort was made to be generally consistent with these previously-completed analyses, but direct comparability of the results is not advised because of differences in data sources, methods, and levels of detail.

In the absence of more detailed and site-specific erosion analysis, the area of future erosion vulnerability is defined by the 2050 Coastal Erosion Hazard Zone (Figure 7-1 through Figure 7-20) developed by Philip Williams and Associates (now ESA) for a 2009 report by the Pacific Institute (Pacific Institute, 2009). This erosion hazard zone was developed for the coast of California, including the three counties in the Plan. Another erosion hazard zone dataset was created more recently for the Monterey Bay Sea-level rise Vulnerability Study (ESA PWA, 2014). Although this dataset is more recent and somewhat more refined than the 2050 Coastal Erosion Hazard Zone dataset used here, it does not include the entire stretch of the San Mateo County coastline that is being analyzed herein. Thus, for consistency's sake, the 2009 dataset is used in this report. Section 7.3 contains a brief comparison of the two erosion hazard zone datasets for the overlapping areas of the Plan area.

It is important to note that the 2050 Coastal Erosion Hazard Zone does not consider existing protective features such as revetments, seawalls, and bulkheads. For this reason, the erosion hazard zone is not a prediction of what will actually happen in the future, but rather a prediction of what would happen by 2050 if there were no erosion mitigation or prevention measures in place. Thus, the hazard zone supports an understanding of the importance of existing and potential future protective structures at reducing coastal erosion in the study area.

7.1.1 Contents

Section 7.2 describes the socioeconomics of the Plan area, summarizes previous studies on the economic impact of erosion and storm damage in the area, and describes the projections of future shoreline erosion developed by others and used in this report.

Section 7.3 presents an inventory of the coastal recreational resources in the Plan area on a beach-by-beach basis. It also includes a basic description of the types of infrastructure and properties vulnerable to coastal erosion.

Section 7.4 describes the methods that are typically used to estimate both marketed and non-marketed recreational value and describes the typical approach to valuing impacts to infrastructure and properties.

Section 7.5 presents some simplified models that can be used to get a basic and preliminary understanding of some of the economic impacts from erosion and from possible beach nourishment in the Plan area.

Section 7.6 summarizes the results of this evaluation and describes what data and analysis are needed to ultimately conduct a benefit-cost analysis of one or more potential beach nourishment projects.

7.2 The Plan Area

Much of the coastline in the Santa Cruz Littoral Cell is undeveloped. From north to south the coastal cities and communities in the Plan area consist of: El Granada and Half Moon Bay in San Mateo County; Davenport, Santa Cruz, Twin Lakes, Capitola, Aptos, Rio Del Mar, La Selva Beach, and the Pajaro Dunes development in the City of Watsonville in Santa Cruz County; and Moss Landing in Monterey County. There are three harbors in the Plan area. From north to south they are Pillar Point, Santa Cruz, and Moss Landing. Many of the beaches in this area are popular destinations for both locals and tourists. As is described in more detail later in this report, the vast majority of the population, property, infrastructure, and recreation value at risk from coastal storm damage and erosion are located in and around the cities of Half Moon Bay, Santa Cruz, Capitola, and Aptos.

7.2.1 Socioeconomics

The populated coastal areas in the Plan area consist of a handful of cities and towns in the Counties of San Mateo, Santa Cruz, and Monterey. According to the latest available data from the U.S. Census Bureau, the coastal communities in the Plan area are home to approximately 108,000 people and 40,000 households. The median household income and the percentage of the population below the poverty level in the area are similar to the values for the state of California. The median value of owner-occupied housing, however is nearly twice the value for broader California, which is not surprising given that these communities are located along the coast.

Table 7-1: Select socioeconomic statistics of coastal communities in the Plan area

	PLAN AREA	CALIFORNIA
Population	108,410	38,332,521
Households	40,024	12,466,331
Median Value of Owner-Occupied Housing Units	$662,631	$383,900
Median Household Income	$66,662	$61,400
Percentage of Population Below Poverty Level	15.3%	15.3%

The economy of the Plan area is dominated by services industries, of which tourism is a major component and a significant driver of overall demand for goods and services in the area. The top two industries by employment are retail trade and accommodation, and food service (US Census Bureau, 2007).

For the City of Santa Cruz and the surrounding towns like Capitola and Aptos, the existence and quality of the local beaches is especially important to their economy. According to a 2010 report produced for the Santa Cruz County Chamber of Commerce and Visitor Center (Santa Cruz County, 2010), nearly three-quarters of surveyed visitors who came from outside of Santa Cruz County went to one of the county's beaches. Although that doesn't necessarily mean that all of those visitors came for the beach, it is reasonable to assume that a large percentage of those tourists would not have come but for the existence and quality of the local beaches. More than one-third of those surveyed stayed overnight, spending on average $275 (2014 dollars) per group in the county. According to the survey, day visitors spent about $100 per group in the county.

The tourism industry not only creates and supports jobs in the region, but is also an important source of tax revenue for the cities and counties in the Plan area. For the City of Half Moon Bay, the Transient Occupancy Tax (TOT), which is a tax charged to hotel guests, is the largest contributor to the City's General Fund (almost $5M in 2013-2014). Visitor-generated tax receipts account for more than 25% of the total tax receipts for both San Mateo and Santa Cruz Counties (Dean Runyan Associates, 2014).

As the population in the region continues to grow, so will the demand for beach and coastal recreation. According to the California Department of Finance's Demographic Research Unit, the populations of the counties of San Mateo and Santa Cruz are expected to grow approximately 25% and 15%, respectively, between 2015 and 2060 (California Department of Finance, 2013). The population of the surrounding counties is forecast to grow by approximately 15% over that same period. Given that a large percentage of the visitors to the coastal towns come from other Northern California counties (around 90% according to the Santa Cruz County Chamber of Commerce and Visitor Center), the forecasted population growth in these counties will mean continued growth in demand for the Plan area's beaches and other coastal recreational opportunities.

As Table 1 shows, the average property value in the coastal communities is much greater than the state average. Greater still are the values of the properties that are along the coast, which are the most at risk from coastal storms and erosion. According to data from the San Mateo and Santa Cruz County assessors and from websites such as zillow.com, most of the beach-front homes are valued at between $1M and $2M. As Section 7.3 describes, no critical public structures such as schools, hospitals, or fire stations have been identified as being vulnerable to coastal erosion over the next several decades.

7.2.2 Previous Studies on Erosion Risk

Little has been written previously about the recreational value or coastal recreational activity at the region's beaches. A search of existing literature shows essentially all beach valuation and beach nourishment studies at California beaches have focused on the popular beaches in Southern California between San Diego and Santa Barbara (Kildow & Colgan, California's Ocean Economy, 2005).

There has, however, been a fair amount written about the history, impact, and future risk of coastal erosion to infrastructure and properties in the area. Much of the literature focuses on the City of Santa Cruz, which has a large percentage of the area's vulnerable infrastructure and properties at risk from wave attack and coastal erosion. Griggs & Johnson (1983) estimated that coastal damage in Santa Cruz County from the January 1983 storm exceeded $10M in 1983 dollars (roughly $24M in current dollars). In that storm, eight homes were destroyed and forty-seven homes and businesses were heavily damaged.

Griggs and Haddad (2011) identify the areas and assets most vulnerable to coastal erosion and direct wave attack in the City of Santa Cruz when considering future sea-level rise and increased storm intensity. The report states that, although the most vulnerable locations in the City have been armored already, sea-level rise combined with increased wave attack over the next few decades will require the City of Santa Cruz to make tough decisions related to adapting to the changed conditions.

The Pacific Institute (Pacific Institute, 2009) conducted an analysis of the current population, infrastructure, and property at risk from future sea-level rise in the absence of measures taken to protect the California coast. The report identifies areas that are at increased risk from erosion as a result of sea-level rise. The study includes essentially the entire coastline of Santa Cruz and Monterey Counties, but the results are reported at the county level.

The Pacific Institute report estimates that, under a scenario of medium to high sea-level rise, by 2100 San Mateo County and Santa Cruz County coastlines will lose 2.4 and 0.9 square miles of land, respectively, because of cliff erosion. The report predicts that, in the absence of measures taken, by 2100 the average cliff erosion distance in San Mateo and Santa Cruz Counties will be 102 and 118 feet, respectively. With 4.6 feet of sea-level rise along the California coast (which could occur by 2100 under "medium to medium high emissions scenarios"), the report estimates that more than 22 miles of roadways in Santa Cruz County will be vulnerable to coastal erosion, all of which are within the Santa Cruz Littoral Cell and environs. San Mateo is estimated to have 28 miles of vulnerable roads and highways, but much of that is north of this littoral cell.

The Pacific Institute report also estimates that by 2100 Santa Cruz and San Mateo have 3,000 and 1,900 parcels, respectively, in what they call the "coastal erosion hazard zone" associated with 4.6 feet of sea-level rise. The GIS dataset created for the Pacific Institute report by Philip Williams and Associates (now ESA) was used to define the erosion hazard zone for this report (called here the "2050 Coastal Erosion Hazard Zone" or simply "erosion hazard zone"). The assumptions, data, and methods used to develop the dataset can be found in the Pacific Institute report (Pacific Institute, 2009).

According to a report by the USGS, the Central California coast has some of the more stable beaches in the state with low accretion and low erosion rates (Hapke, 2006). The shoreline between Capitola and the mouth of the Pajaro River has been stable over the long term, and has even accreted somewhat. The short term trend (1950s to 2002), however, is one of erosion for most of the shoreline. The USGS report makes it clear that these rates of change are not intended to predict future shoreline positions or rates of change (Hapke, 2006).

There are stretches of coastline in the Plan area where beaches, infrastructure, and homes have been severely affected by wave attack and coastal erosion. According to (Griggs & Johnson, 1983), storm damage and coastal erosion are somewhat of a localized process, and a storm that causes significant damage in one stretch of coastline may have little or no impact on a nearby stretch. From page 164:

> *The orientation of the coastline relative to the direction of the wave approach, the wave height and length, offshore topography, persistence of wave attack (such as the number of storms per season), tidal stage, presence or absence of a protective beach or an engineering structure are all important in determining the impact of any particular storm on any stretch of coastline.*

Making the forecast of erosion and storm damage impacts even more challenging is the fact that climate change and sea-level rise are expected to worsen cliff erosion on the West Coast of the United States. According to (Griggs & Haddad, 2011), over the past 25 years California has experienced increasingly intense winter storms and greater wave heights, which may be leading to more severe winter erosion. In the future, greater wave heights from more intense storms, combined with higher sea levels, are expected to result in more erosion in the region and more economic damages from erosion and wave attack. Many of the areas most exposed to erosion risk have already been armored, and the CCC is increasingly hesitant to approve any new armoring along the coast (Griggs & Haddad, 2011).

7.2.3 Beach Nourishment History

Beach nourishment can play an important role in preserving or enhancing recreation value at several beaches in the littoral cell, while reducing the risk to infrastructure and properties on or near cliffs or dunes that are not currently armored – and reducing or delaying the need to armor the back beach.

Although beach nourishment has been important for broader California, little beach nourishment activity has occurred in the littoral cell. Between 1960 and 2013, just over $300 million was spent on beach nourishment in California, placing more than 620 million cy of sand (Kildow, 2014). During this time, California ranked first in the nation in the volume of sand moved, and sixth in spending on beach nourishment. An analysis of historical dredging data compiled by the CCC – and updated by the CSMW in 2008 – shows that less than 1% (by volume) of all beach nourishment activity in California occurred in the littoral cell, and a total of approximately 5 million cy of sand have been placed at just four locations – Capitola City Beach, Twin Lakes State Beach, Seabright State Beach, and Moss Landing State Beach. The vast majority of the 5 million cy was dredged from Santa Cruz Harbor and placed on the adjacent Twin Lakes State Beach. Artificial beach nourishment has not taken place at any other beach in the Plan area.

The 2002 Beach Restoration Report (California Department of Boating & Waterways & California Coastal Conservancy, 2002) estimates that the State of California needs to invest $120M in one-time beach nourishment costs and $27M in annual beach maintenance costs to prevent a loss of economic value associated with the State's beaches.

7.3 Inventory of Beaches and Assets in the Erosion Hazard Zones

This section briefly describes the major recreational resources, infrastructure, and the number and type of properties that are in the erosion hazard zone within the Plan area.

The actual economic risk of erosion (Box 7.1) differs along the coast – in some places it is quite high whereas in others it is low or zero. An area can be vulnerable to erosion, but if there is little or no economic value along the coast, then the economic risk would be characterized as low. In some locations as little as several feet of additional erosion could shut down a major highway (high economic risk), whereas in other areas there are no assets and little or no recreation value vulnerable to erosion for the foreseeable future (low economic risk). In locations where armoring of the bluff with a seawall or riprap has already occurred, the erosion risk to assets on or behind the bluff will have been significantly reduced, but a narrowing of the

Box 7.1: Risk vs Vulnerability

The terms "risk" and "vulnerability" are both used in this report, but they mean different things.

Risk is quantifiable, and is typically defined as the probability of something bad happening multiplied by the consequence of its occurrence. Thus, to really understand the risk of something bad happening (in this case erosion or storm damage), you must have an idea of its likelihood. Accurately estimating the likelihood of something occurring is often challenging and uncertain, and often requires in-depth analysis and high quality data.

"Vulnerability" is a more general, qualitative term that is used when assets or resources are thought to be in harm's way, but not enough information is known about the likelihood or consequences of the threat to quantify it in a meaningful way.

beach may still occur. This narrowing of the beach would be expected to reduce total recreation value at the beach. Also, future sea-level rise is expected to increase the risk of damage from coastal erosion along the coast of the Plan area, and areas that have not historically been viewed as high risk may become so over time as the likelihood and rate of erosion increases (Griggs 2011).

Erosion vulnerability and risk obviously depend on assumptions related to the rate of future erosion. This evaluation uses the aforementioned GIS shapefile created by ESA for a Pacific Institute report (Pacific Institute, 2009) to define the erosion hazard zone in the Plan area through the year 2050.

The inventory of recreational resources and assets focuses on the more popular beaches in the Plan area, although it is recognized that there are some additional small beaches and bluff-top trails and overlooks that may be threatened by future coastal erosion. The California Coastal Access Guide (2003) was extremely helpful for the task of inventorying the many named beaches along this approximately 75-mile stretch of coastline.

An important variable for the estimate of the economic value of a beach is its attendance. Accurate beach attendance is notoriously difficult to obtain (King & McGregor, 2012). Most of the popular beaches in the Plan area are California State Beaches, and annual attendance is tracked by the State Parks Department. Attendance estimates for two of the popular beaches in Santa Cruz County were provided by the United States Lifesaving Association. The following sections describe the beaches and development along the coast in each of the seven reaches (Figure 2-4).

7.3.1 Reach 1: Princeton to Pillar Point Harbor

This reach is entirely inside the outer breakwaters of Pillar Point Harbor, which were constructed by USACE in 1961. Along the approximately one mile of shoreline between the West Breakwater and the western arm of the inner breakwater are the West Shoreline Trail and a handful of commercial properties. The trail has been affected by erosion, and most of the properties have been fronted with riprap or debris to reduce the risk of future erosion. The erosion problem and potential measures to remedy it have been studied extensively (Moffatt & Nichol Engineers, 2001), but, according to conversations with local stakeholders, no erosion risk reduction project is currently being planned. This area is not included in the 2050 Coastal Erosion Hazard Zone dataset. No estimate of the use of the Shoreline Trail was available for this report.

7.3.2 Reach 2: Pillar Point Harbor to Miramontes Point

The recreational resources in this reach include several popular beaches, segments of the Coastside Trail, bluff-top park land, and a golf course. Although most are fronted by a rock revetment, there are numerous residential and commercial structures that are in the erosion hazard zone. Highway 1 and a segment of the Coastside Trail are only several feet away from the unprotected bluff in one location.

At the northern end of the reach, just outside of the Pillar Point Harbor East Breakwater, are El Granada or Surfer's Beach and an area that includes Vallejo Beach and Miramar Beach, which are adjacent, small beaches (Figure 7-1). This area has experienced significant erosion of the beach and bluff since the construction of the breakwater. In a 2009 report, the USACE stated that the construction of the breakwater accelerated the beach and bluff erosion in this area beyond what would have occurred without the breakwater (U.S. Army Corps of Engineers, San Francisco District, 2009).

Figure 7-1. Erosion hazard zone - Surfer's Beach area

The northern end of this reach is popular with local surfers (hence the name). From site visits and a discussion with a local surfer, it was estimated that the average use by surfers was as much as 40,000 per year. According to a representative of the Surfrider Foundation, changed conditions at Surfer's Beach over the last several years – including loss of the beach seafloor scour – have resulted in more dangerous surf conditions as it has become more challenging to exit the surf zone at medium to high tide. As the visible beach continues to disappear and the surf conditions become more dangerous, it is likely that the number of surfers will decrease as compared to the current estimate.

There are several small and large hotels in the area whose business is driven by the aesthetics and the recreation opportunities in the area. Besides surfers and those walking on the beach, beach attendance is relatively sparse – presumably because of the narrow beach, limited parking, and lack of facilities such as restrooms. From site visits, most of the beachgoers appear to be patrons of the area's various hotels and restaurants.

The Coastside Trail runs along the eastern boundary of the four beaches in this reach, providing close to a three-mile stretch to walk, jog or ride bikes. Erosion of the bluff along Surfer's Beach has pushed the trail to the edge of the heavily-traveled Highway 1, which is a safety concern (Figure 7-2).

Figure 7-2. Vulnerable section of Highway 1 at Surfer's Beach

From an economic perspective, Highway 1 – which is less than 20 feet from the top of the bluff in some locations – is the most important single piece of infrastructure at risk from potential future bluff erosion in this reach. Traffic counts from 2012 show that there are, on average, approximately 43,000 daily trips along this stretch of Highway 1 (Caltrans, 2012). Currently, approximately 800 feet of the bluff along the highway is armored with riprap to reduce erosion. Because some areas are unprotected, the threat of erosion to Highway 1 is imminent, and preventing or delaying adverse impacts to the highway will require measures such as beach nourishment, armoring of the bluff, or relocation of the road.

Along the coast just south of Surfer's Beach is a small, two-lane coastal road (Mirada Road) with several residential and commercial properties, including a restaurant along its landward side. The road and these properties are fronted with a rock revetment.

South of the Mirada Road are three state beaches: Dunes Beach, Venice Beach, and Francis Beach (Figure 7-3). All three are sandy beaches with bluffs that have restrooms, parking, and bike paths. Francis Beach also has a campground with 52 spots for either tent camping or for recreational vehicles. The beaches make up Half Moon Bay State Beach, which was estimated by the DPR to have had 684,000 visitors in 2013 (California State Parks, Santa Cruz District, 2014). Several parking lots are in the erosion hazard zone.

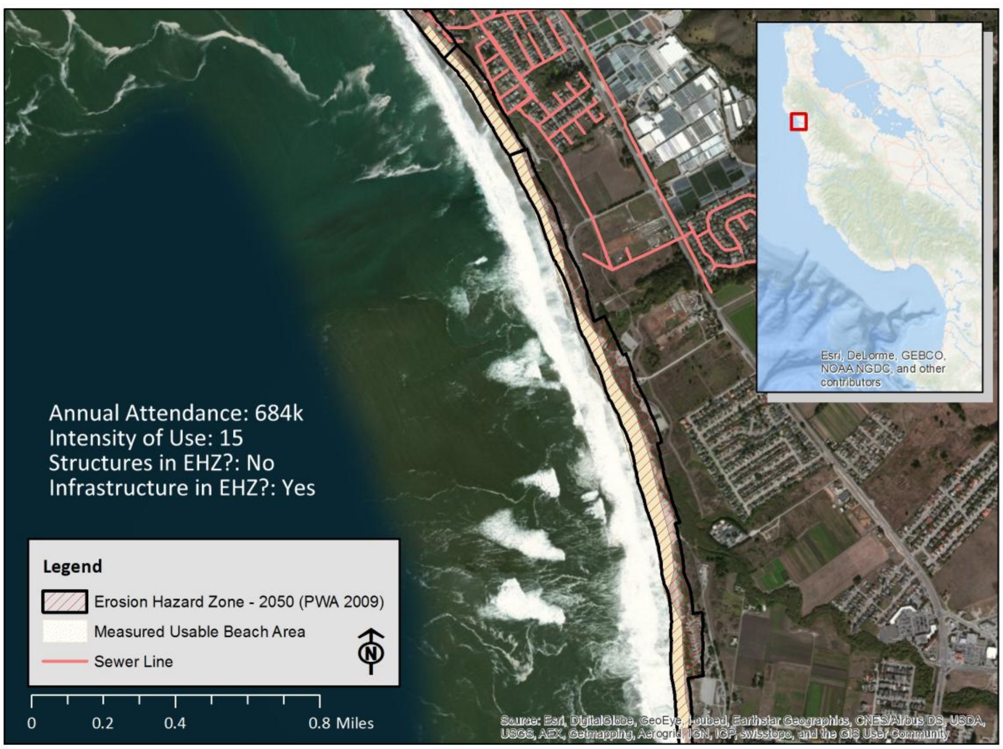


Figure 7-3. Erosion hazard zone - Half Moon Bay State Beach

At the southern end of this reach is the Ritz-Carlton resort, which includes a luxury hotel, golf course, and associated amenities. Sections of the golf course are vulnerable to cliff erosion and are in the erosion hazard zone.

7.3.3 Reach 3: Miramontes Point to Pescadero Creek

Except for one area, this reach is largely undeveloped. Sandy beaches backed by bluffs and some stretches of rocky shoreline characterize the accessible coastal areas in this reach.

Arroyo Canada Verde Beach and Cowell Ranch Beach are located at the north end of the reach. Both beaches have limited parking and basic facilities including restrooms. Farther south is Martin's Beach, which is a privately developed fishing cove with a sand beach and bluff. The small, crescent-shaped beach is known for good fishing and great surfing. Facilities include restrooms, picnic tables, and a general store. Parking is for a fee. Behind approximately 1,000 feet of riprap revetment along the bluff are approximately fifty structures – mostly cabins for lease. There is currently a legal battle between the owner of the 53-acre property atop the bluff and the Surfrider Foundation over access to the beach area in accordance with the 1972 Coastal Zone Conservation Initiative (San Francisco Chronicle, 2014).

South of Martin's beach is Tunitas Beach, located at the mouth of the Tunitas Creek. There is limited parking available for those wishing to walk or hike to beach below. At the northern end of this beach is an area of bluff erosion that may eventually threaten Highway 1. According to Caltrans, there are on average approximately 14,000 daily trips along this stretch of the highway, which equates to about 5.1 million trips annually. Measurements taken using aerial images from February 2014 show that the shortest distance between the bluff top and the highway is just over 100 feet.

Farther south are San Gregorio, Pomponio, and Pescadero Beaches – all are State Beaches. This area is characterized by sandy beaches, some rocky shoreline, and bluffs as high as 150 feet in some areas. All of the beaches have parking, restrooms, and picnic facilities, and all but Pescadero charge a day-use fee. The San Gregorio parking lot has approximately 150 spots, whereas the other two sites have approximately 75 parking spots available. San Gregorio is the most attended beach, with an estimated 373,000 visitors in 2013. San Gregorio is located at the mouth of San Gregorio Creek, and the resultant estuary and marsh are important wildlife habitats (CA Coastal Commission 2003).

7.3.4 Reach 4

This reach has several recreation areas but little coastal development. Compared to the northern reaches, the beaches are generally shorter, narrower, and rockier. Development adjacent to the coast is limited to a handful of widely scattered properties, including the 52-bed Pigeon Point Lighthouse Hostel, which is in the erosion hazard zone.

The major beaches include Pebble Beach, Bean Hollow (Figure 7-4), Gazos Creek, and Año Nuevo. All of those beaches have parking lots and basic facilities such as restrooms and picnic tables. Pebble Beach, Bean Hollow, and Gazos Creek have parking lots for less than 26 cars, whereas Año Nuevo is a State Reserve with a large lot for more than 125 vehicles.

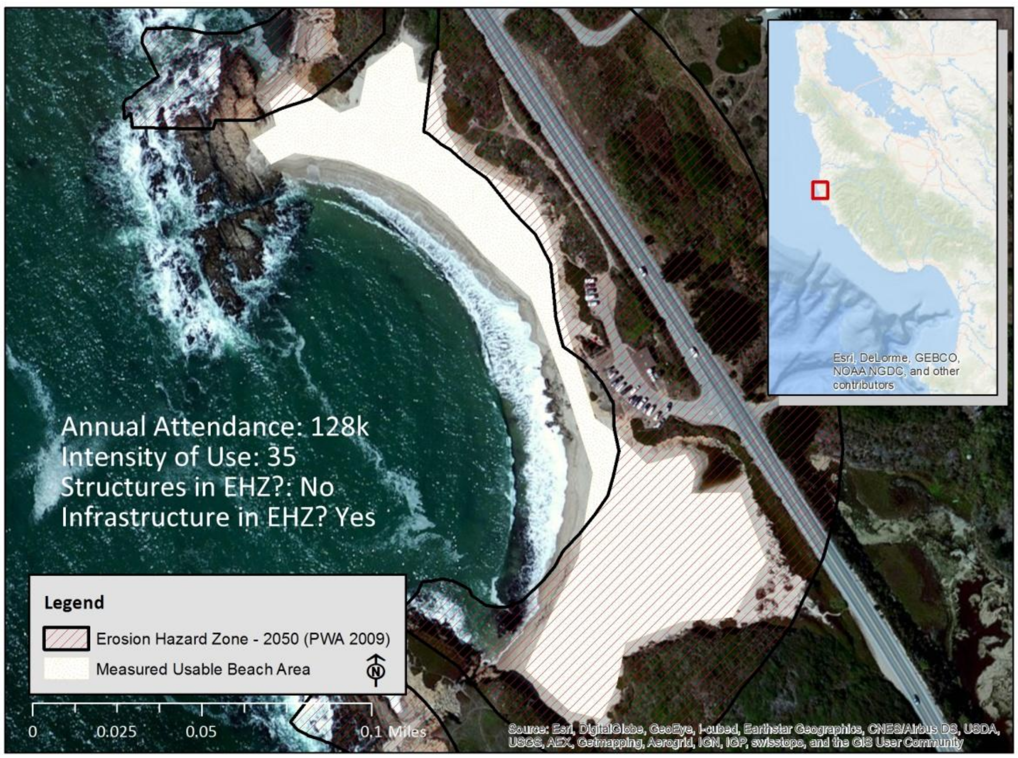


Figure 7-4. Erosion hazard zone - Bean Hollow State Beach

Año Nuevo is a protected breeding ground for elephant seals, and also is popular for bird and whale watching. Parts of the Reserve are closed to visitors during the elephant seal breeding season, which is several months long. Bean Hollow is the most intensively used beach in this reach, with more than 125,000 visitors in 2013, although some unknown percentage of that number presumably did not use the beach but were hiking the coastal trail or exploring the rocky shore at this location. At Bean Hollow, both Highway 1 and the parking lot are in the erosion hazard zone.

7.3.5 Reach 5: Point Año Nuevo Natural Bridges State Beach

There are numerous named beaches in this reach, which is characterized by sandy beaches, dunes, and bluffs. Parking at several of the beaches is limited to the shoulder of Highway 1. There are few vulnerable properties.

At the north end of the reach is Waddell Creek Beach (Figure 7-5), which is internationally known for its exceptional windsurfing conditions. There is extensive armoring along Highway 1 just north of the beach, and some armoring on the beach. Both Waddell Creek Beach and the adjacent Greyhound Rock Beach each have parking lots with space for more than fifty vehicles. Greyhound Rock Beach is a popular rock fishing spot and has basic facilities such as picnic tables and toilets. Highway 1 and parking lots are both in the erosion hazard zone.

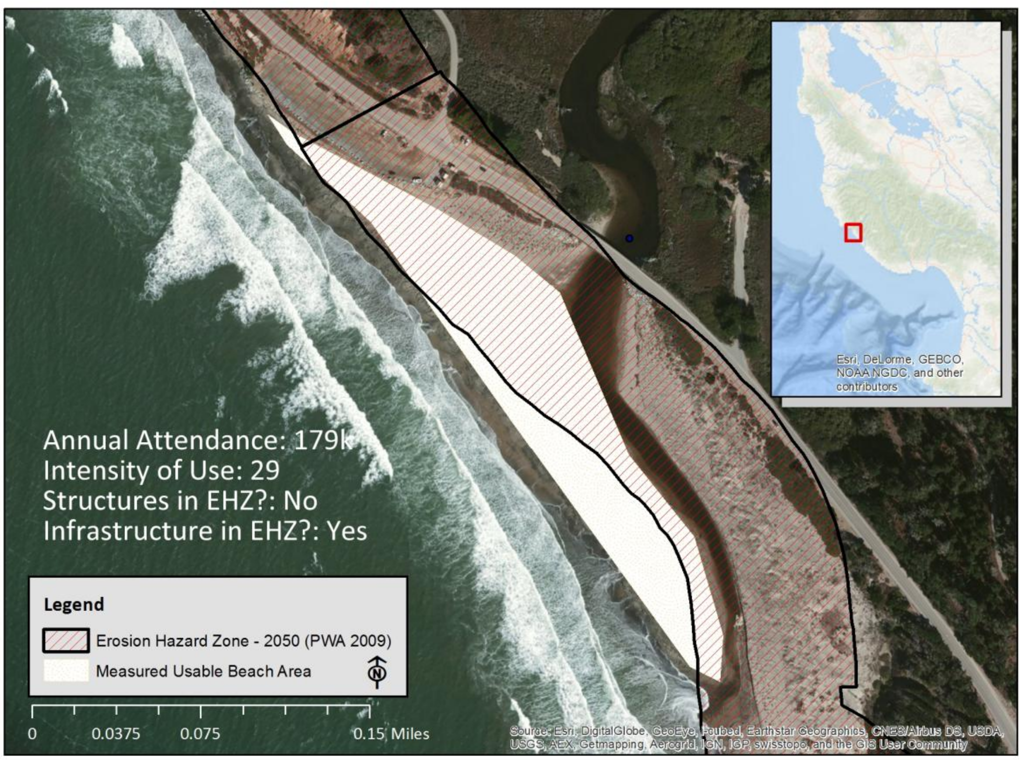


Figure 7-5. Erosion hazard zone - Waddell Creek Beach

Scott Creek beach is popular with birders and surfers, but parking is limited to an improved shoulder. Armoring is in place along approximately 700 feet of Highway 1 at the beach, which appears to be within as little as fifteen feet of the bluff top in some locations. Davenport Landing is popular for surfing and kite flying. There are several residential structures and a large commercial property (American Abalone Farms) above this beach's low bluff. Little rock revetment is in place currently.

At the adjacent Davenport Beach, erosion may eventually threaten the railroad tracks that have historically served the large cement plant located just across Highway 1 – the tracks are not in the 2050 erosion hazard zone. This stretch of Union Pacific railway is currently inactive as a result of the closure of the cement plant in 2010. The Big Creek Lumber Company is located on the east side of Highway 1 just above Waddell Creek Beach and contains a saw mill and the wholesale and administrative offices of the company. This property is not in the 2050 erosion hazard zone.

Farther south, Wilder Ranch State Park has two small beaches that are part of the large complex that includes 34 miles of hiking, biking, and equestrian trails.

The popular Natural Bridges State Park (Figure 7-6 and Figure 7-7) is at the southern end of this reach**.** The area has a picnic area with tables, barbecues, water faucets and restroom facilities. There is a day-use fee per car to park in the state beach area. There is a visitor center, and one of the park's attractions is its monarch butterfly preserve where up to 10,000 butterflies live in the fall and winter months (California State Parks 2014). There were an estimated 800,000 visitors to the beach and adjacent parkland in 2013, and although the proportion of those visitors that used the beach is unknown, it is safe to say that this beach is one of the most popular and most intensively used in this reach. As shown in Figure 7-6, a local road, a parking lot, and several homes adjacent to the beach are in the erosion hazard zone.

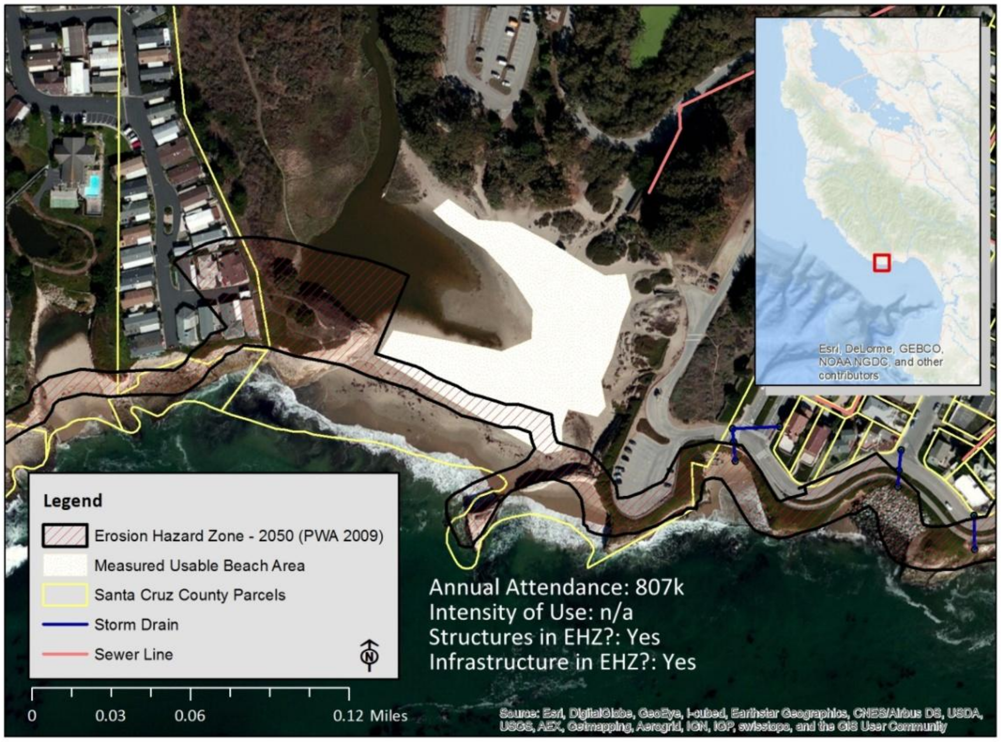


Figure 7-6. Erosion hazard zone - Natural Bridges State Beach

Figure 7-7. Rock formations at Natural Bridges State Beach

7.3.6 Reach 6: Natural Bridges State Beach to New Brighton State Beach

There is significant value at risk in this reach, including homes, businesses, roads and other public infrastructure, and recreational locales. Most of the commercial-structure value is located at the Santa Cruz Main Beach and the Capitola City Beach. The residential properties along the shoreline are mostly high-value, single family-homes currently valued at between $1M and $2M. The area is renowned for having some of the best surfing in the country, and the sandy beaches and surfing opportunities are an important driver of the large tourism economy in the area.

Lighthouse Field State Beach (also known as Its Beach, Figure 7-8) overlooks the Steamer Lane surfing mecca. It also contains the Santa Cruz Surfing Museum, which is housed in the 1967 lighthouse. There are numerous small parking lots that, in total, appear to be able to accommodate approximately 75 vehicles. The beach is within walking distance of downtown Santa Cruz. The beach is popular and heavily used during the summer months, but winter storms generally lower the beach sand level to the point that the beach disappears at high tide. Despite strong wave attacks during winter storms, the cliffs have changed little over the past century, although in the unprotected areas cliff erosion appears to have been between 6 and 8 inches per year (Griggs & Haddad, 2011).

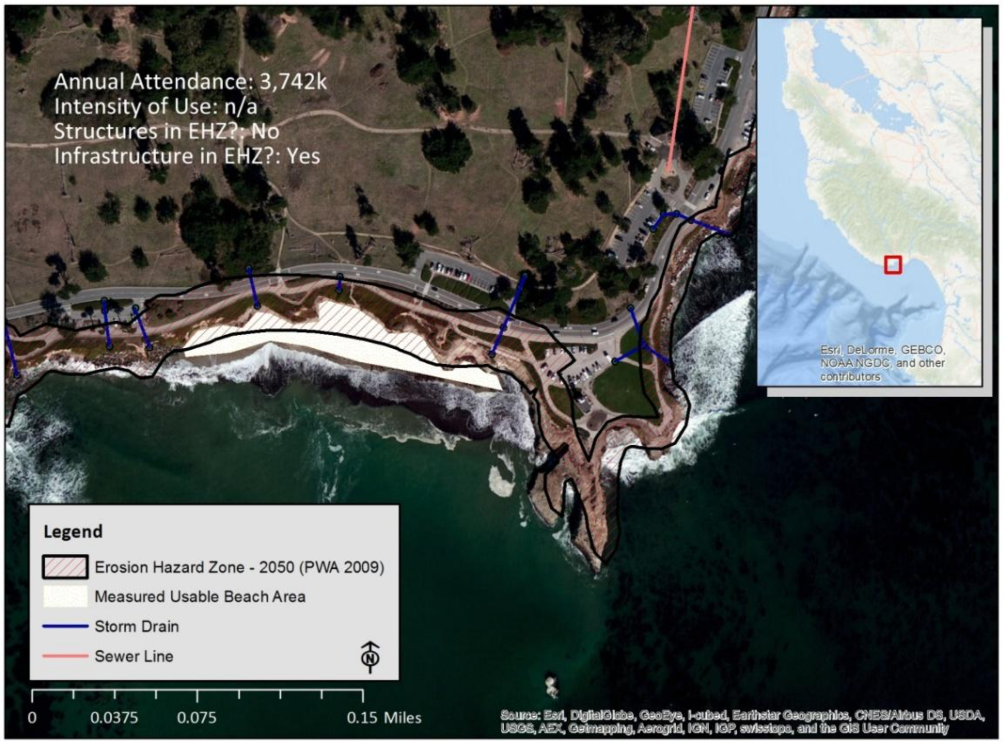


Figure 7-8. Erosion hazard zone - Lighthouse State Beach

Cowell Beach and Santa Cruz Main Beach (Figure 7-9) are located near downtown Santa Cruz on either side of the wharf. This is one of the most popular beach complexes in the region, and averages around 750,000 annual users (United States Lifesaving Association). This mile-long stretch of beach is popular for volleyball, surfing, swimming, and other typical beach activities. The area includes a historic amusement center that has rides, arcades, and concessions. The infrastructure and properties on the back beach are protected by a seawall, but the relatively flat beach is vulnerable to erosion from large storms, which also tend to deposit logs and debris from the nearby San Lorenzo River across the beach. The flatness of the beach also makes it vulnerable to even low levels of sea-level rise (Griggs & Haddad, 2011). Numerous commercial structures, parking lots, roads, a railway, and public utility lines are in the erosion hazard zone.

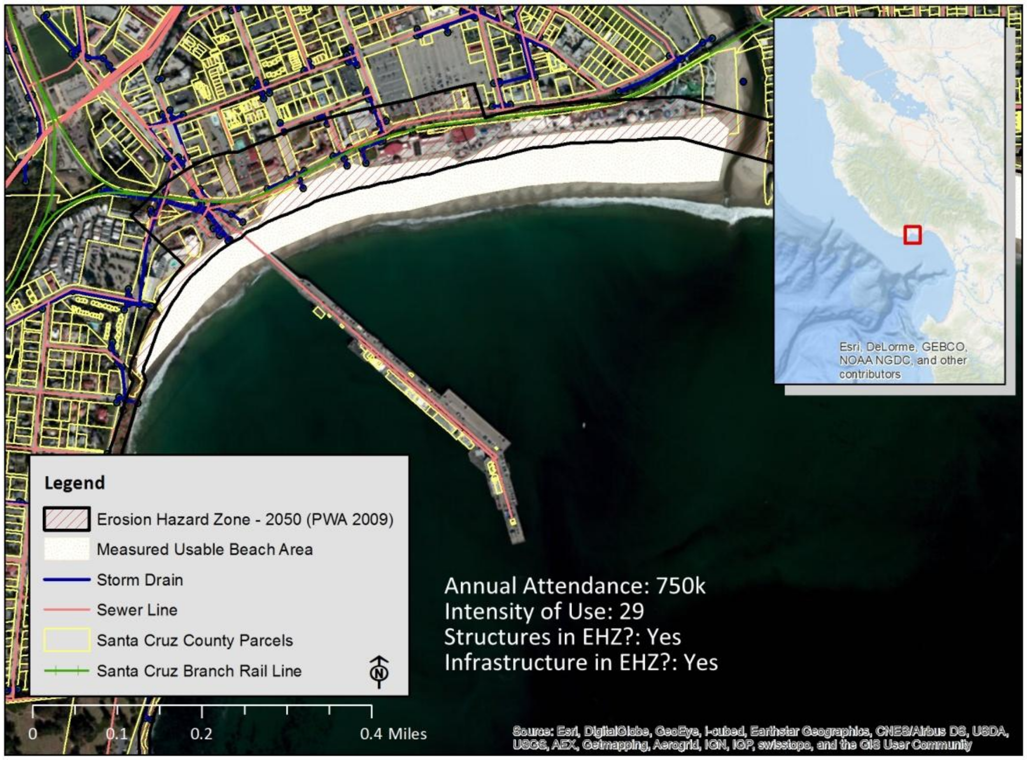


Figure 7-9. Erosion hazard zone - Santa Cruz Main Beach

Seabright State Beach is located between the mouth of the San Lorenzo River and the Santa Cruz Harbor. The wide sandy beach has lifeguard service, fire pits, restrooms, and limited street parking. The beach is wide and nearly permanent because of the construction of the jetties on both sides of the beach. Because of the wide beach, the properties and infrastructure on the back beach are not currently highly vulnerable, but will become more vulnerable with any future sea-level rise. Several homes, a local road, and utility lines are in the erosion hazard zone.

The adjacent Twin Lakes State Beach (Figure 7-10), which extends across half a mile of sandy shoreline, is popular for swimming and picnicking. There are volleyball nets and a beachside café and restaurant. The small craft harbor in downtown Santa Cruz is approximately in the middle of Twin Lakes State Beach. Most of the material that is dredged from the Santa Cruz Harbor entrance channel is placed on the beach just east of the harbor, which nourishes an area that would otherwise be sand starved because of the location and effect of the harbor's jetties. Riprap armoring has been placed to reduce the risk of erosion to the two-lane East Cliff Drive as well as in front of numerous large homes located atop the bluff. Numerous homes, several roads, and utility lines are in the erosion hazard zone.

Figure 7-10. Erosion hazard zone - Twin Lakes State Beach

Along most of the previously described coastline, roads and parking lots were generally the first manmade assets landward of the beaches, cliffs, and bluffs. Starting at Twin Lakes State Beach and moving south and east along the coast, however, the majority of the vulnerable assets are residential properties and the local roads that serve them.

Corcoran Lagoon Beach (Figure 7-11) is a small stretch of sandy beach with tide pools. There are no facilities and only street parking is available. There are a handful of single-family homes that are on the bluff and an apartment building located on the beach. Between Corcoran Lagoon Beach and Moran Lake Beach there are approximately 20 large single family residences along the narrow strip of beach and armored (riprap) bluff, which is representative of the armoring fronting many residential properties in Reach 6.

Figure 7-11. Armored properties near Corcoran Lagoon Beach. Source: Bing Maps

Moran Lake Beach is a small pocket sandy with a small parking lot with around 35 spaces and restrooms available. Pleasure Point Beach and Opal Cliffs are narrow stretches of sandy beach with tide pools that are covered at high tide. The area is popular with surfers. Parking is limited.

Hooper Beach and Capitola City Beach (Figure 7-12) are on each side of the Capitola Wharf. This is a popular area for swimming and other beach activities including volleyball. There are a hotel and several restaurants and shops on the beach, with street and lot parking available. This is a seasonal beach, generally open from May to October each year. The sandy beach comes and goes as a result of the opening and closing of the lagoon at Soquel Creek by the City of Capitola. This beach is intensively used, with an estimated 386,000 users during just six months in 2013.

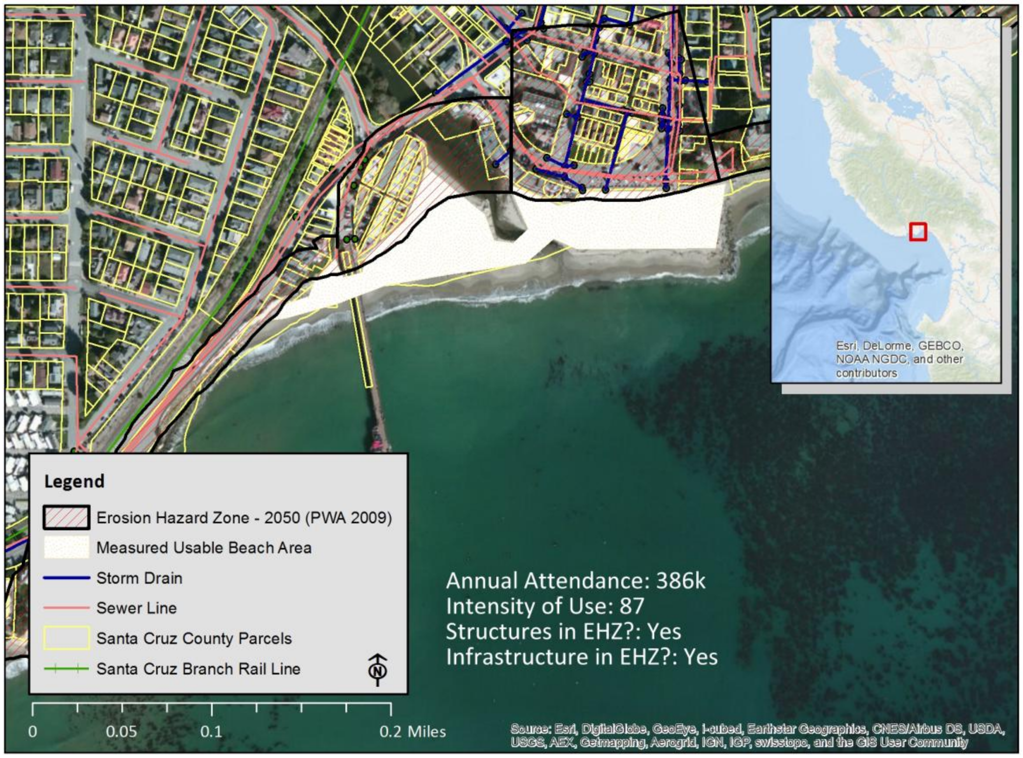


Figure 7-12. Erosion hazard zone - Capitola Beach

Just east of Capitola Beach is an area known as Depot Hill, which consists of a narrow beach with little armoring and cliffs that are currently exposed to direct wave attack (Figure 7-13). Local roads and large residential properties atop the cliff are in the erosion hazard zone. The between 25 and 30 homes are in the hazard zone have a current assessed value of nearly $48 million.

Figure 7-13. Vulnerable properties at Depot Hill. Source: Bing Maps

The Santa Cruz Branch Rail Line, which runs near the top of the cliff in one stretch of this reach, is in the erosion hazard zone. The rail line is used for both freight and passenger service. According to the Santa Cruz County Transportation Commission, lumber shipments along the line are expected to resume soon. Currently, passenger service along the railway is primarily during the holiday season (dinner trains, Christmas train, etc.), but the feasibility of more regular commuter service is currently being studied.

7.3.7 Reach 7: New Brighton State Beach to Monterey Submarine Canyon

Since the late 1920s, there have been at least 11 storms that have caused significant and documented damage to coastal assets in this reach (Griggs 1983). Storm-driven waves have destroyed seawalls, roads, buildings, parking lots, sewer lines, and recreational facilities such as camping sites. Given the location and orientation of the coastline in this reach, all of the damaging storms have come from the southwest direction. Over time, nearly all of the development on the back beach from New Brighton State Beach to Rio Del Mar has been armored by stone riprap, bulkheads, or seawalls. At the southern end of this reach, many homes have been built on active dunes just north of the mouth of the Pajaro River. In response to severe erosion during the storms of January 1983, riprap has been placed along approximately 1 mile of shoreline fronting the Pajaro Dunes development (Griggs, Patsch, & Savoy, 2005).

New Brighton State Beach (Figure 7-14) features picnic areas, and is popular for swimming, fishing and camping. The camping area is on a bluff overlooking northern Monterey Bay. A visitor center and park store are open during the spring and summer season. East of the campground area on the back beach there are approximately 20 residential properties. All of these are within the erosion hazard zone. The area is popular with beachgoers and birdwatchers, and had nearly 350,000 visitors in 2013.

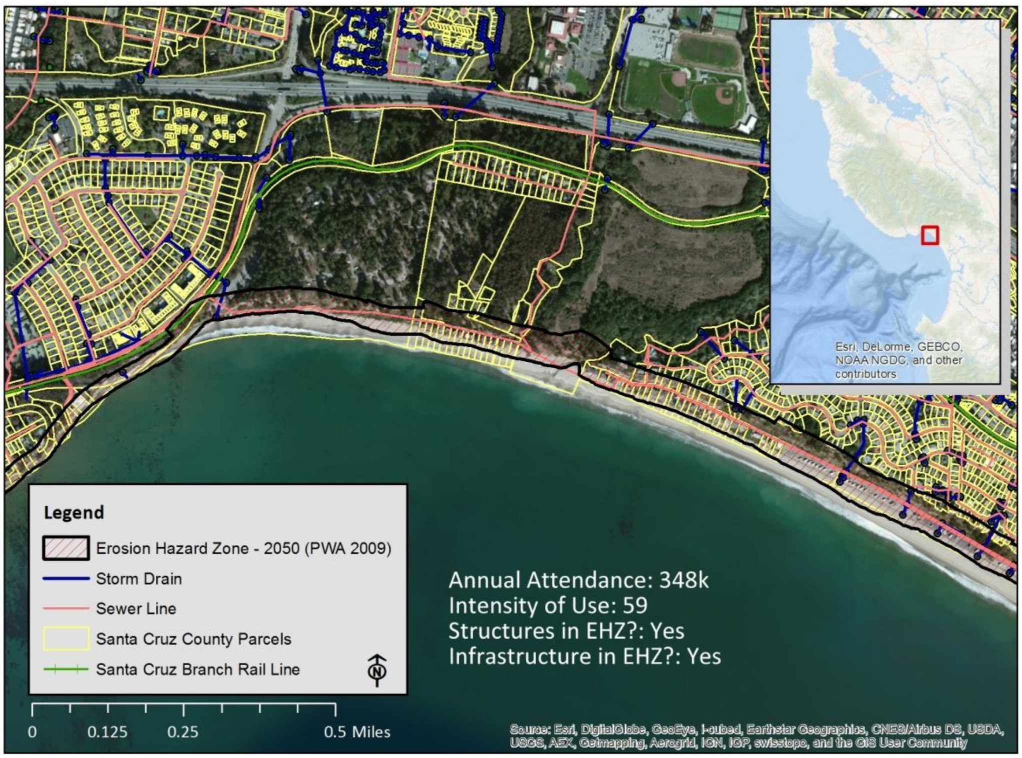


Figure 7-14. Erosion hazard zone - New Brighton State Beach

Farther down coast, Seacliff State Beach is an almost two mile-long stretch of sandy beach with residential properties and a large number of trailer hookups and parking spots along the coast (Figure 7-15 and Figure 7-16). A large number of homes, parking lots, and roads are in the erosion hazard zone. There are picnic tables and a visitor center. One of the most popular beaches in the region, an estimated 560,000 people visited the beach in 2013. Rio Del Mar Beach is at the eastern end of Seacliff State Beach, and has restrooms and a parking lot. There are residential properties, a local two-lane road, and a bluff-top parking lot along the beach.

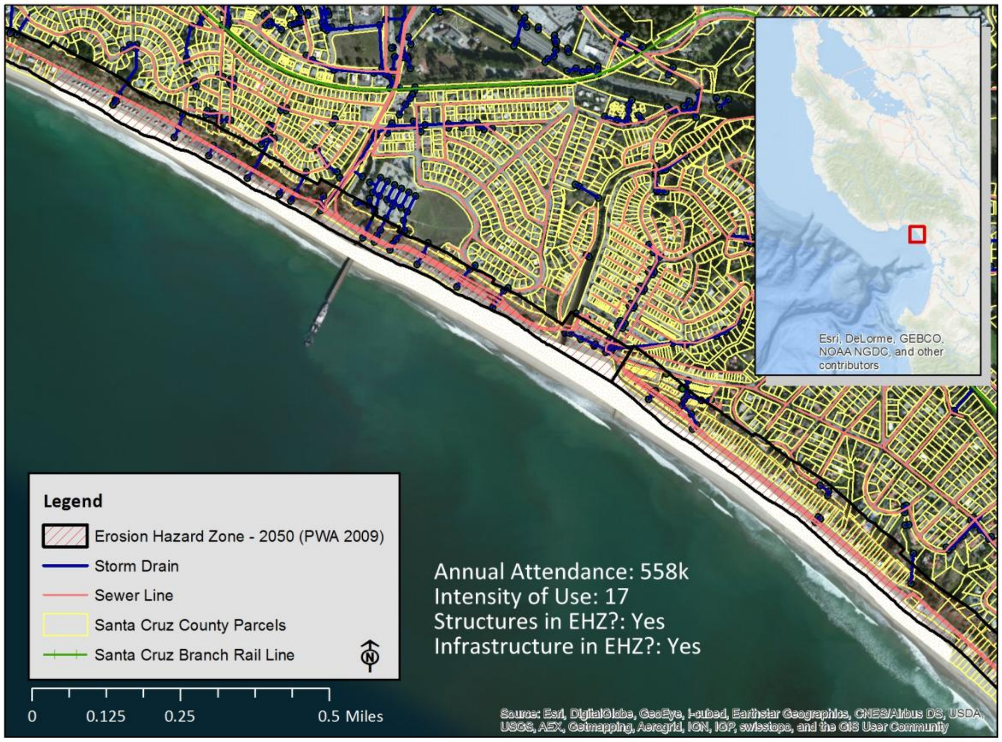


Figure 7-15. Erosion hazard zone - Seacliff State Beach

Figure 7-16. Armoring at Seacliff State Beach. Source: Bing Maps

Near the southern end of the reach are Manresa State Beach (Figure 7-17) and Sunset State Beach (Figure 7-18), which together span more than 5 miles of sandy coastline in Santa Cruz County. Both have fee parking lots and basic facilities such as restrooms and showers. The beaches are popular for camping and fishing. High surf and strong rip currents make for hazardous swimming conditions in the area. Dozens of residential properties are located on the bluff top near the mouth of the Pajaro River. The area has experienced damaging storms in the past, and many – but not all – of the homes are now fronted with a riprap revetment. The Santa Cruz Branch rail line, which runs close to Manresa Beach, is in the erosion hazard zone.

Figure 7-17. Erosion hazard zone - Manresa State Beach

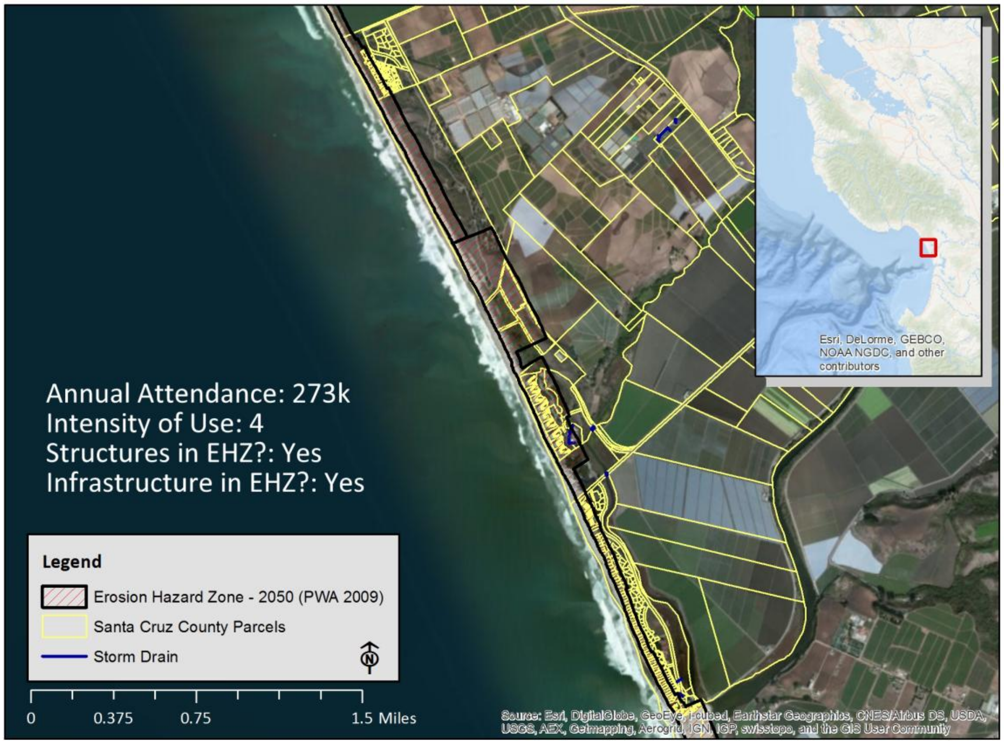


Figure 7-18. Erosion hazard zone – Sunset State Beach

Just north of Moss Landing Harbor, whose entrance channel is across from the Monterey Submarine Canyon are Zmudowski State Beach and Moss Landing State Beach. Both are sandy beaches backed by dunes, and have free parking and restrooms available. Zmudowski Beach is popular for fishing and clamming. Moss Landing Beach is popular for bird watching, fishing, surfing, and windsurfing. Some beach nourishment has occurred at Moss Landing Beach, which has been nourished with the suitable material dredged from the adjacent Moss Landing Harbor. Located just south of the entrance channel to Moss Landing Harbor, the Monterey Bay Aquarium Research Institute (MBARI) is in the 2050 erosion hazard zone. MBARI is a private, non-profit research center that employs approximately 220 people.

7.3.8 Inventory of the 2050 Coastal Erosion Hazard Zone

The above sections describe the primary amenities and activities undertaken at each of the main beaches in the Plan area. They also describe in general terms the kinds of properties and assets along the coast and in the 2050 Coastal Erosion Hazard Zone. Table 7-2, Table 7-3, and Table 7-4 summarize both the recreational value at each of the beaches and the types and quantities of assets that are located in the coastal erosion hazard zone.

Table 7-2: Beach attendance and intensity of use

Reach # and Name	Beach or Area Name	Usable Beach Area* (acres)	Estimated Annual Attendance (1,000s)	Intensity of Use Factor**
1 Princeton - Pillar Point Harbor	n/a	n/a	n/a	n/a
2 Pillar Point Harbor to Miramontes Point	El Granada (Surfer's)	5.0	40	8
	Half Moon Bay State Beach	45.7	684	15
3 Miramontes Point to Pescadero Creek	San Gregorio	18.8	373	20
	Pomponio	22.5	201	9
	Pescadero	21.7	178	8
4 Pescadero Creek to Point Año Nuevo	Bean Hollow	3.7	128	35
	Año Nuevo	26.2	178	7
5 Point Año Nuevo to Natural Bridges State Park	Waddell Creek	6.2	179	29
	Natural Bridges	3.7	807^	n/a
6 Natural Bridges State Park to New Brighton State Beach	Lighthouse Point & Field	1.2	3,742^	n/a
	Santa Cruz Main	26.2	750	29
	Twin Lakes	32.9	535	16
	Capitola	4.4	386	87
	New Brighton	5.9	348	59
7 New Brighton State Beach to Monterey Submarine Canyon	Seacliff	32.6	558	17
	Manresa	47.9	241	5
	Sunset	68.9	273	4

Notes:

*Usable beach area is approximate because it was measured from CA State Park Boundary shapefiles and aerial imagery.

**Intensity of Use Factor is the quotient of Annual Attendance and Usable Beach Area.

^Intensity of Use was not calculated because no beach-only attendance data was available.

Table 7-2 describes the recreational resources in terms of annual attendance, usable beach area, and what is called here an "intensity of use factor." This factor is simply the usable beach area (in acres) divided by the annual attendance. The usable beach area was measured on a GIS aerial image using the approximate wet sand line and the toe of the bluff, dune, or hard structure on the back beach as the bounds. The length of each beach is given in a GIS shapefile called California State Park Boundaries 2014/15. The DPR created the shapefile, and it is available from their website (California State Parks). Except for Surfer's Beach, the California Department of Parks and Recreation, the City of Capitola, or the National Lifesaving Association provided the beach attendance estimates. Attendance at Surfer's Beach was estimated during site visits.

The intensity of use factor is intended to help understand how much each beach is used relative to the others in the Plan area. It is meant to be a measure of the relative "crowdedness" of each beach and may also be a potential indicator of the relative efficiency of beach nourishment at each site. In theory, all else equal, the greater the intensity of use factor the greater the "bang for the buck" in terms of recreation value per dollar of nourishment cost. As the table shows, Capitola and New Brighton are the most intensively used beaches in the area. It should be noted there is uncertainty in the attendance estimates as well as the estimate of usable beach area.

Table 7-2 does not consider the fact that different beaches will have different average values per user based on the particular amenities and the varying distribution of beach activities. Ideally, beach-specific surveys would be conducted to estimate the average value per user (and the total non-marketed value) for each of the beaches.

Table 7-3 identifies which beaches have homes, businesses, and infrastructure in the erosion hazard zone. An asset is considered vulnerable if it is within the boundary of the coastal erosion hazard zone for the high sea-level rise scenario through the year 2050 (Pacific Institute, 2009). As the report notes, the methodology used to develop the erosion hazard zone was somewhat simplified by necessity (applied to the entire California coast), and a more detailed consideration of local conditions may show different results.

Because it does not factor in any detailed forecasts of localized future erosion (consider existing armoring, for example), or the cost or the effectiveness of a potential beach nourishment project at each site (e.g., how long the sand will stay on the beach), Table 7-3 cannot, by itself, be used to rank or prioritize beaches for potential future nourishment. It is simply meant to provide a basis for narrowing the focus of the analysis to areas where overall erosion vulnerability appears to be highest.

Table 7-3: Qualitative description of assets in erosion hazard zone

Reach	Beach or Area Name	Infrastructure in Hazard Zone	Structures in Hazard Zone	Description of Assets in Hazard Zone	Backbeach Armoring
1	Princeton-Pillar Point Harbor	•	•	Comm. Properties, Trail, Utilities	Some
2	Surfer's	•	•	Highway 1, Trail, Res. & Comm. Properties, Utilities	Some
	Dunes	•	•	Parking Lots, Res. Properties, Utilities	None
	Venice	•			None
	Francis	•			None
3	San Gregorio	•		Highway 1	None
	Pomponio	•		Highway 1, Parking Lots	None
	Pescadero	•		Highway 1, Parking Lots	Some
4	Bean Hollow	•		Highway 1, Parking Lot	None
	Año Nuevo	•		Highway 1, Parking Lot	None
5	Waddell Creek	•		Highway 1, Parking Lot	Some
	Natural Bridges	•	•	Res. Properties, Parking Lot, Local Roads, Utilities	None
6	Lighthouse Point & Field	•		Parking Lot, Local Roads, Utilities	Some
	Santa Cruz Main	•	•	Comm. Properties, Local Roads, Railway, Parking Lots, Utilities	Extensive
	Twin Lakes	•	•	Res. & Comm. Properties, Local Roads, Parking Lots, Utilities	Some
	Capitola	•	•	Res. & Comm. Properties, Local Roads, Parking Lots, Utilities	Extensive
	Depot Hill	•	•	Res. Properties, Local Roads, Utilities	None
	New Brighton	•	•	Res. Properties, Parking Lot, Local Road, Utilities	Some
7	Seacliff	•	•	Res. & Comm. Properties, Parking Lots, Local Roads, Utilities	Extensive
	Manresa	•	•	Railway Line, Res. Properties, Parking Lot, Utilities	None
	Sunset	•	•	Res. Properties, Parking Lot, Utilities	Extensive

Table 7-4 shows a more detailed inventory of the parcels, roads, railways, sewer lines, and storm drains located in the 2050 Coastal Erosion Hazard Zone. The estimates were developed by overlaying the relevant shapefiles. The analysis was conducted on what appeared to be the areas with the most value within the erosion hazard zone. The land value and structure values shown include all parcels that are wholly or partially in the erosion hazard zone, but the Parcel Acreage includes just the land that is within the erosion hazard zone. The assessed values shown are lower than the actual current values because of the effect of California's Proposition 13, which limits the annual increase in assessed property values (used to determine property taxes) to a maximum of 2% per year except when there is a change of ownership or significant new construction.

Table 7-4: Quantitative description of assets in erosion hazard zone for select beaches

Beach/Area Name	# Parcels Affected	Assessed Value of Land (1,000s)	Assessed Value of Structures (1,000s)	Parcel Acreage	Roads (miles)	Railways (miles)	Storm & Sewer Lines (miles)
Surfer's	23	n/a	n/a	2.5	0.7	0	n/a
Santa Cruz Main	36	$16,434	$20,446	24	0.8	0.6	1.3
Twin Lakes	109	$60,527	$22,425	9	1.2	0	2.2
Capitola	118	$36,523	$17,803	5	0.6	0	1.3
Depot Hill	30	$29,700	$18,000	7	0.1	0	0.08
Seacliff	258	$140,011	$51,255	23	2.4	0	6.1
Manresa	166	$93,919	$59,988	61	0.6	0.3	0.5
Sunset	526	$183,208	$112,258	71	3.1	0	0.1
Total		$560,322	$302,175	203	9.5	0.9	11.58

Notes:

1) Land and structure values are from the Santa Cruz County Assessor, August 2014. Because of California's Proposition 13, the actual current value is greater than the assessed value shown here.

2) Only privately-owned parcels and acreage are included in data.

3) Assessor data and utility data are not available for San Mateo County.

As stated previously, it is important to note that the 2050 Coastal Erosion Hazard Zone does not consider existing protective features such as revetments, seawalls, and bulkheads. For this reason, the erosion hazard zone is not a prediction of what will actually happen in the future, but rather a prediction of what would happen by 2050 if there were no erosion mitigation or prevention measures in place. Thus, the hazard zone supports an understanding of the importance of existing and potential future protective structures at reducing coastal erosion in the study area. For example, the seawall along Santa Cruz Main Beach greatly reduces or eliminates the current risk of erosion to the homes, businesses, and infrastructure behind the seawall, and if maintained it is expected that it would continue to do so in the future.

7.3.9 Comparison of Erosion Hazard Zones

In addition to the 2050 Coastal Erosion Hazard Zone dataset (the "2009 dataset"), ESA PWA has more recently created an erosion hazard dataset that considers multiple future scenarios and improves upon the resolution of the forecast. As the ESA PWA (2014) report states: "The present study has improved the methods from the Pacific Institute Study and applied them to the Monterey Bay study area with higher resolution local data and review by local experts." (ESA PWA, 2014). It is useful though, to compare the two hazard zones to understand how the use of the more recently developed and more refined dataset might change the results of an economic impact analysis (Figure 7-19).

At Seacliff State Beach, the 2009 dataset combines areas of both cliff and dune erosion, the 2014 dataset separates the two. Although the extents of the predicted erosion zones are similar, using the 2014 dataset (which is more detailed but also extends to the year 2060) would have resulted in a modest overall increase in the estimated impact of erosion in this area. Figure 7-20 shows the comparison of the erosion hazard datasets for the Santa Cruz Main Beach area.

Figure 7-19. Comparison of erosion hazard zones – Seacliff State Beach

Figure 7-20. Comparison of erosion hazard zones - Santa Cruz Main Beach and Twin Lakes State Beach

7.4 Methods to Estimate the Economic Impact of Storm Damage and Erosion

Coastal storm damage and erosion cause many types of adverse economic impacts. Damage to structures and the permanent loss of land are two kinds of impacts, but there are other types of direct and indirect damages that can result. This chapter identifies the primary categories of erosion and coastal storm damage and explains how the economic impact is typically measured. The text includes a discussion of two important concepts: 1) the role of the time value of money in the estimate of the benefits from beach nourishment, and 2) the distinction between regional/local and national economic impacts from recreation.

7.4.1 Property and Infrastructure Damage

Communities along the Santa Cruz Littoral Cell are well aware of the potential severity of coastal storm damage. Perhaps the most notorious year for coastal storm damage was 1983 when 12 large storms hit the California coastline during just the first three months of the year. The storms caused an estimated $200 million in damage to houses, businesses, parks, harbors, and public infrastructure in California, including an estimated $10M ($24M in today's dollars) in damage in the City of Santa Cruz (Griggs & Johnson, 1983). This is an example of direct damage from a coastal storm. But besides direct damage from an actual storm, there are several other categories of damage to consider. The relevant categories of economic impact from storm damage and erosion typically include:

- Cost of repair
- Increased shoreline and property protection costs (revetment, seawall, etc.)
- Increased cost of shoreline and property maintenance costs
- Value of land lost from erosion
- Cost of emergency evacuation and response
- Travel delay and detour costs

Box 7.2: Erosion & Property Values

It makes sense that the sales price of a home would be affected by its risk of falling into the ocean in the foreseeable future. But to what extent does this actually happen, and does this variable show up in market data? University of Georgia researchers attempted to understand how expectations of erosion damage affect property values of coastal homes (H. John Heinz III Center for Science, Economics, and the Environment, 2000) They conducted research on the relationship between the property value and the number of years expected before the property is affected by erosion . Using a method known as the hedonic price analysis, they found a statistically significant relationship between the two variables. As an example, the study estimates that Pacific Coast properties that are anticipated to be affected by erosion in 20 years have a value that is 80% of those that are expected to be affected by erosion in 100 years.

A widened beach can reduce the vulnerability of the coastal property and infrastructure to coastal storm damage by reducing the likelihood of water and waves reaching the assets on land and by reducing the severity of the impact when it does occur. The present value of the sum of the costs avoided that can be attributed to the wider beach would be considered an economic benefit of beach nourishment.

The USACE considers the categories of benefits that are listed above national in nature because they are related to the avoidance of impacts and costs that, but for the storm or erosion, would not have been incurred by residents; businesses; and local, regional, or state governments. The USACE terms these National Economic Development (NED) impacts (U.S. Army Corps of Engineers, 2000).

The actual economic benefits (national or otherwise) of a beach nourishment project will, of course, depend on the specifics of the project and on the location. The size of the project, the duration that the project is effective, and the location, value, and vulnerability of the assets at risk are important variables for the quantification of storm damage risk reduction and project economic benefits.

The degree to which any nourishment project or regime would mitigate or eliminate the damage caused by any single storm is uncertain – would require detailed modeling to understand. Also, any reduction in risk to property and infrastructure from a single beach nourishment project is temporary. The risk reduction and the benefits associated with the nourishment will decrease over time as the sand is naturally transported elsewhere in the littoral cell. Table 7-5 illustrates how the economic benefit from a delay (and not a total prevention) in damage is calculated.

Table 7-5: Example - present value of a delay in damage

	Damage WITHOUT Nourishment				
Year	Asset A	Asset B	Asset C	Total	Present Value of Total
2016	$0	$0	$0	$0	$0
2017	$500	$0	$0	$0	$467
2018	$0	$500	$0	$500	$437
2019	$0	$0	$500	$500	$408
2020	$0	$0	$0	$0	$0
2021	$0	$0	$0	$0	$0
2022	$0	$0	$0	$0	$0
2023	$0	$0	$0	$0	$0
2024	$0	$0	$0	$0	$0
2025	$0	$0	$0	$0	$0
Total	$500	$500	$500	$1,500	$1,312
Average Annual Value					$187

	Damage WITH Nourishment				
Year	Asset A	Asset B	Asset C	Total	Present Value of Total
2016	$0	$0	$0	$0	$0
2017	$0	$0	$0	$0	$0
2018	$0	$0	$0	$0	$0
2019	$0	$0	$0	$0	$0
2020	$0	$0	$0	$0	$0
2021	$0	$0	$0	$0	$0
2022	$500	$0	$0	$500	$333
2023	$0	$500	$0	$500	$311
2024	$0	$0	$500	$500	$291
2025	$0	$0	$0	$0	$0
Total	$500	$500	$500	$1,500	$936
Average Annual Value					$133

In the example, the damage expected to the three unspecified assets as the result of coastal erosion is delayed by five years because of a one-time beach nourishment project. The economic benefit from nourishment is the difference in the total present value with and without nourishment – in this case $1,312 minus $936. This example uses a discount rate of 7% over a ten-year period. All else equal, the present value of the decrease in damage is positively correlated with the value of the assets and the duration of the delay in damage, and negatively correlated with the interest rate. A lower discount rate makes future benefits more valuable in today's dollars, which, when compared to a one-time project cost, would increase the likelihood of economic justification.

To estimate the economic benefits to property and assets of a beach nourishment project, an estimate or assumption would have to be made regarding how the new beach profile changes over time and how effective it is along the way at reducing the risk to coastal assets. A complete and accurate benefit estimate would also require considering what actions would be taken in the absence of a nourishment project. For example, it would not be accurate to assume that in all cases the benefit of beach nourishment is equal to the value of the vulnerable land or the replacement value of structures and infrastructure. This is because property owners or others may take action on their own when possible to mitigate or prevent damage from storms and erosion.

The placement of riprap along the toe of a cliff is one type of measure that has been taken in the Plan area to protect properties and infrastructure from wave attack and erosion. If this type of action is allowed, would be taken, and would be effective at slowing or stopping erosion, then the benefit of beach nourishment may in fact be limited to the temporary avoidance of the cost of implementing the protective measure.

7.4.2 Recreation

California's beaches play a prominent role in making California the number-one travel destination in the United States (Kildow & Colgan, 2005). And, the San Mateo and Santa Cruz County coastlines are popular destinations for foreign and domestic tourists alike. The area is well known for hiking, surfing, whale-watching, and the unique and rugged beauty of the protected Monterey Bay environment. A 2010 survey of visitors to Santa Cruz County, commissioned by the Santa Cruz Chamber of Commerce (Santa Cruz County, 2010), found that going to the beach was the number-one activity undertaken. These beach visits have both market and non-market economic impacts.

Visitors to beaches stimulate the local economy by purchasing goods and services (e.g., gas, food, sunscreen, surf lessons, hotel stays) at or near the beach. The impact to the local and regional economy of tourist spending is a function of the number of tourists, the average spending per visitor, and to what extent each tourist dollar gets spent again in the local economy (known as a multiplier). This impact is classified as a market impact because it can be measured in a market transaction (sales). This is the type of impact local governments are typically most interested in because of the impact on employment, income, and tax revenue in the region.

From a local or regional perspective, the actual impact of these expenditures exceeds their dollar value as the spending stimulates additional demand for goods and services. For example, store shelves or inventories are restocked, and income received by owners and employees is spent elsewhere in the economy. Economists classify the impact of spending on aggregate demand as either a direct, indirect or induced effect.

Box 7.3: What is a Beach Day Worth?

Besides the occasional parking fee and the cost to get there, use of the beach is free. As a result, there is no direct market data that can be used to estimate the value of the beach to the public. Numerous studies, however, have tried to estimate what people would, in theory, be willing to pay for a day at the beach. The estimates are typically based on an analysis of survey responses of beach users. According to information on the National Ocean Economics Program website (www.oceaneconomics.org), the results of the various studies indicate that willingness to pay varies significantly by beach. When adjusted for inflation, studies of California beaches that used the Travel Cost Method (an accepted and widely-used valuation method), estimated that, depending on the beach, a beach day was worth between $13 and $126 dollars per person. The median value from the studies was approximately $25 in 2014 dollars.

To illustrate the difference between these three effects, take, for example, the case where a beach nourishment project is anticipated to increase the number of overnight tourists visiting a beach town. The additional demand for hotel rooms increases hotel revenues and employment, and the additional employee wages and local and state taxes would be classified as a direct effect of the increased demand. The increased demand for hotel rooms would then increase the demand by the hotel industry for goods and services supplied to the hotel by others – such as from a restaurant supply company. This would be an indirect effect of the increase in demand attributed to the project. When the newly-hired hotel employees spend their income in the local economy (e.g., going to dinner, getting a massage), this is an example of the induced effect of the increased demand for hotel rooms. In this way, each additional dollar spent in an economy results in more than one dollar's worth of increase in final demand. Section 7.5 includes an estimate of the direct, indirect, and induced effect of beachgoers on the local economy for several popular beaches in Santa Cruz County.

From a national perspective though, the ability of a particular coastal community to attract tourists and their vacation dollars with high-quality recreational resources is somewhat less of a concern. This is because, as the theory goes, there is little net gain in economic activity in the nation overall. If they hadn't vacationed at that particular beach they would have gone to a different beach or undertaken a different type of vacation altogether somewhere else in the country. One clear exception, of course, would be foreign tourists that come to the U.S. expressly for the beach experience that otherwise would not have visited – in which case there would be a net loss in national output. Although the theory may not reflect reality for all beaches all of the time, it is generally the policy perspective of the agencies like USACE. These agencies do not consider the impact of recreation on final demand to be a National Economic Development (NED) impact, and thus do not factor it into the benefit-cost ratio for potential projects.

That does not mean, however, that recreation does not have value from a national (or federal agency) perspective. Beaches have additional non-marketed value that is not reflected in a market transaction such as the purchase of a night's stay in a hotel. The value to the individual that is above and beyond what was actually paid (which at the beach is often zero or close to zero) is known as "consumer surplus." The most complete and accurate estimate of the value of a recreation experience would capture the total willingness to pay of each individual beachgoer, which would include each person's consumer surplus. This is, in fact, how agencies like USACE would value the impact of a project on recreation output. Summing the consumer surplus values for all beach users would give an estimate of the total non-market recreation value of the beach. This non-marketed value is considered an NED impact and can be counted in the benefit-cost ratio (although there is a limit on the percentage of the benefits for economic justification that can be from recreation).

No matter what the perspective, it is safe to say that clean, wide, accessible beaches are an important component of the local economies in the Plan area. A study conducted by King (2001) concluded that beach erosion leads to significant loss of business and tax revenues throughout California. Determining to what extent the number of tourists (and the amount that they spend) depends on the existence of a high-quality beach is difficult to say. More difficult still is determining how an incremental change to the beach profile (for example erosion that narrows the beach or nourishment that widens the beach) would affect the local economy. For example, how many fewer annual visits would there be to the Santa Cruz Main Beach if it were only half as wide as it is now? Alternatively, how many additional visits would there be if the beach were twice as wide?

Economists have tried to estimate the willingness of beachgoers to pay for the experience through detailed surveys of beachgoers (Chapman & Hanemann, 2001). The USACE has developed a tool – Coastal Sediment Benefits Analysis Tool (CSBAT) that has been used in other RSM studies to estimate the increase in recreation value as a result of a wider beach. The uses beach-specific data such as attendance and visitor spending, and parameters associated with the quality of the beach experience (weather, water quality, capacity, etc.) to estimate the economic value of a beach nourishment project in terms of both willingness-to-pay and the increase in local spending and tax revenues.

The Coastal Regional Sediment Management Plan for Southern Monterey Bay (Philip Williams and Associates, 2008) used CSBAT to analyze two beach nourishment alternatives. The report combined limited, location-specific economic data on the beaches of the Southern Bight (Seaside, Sand City, and Monterey) with data developed for and used in another previous CSBAT application (San Diego). In the Southern Monterey Bay report, the assumption made was that doubling the beach width would increase attendance by 2.5% and increase recreational value per user by 18%.

No beach nourishment alternatives are currently being analyzed as part of the RSM Plan, so the CSBAT model was not used. But, the results of the San Diego application of the CSBAT (which were carried forward in the Southern Monterey Bay report) give a rough idea of the magnitude of change if the widening of a particular beach in the Plan area were analyzed. To understand the total economic impact, however, it is critical to understand how long the widened beach will persist. More work is needed before the benefit of a beach nourishment project at one of the area's beaches can be estimated – including detailed and site-specific user surveys.

7.5 Simplified Impact Models

The inventory of recreational resources and assets described in the previous chapters has been used to identify in which areas the storm damage and coastal erosion vulnerability is greatest. Because of funding constraints, the scope of this report does not include a detailed erosion impact analysis or benefit-cost analysis of potential nourishment projects. For some impact categories, however, it is possible to develop a simplified model that can be used to roughly estimate economic impacts – sort of a rule of thumb approach in the absence of a more detailed analysis. The paragraphs below describe simplified approaches to understanding the potential impact of erosion for select categories. Additional studies will be needed to estimate the economic impact of erosion or of a nourishment project at specific sites.

7.5.1 Beaches

A previous study (King, 2001) found that (not surprisingly) people prefer wide beaches to narrow beaches. According to that study, widening a beach is expected to be associated with some increase in attendance as well as with a greater average value per person for each beach day (as measured by willingness to pay). Accordingly, narrowing a beach would be expected to have the opposite effect: lower attendance and lower recreation value per person.

Surveys of beachgoers at several Southern California beaches (King, 2001) indicate that beach attendance would decrease by approximately 17% if the subject beaches were half as wide. This is one estimate of the elasticity of demand with respect to beach width. Although many of the beaches in the Southern California study are already rather narrow (Encinitas, for example), their width is not drastically different from many of the beaches in the Plan area. In the absence of similar surveys completed for the beaches in this littoral cell, this Plan will use the King results for the assumption of the elasticity of demand at the Plan area beaches.

Given the importance of several of the Plan area's beaches to the local and regional economies, in many locations a decrease in beach attendance would adversely affect employment, business revenues, and tax revenues. In the cities and towns of Half Moon Bay, Santa Cruz, Capitola, and Aptos; the beach is the engine of the tourism sector that is central to the local economy.

A 2010 survey of visitors to Santa Cruz County estimates that nearly three-quarters of the surveyed visitors who came from outside of Santa Cruz County went to one of the county's beaches (Santa Cruz County, 2010). More than one-third of those surveyed visitors stayed overnight, spending, on average, $275 (2014 dollars) per group in the county, and day visitors spent about $100 per group. To estimate the expenditures of just the beachgoers, it is necessary to estimate or assume the proportion of beachgoers that are local versus non-local. Without a detailed survey of beachgoers for the beaches in the Plan area, it is necessary to draw on the results of surveys completed for other beaches. Survey results from King (2001) estimate that for nine Southern California beaches, between 10% and 30% of the beachgoers were non-locals that stayed overnight in the area. Assuming that 20% of the beachgoers at the major Santa Cruz County beaches stay overnight and the remainder are day users, the total annual expenditures for selected major beaches in Santa Cruz County is shown in Table 7-6. The beach at Lighthouse Point is not included because no beach-only attendance estimate was available.

Table 7-6: Estimate of total expenditures for select Santa Cruz County beaches

Beach Name	2013 Annual Attendance	Direct Expenditures Minus Leakage (1,000s)	Indirect & Induced Expenditures (1,000s)	Total Annual Expenditures (1,000s)
Natural Bridges	807,000	$27,845	$13,923	$41,768
Santa Cruz Main	750,000	$25,879	$12,939	$38,818
Capitola	358,900	$12,384	$6,192	$18,576
New Brighton	347,700	$11,997	$5,999	$17,996
Seacliff	558,000	$19,254	$9,627	$28,881

Notes:

1) Inflation-adjusted spending per group: Overnight (20%) - $275; Day Use (80%) - $100 (SC County Visitor Profile, 2012)

2) Average of 3.13 persons per group (SC County Visitor Profile, 2012).

3) Assumptions: 80% capture rate, sales multiplier of 1.5.

Table 7-6 has rough estimates of annual direct expenditures associated with beach attendance. The actual economic impact of these expenditures is greater than the sum of direct expenditures because of the multiplier effect (explained in Section 7.4). Because the tourism industries are labor and income intensive, the extent to which direct spending gets re-spent in the local economy is relatively high. It is not unusual for tourism economic-impact studies to assume a direct spending multiplier of 2 (Stynes, 1997), which would mean that each direct dollar spent would have a total impact of two dollars in the economy. After subtracting the 20% of direct sales attributable to retail goods (which are likely made outside the County), it is reasonable to assume that the direct spending multiplier from the County's perspective is at least 1.5.

Table 7-6 shows the estimate of annual expenditures in Santa Cruz County associated with select major beaches. The results are similar to those results found when using Michigan State University's Money Generation Model (v.2), which is a spreadsheet model developed to estimate the economic impacts of National Park Service visitor spending on a local economy. The estimate was only made for Santa Cruz County beaches because detailed visitor spending data was not available for San Mateo County coastal communities.

Figure 7-21 was developed using the results of the expenditure estimate for Santa Cruz County to present a simplified model of the economic impact of spending by beachgoers in the county. The relationship between attendance and total expenditures depends on several factors, including the definition of the region of interest. Here, that region is defined at the county level – Santa Cruz County in particular. The other factors include:

1. the average expenditures for day users and those staying overnight,
2. the proportion of beachgoers that are day users versus those staying overnight,
3. the percentage of expenditures that stay in the region of interest – all but the markup on retail sales is typically assumed to leave the region since it was likely made elsewhere, and
4. the spending multiplier.

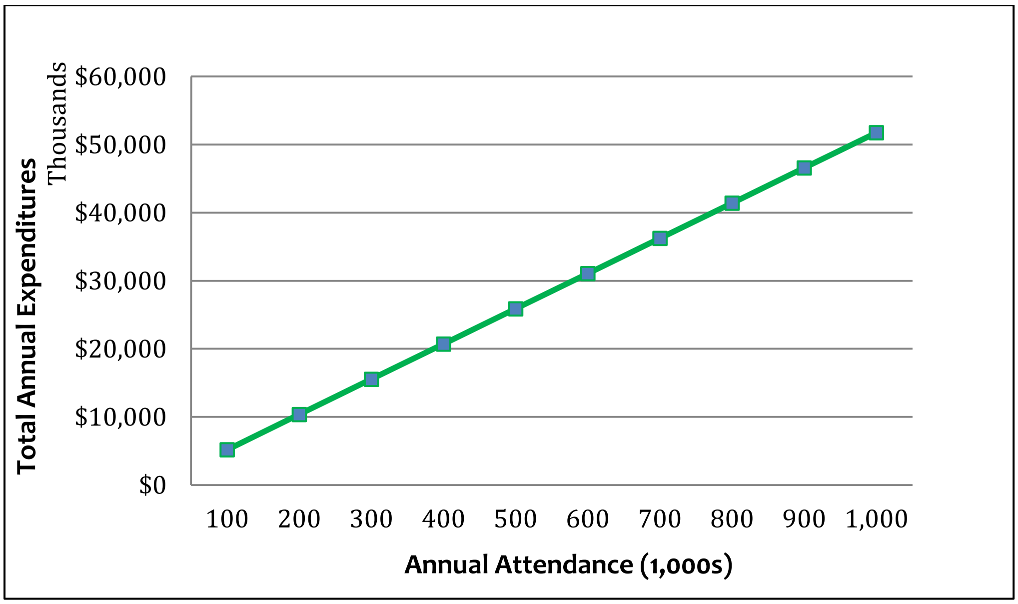


Figure 7-21. Simplified model of beach attendance economic impact – Santa Cruz County

These estimates of the total economic impact are generally consistent (albeit lower) on a per-person basis with other more detailed beach expenditure studies (King 2001). Whereas estimates of jobs created and tax revenue generated are beyond the scope of this analysis, it is safe to say that beach tourism creates and supports thousands of jobs in the Plan area and raises millions of dollars in sales and occupancy taxes each year. A more detailed study that includes surveys of beachgoers at each site would provide more accurate estimates of the economic impact from beach attendance.

Obviously, if the loss of beach width is believed to decrease attendance, expenditures in the affected coastal communities will decrease. For several coastal communities, any significant amount of permanent beach erosion will lead to a significant loss of business and tax revenues, which will adversely affect regional employment and economic growth.

7.5.2 Roads

Whereas Highway 1 is vulnerable to erosion in many locations, particularly in Reaches 2, 3, and 5, many smaller roads are also within the erosion hazard zone. The economic impact of a road closure has both marketed and non-marketed economic impacts. The actual damage to the road is a direct, marketed cost that would be valued at the cost of repair or relocation. A closure or delay would also increase costs to businesses by delaying deliveries, disrupting supply chains, requiring extra fuel, and vehicle wear.

Estimating the total cost to businesses of a highway or road closure is challenging (Hu, 2008) and involves a great deal of uncertainty. There is, however, a framework established for estimating the personal cost of a travel delay to affected drivers and passengers. The method for estimating this is described below, and a simplified model is presented that can be applied to roads in the Plan area for a rough idea of the magnitude of this category of impact.

The USACE Institute for Water Resources (IWR) Report 91-R-12 '*Value of Time Saved for Use in Corps Planning Studies'* lays out a straightforward method for estimating the personal value of time associated with a traffic delay. According to the report, the cost of each individual delay is a function of the duration of the delay, the income of the traveler, and the trip purpose. The total daily value for all affected persons is simply the product of the average value of delay and the number of daily trips.

Using the methodology described in the IWR report, and with the help of some simplifying assumptions on the distribution of trip purpose (including that weekends and weekdays have the same distribution), shows a simplified model to estimate the total non-market value (time value) of a day of road closure in the Plan area. Because of the uncertainty as well as the preliminary nature of this impact analysis, the values are represented as bands rather than point estimates.

For example, as illustrated in Figure 7-22, if the average delay caused by a road closure was thirty minutes in Reach 2 (Highway 1 at Surfer's Beach), the total daily economic cost would be nearly $600,000. A thirty-minute delay in the less trafficked Reaches 3, 5, and 6 (Reach 6 includes West Cliff Dr. and East Cliff Dr.) would be associated with between $200,000 and $400,000 in the time value of delay cost, depending on the location. This does not count costs (e.g., gas, vehicle wear and tear) or direct or indirect impacts to businesses. Nor does it include the cost of any emergency response or the cost to repair, rebuild, or relocate the roadway. These more direct costs, which would vary greatly by location, are too variable to present in even a simplified model for this report. The actual total economic cost of erosion or storm damage to a highway of road would be much greater than described here.

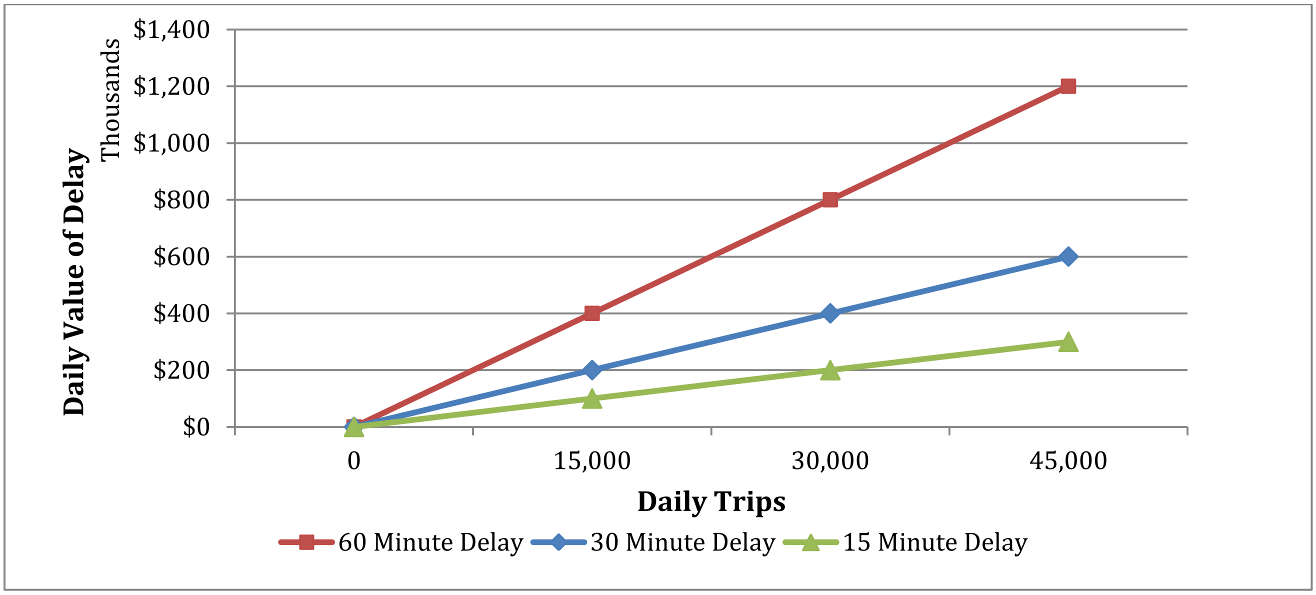


Figure 7-22. Simplified model of traffic delay cost

Other Public Infrastructure (Table 7-4) shows a more detailed inventory of the parcels, roads, railways, sewer lines, and storm drains located in the 2050 Coastal Erosion Hazard Zone. The estimates were developed by overlaying the relevant shapefiles. The analysis was conducted on what appeared to be the areas with the most value within the erosion hazard zone. The land value and structure values shown include all parcels that are wholly or partially in the erosion hazard zone, but the Parcel Acreage includes just the land that is within the erosion hazard zone. The assessed values shown are lower than the actual current values because of the effect of California's Proposition 13, which limits the annual increase in assessed property values (used to determine property taxes) to a maximum of 2% per year except when there is a change of ownership or significant new construction.

Table 7-4 shows that there are at least 11.5 miles (nearly 61,000 feet) of storm and sewer lines in the erosion hazard zone. The cost to protect, rebuild, or relocate this infrastructure depends on site-specific conditions, so it is highly variable. More in-depth analysis and cost estimating would be required to develop even a preliminary estimate of the impact of erosion to these assets at particular locations in the Plan area.

7.5.3 Structures and Land

The vast majority of structures that are located on the coast in the Plan area are high value, single family homes. The Pacific Institute (Pacific Institute, 2009) estimates that the average coastal parcel in California is valued at approximately $1.4 million. A check of recent sales of coastal properties confirms that it is reasonable to assume this value can be applied to the coastal parcels in Santa Cruz and San Mateo Counties. Using this value, a loss of two thirds of the parcels in the 2050 erosion hazard zone at just the seven beaches identified in Table 5 would result in a loss of $1,100,000,000 in land and structures value. These estimates are made using simplifying assumptions, and more work is needed to understand the risk to particular areas of the coastline.

7.6 Next Steps: Understanding Economic Feasibility

More work is needed before the economic impact of future coastal storms and erosion at one or more beaches in the Santa Cruz Littoral Cell is well understood. Beyond that, additional steps would be required to estimate the economic feasibility of a nourishment project by completing a benefit-cost analysis.

The first, and perhaps most challenging, step would be to describe the most likely without-project condition in the area that will be affected by the beach nourishment project (and any other measures implemented). This includes estimating the expected rate and extent of erosion and describing what measures, if any, would be implemented by others in the absence of a nourishment project. This may or may not require detailed coastal modeling of the area.

The next step would be to determine the size, cost, effectiveness, and life cycle (how long the sand persists and the rate of change) of one or more nourishment alternatives. For the estimate of the benefits to properties and infrastructure, the analysis can be as simple as calculating the difference in the present value of damage to the affected assets using simplifying assumptions (such as average erosion rate), or as complicated as developing or using an event-based Monte Carlo simulation model such as Beach-fx (USACE, 2014e)

For the estimate of the economic benefits to recreation of a nourished (widened) beach, detailed user surveys should be conducted to gather the data to reasonably estimate total willingness to pay. There are several methods of estimating user willingness to pay, but the method most frequently used in studies of California beaches is the Travel Cost Method.

8. RECOMMENDED REGIONAL SEDIMENT MANAGEMENT STRATEGIES

This section outlines specific RSM measures that could be implemented at each of the BECAs and SICHs identified in Section 3.3. The objective of this section is to present several RSM options with a discussion of site-specific advantages and disadvantages. This discussion was formulated to expand on the general descriptions of RSM measures in Section 4 and Table 4-1, and is not necessarily an exhaustive list of all potential options at each site.

8.1 Princeton Shoreline in Pillar Point Harbor

The considerable erosion along the Princeton shoreline has been the subject of recent planning efforts (Dyett & Bhatia, 2014), and may be addressed by several RSM measures. The Princeton shoreline is unique from a regulatory standpoint, because it lies outside of the boundary of the MBNMS. As a result, this site could provide an ideal location to implement a RSM measure (e.g., beach nourishment) that is currently prohibited in the MBNMS. If implemented, the given measure could be closely monitored, with the results of the monitoring providing valuable information on project performance and potential environmental impacts.

8.1.1 No Action

This approach assumes that the existing practice of randomly armoring the eroding low bluff with riprap will continue over the next 50 years. This approach offers the advantage of serving to protect at least some of the vulnerable infrastructure and parcels in the short term. But, this approach does not provide a long-term solution to the erosion problem, and it is likely that continued maintenance will incur additional costs. In addition, the continued haphazard placement of riprap could pose a safety hazard to visitors and prevent access to the beach area exposed at low tide.

8.1.2 Bluff Stabilization via Rock Revetment

This measure would involve the construction of an engineered rock revetment. Variations of this concept have been evaluated by previous shore-protection studies (Moffatt & Nichol, 2001; USACE, 2006). A rock revetment presents the advantages of offering protection to existing infrastructure with a fairly high certainty that the structure will perform this task. In addition, the revetment may be designed to enhance public access to the shoreline with stairways, ramps, or other access features. A rock revetment, however, may also indirectly contribute the narrowing of the sub-aerial beach through the process of passive erosion, and could present permitting issues with respect to the CCC. Additional concerns include a relatively high cost (up to $9 million per USACE, 2006) and impacts to aesthetics and views.

8.1.3 Beach Nourishment

This measure would involve placement of sand directly on and below the toe of the eroding bluff to reduce the impacts of wave attack on the bluff toe. Beach nourishment offers the advantage of providing additional space for recreation, and the site is in an ideal location to receive suitable sediments dredged from the harbor. There is considerable uncertainty, however, as to whether beach nourishment can provide protection to existing infrastructure and commercial parcels, particularly when implemented as a stand-alone measure. In addition, the cost could be quite high, and a preliminary economic analysis suggests that public use of the beach is rather low when compared to other beaches in the Santa Cruz Littoral Cell (Bierman, pers. comm., 2014; Section 7.3.2).

8.1.4 Beach Nourishment with Retention Structures or a Perched Beach

The likelihood of success of the beach nourishment measure could be increased if the nourishment were to be combined with one or more structures designed to retain sand. These structures could be placed in either a shore perpendicular (groins) or parallel configuration (perched beach). They would comprise rock or other material such as geotextile tubes filled with sand. Advantages include longer retention time of placed sand and a higher degree of certainty that the backshore will be protected from wave attack. Disadvantages include high construction costs and potential permitting and regulatory issues (Section 6).

8.2 El Granada County (Surfer's) Beach

The erosion of the beach and bluffs adjacent to Highway 1 at Surfer's Beach has been a significant source of concern for the local community for decades. This erosion issue has been the focus of a number of studies, with recent work by USACE strongly suggesting that construction of the Pillar Point Harbor outer breakwaters, particularly the East Breakwater, has exacerbated the erosion problem. As a result, the community, private sector, and government agencies have proposed a number of erosion-mitigation measures: several of the most well documented ones are presented below.

8.2.1 No Action

This approach assumes that Caltrans and San Mateo County will continue to take the necessary actions to maintain Highway 1. In the past, this action has included the construction of a rock revetment just downcoast of the root of the East Breakwater. As of this writing, Caltrans and San Mateo County are actively designing an approximately 150-foot-long extension to the revetment (Section 2.5.3). Thus, it can be assumed that this Highway 1 will continue to be protected at least over the next several years. The current "status quo" presents the disadvantages of only offering a temporary fix to a persistent erosion problem and of continuing the impacts of armoring on public access and surf conditions at this popular surf break.

8.2.2 Beach Nourishment

Beach nourishment at Surfer's Beach would likely involve the direct placement of 150,000 to 200,000 cy of sand on the beach (USACE, 2014b). This option presents several advantages, including a wider beach for recreation and access and potentially reducing wave attack on the toe of the eroding bluff. In addition, Surfer's Beach presents a logical placement site for sand dredged from the harbor side of the East Breakwater with minimal transportation costs because of the proximity of this beach to the potential sand source. Preliminary cost estimates suggest that placement of 150,000 cy of sand would cost approximately $5 million including a 20 percent contingency (USACE, 2014b). But, there is considerable uncertainty whether the sand placed on the beach will persist beyond several years, particularly if a large storm were to occur shortly after placement. There are also potential impacts to sandy habitats during beach placement (Section 5) along with permitting challenges involving the MBNMS (Section 6).

Beach nourishment could also be difficult to justify from an economic perspective in terms of preventing damage to infrastructure, particularly if it assumed that actions will be taken to protect Highway 1 independent of any beach nourishment project. However, stakeholders could engage Caltrans and San Mateo County in a discussion regarding potential financial support for a future beach nourishment project in conjunction with the currently planned Highway 1 stabilization project (Section 2.5.3).

8.2.3 Offshore Artificial Reef

This measure would involve the construction of one or more offshore artificial reefs designed to dissipate wave energy and facilitate the formation of one or more salient beach features. These reefs offer the advantage of increasing beach width and enhancement to recreational opportunities such as surfing. There are also several disadvantages, including uncertainty of performance – these features are rare on the US West Coast – and significant alteration of seafloor habitats. The design process could also be relatively costly as complex hydrodynamic modeling of the wave reflection from the East Breakwater and the nearby revetment would be necessary. In addition, there are also likely to be significant permitting challenges under current MBNMS regulations (Section 6).

8.2.4 Managed Retreat

Highway 1 will continue to be threatened by erosion, which will likely result in the need for a considerable maintenance effort including extension of the existing revetment south along the unprotected bluff. There may be a point at which maintenance of Highway 1 in its current alignment becomes prohibitively costly. With that in mind, the community and Caltrans have already started to discuss potential realignment options (Local Government Commission et al., 2010; Whitman, pers. comm., 2014). The primary advantage of this approach is that it represents a long-term systematic approach to managing infrastructure in the face of continuing erosion. Other advantages include significantly reduced infrastructure maintenance costs, removal of armoring, and the potential for improved public access.

The primary disadvantage involves the high cost of highway realignment, which could be in the range of $4,000 per linear foot of highway (Moffatt & Nichol, 2007; USACE, 2014b). This would translate into approximately $18 million if 4,400 feet of Highway 1 is realigned as proposed by some of the conceptual plans (Government Commission et al., 2010). While the initial cost of highway realignment is significantly greater than a one-time beach nourishment of 150,000 cy, it is likely that several beach nourishment episodes will be necessary over the next 50 years to generate comparable benefits. Thus, a careful long-term analysis of costs associated the different measures should be undertaken as part of the long-term planning process.

8.3 Pescadero Lagoon and Butano Creek

The construction of Highway 1 on the spit that separates Pescadero Lagoon from the open coast has effectively fixed and constricted the lagoon mouth. This has resulted in reduced sediment exchange between the lagoon and open coast. In addition, major land use changes in the Pescadero-Butano watershed have resulted in a 15-fold increase in sediment inputs to the marsh (Frucht, 2015). These land use changes have also resulted in significant sediment accumulation in Butano Creek, which has increased the risk of fluvial flooding along Pescadero Creek Road (cbec and Stillwater Sciences, 2014).

8.3.1 No Action

This approach assumes that no action will be taken to address excess sedimentation in Pescadero Marsh and Pescadero Creek, and that Caltrans will continue current Highway 1 maintenance activities. The primary advantage to this approach is the relatively low cost of current infrastructure maintenance activities along Highway 1. But, this approach presents the disadvantage of not providing any mitigation to the current flood risk along Butano Creek in the vicinity of the Pescadero Road Bridge.

8.3.2 Dredging of Butano Creek Channel

This measure would involve removing up to 48,000 cy of sediment from the channel starting approximately 6,500 feet upstream at the Pescadero Road Bridge. This approach presents two advantages: reduction of flood risk and generation of sand and finer sediments for beach nourishment or raising elevations of flood prone areas (cbec and Stillwater Sciences, 2014). This approach does not systematically address the changes in the tributary watershed that have induced this sedimentation. In addition, there are concerns regarding cost, because one dredging episode could cost from approximately $200,000 to just over $2,000,000, depending on the extent of dredging (cbec and Stillwater Sciences, 2014).

8.3.3 Realignment of Infrastructure and Restoration

Realignment of Highway 1 is unlikely within the next several decades, because the Pescadero Creek Bridge was replaced in the 1980s, and a Caltrans analysis indicated that realignment would be infeasible because of environmental and cost factors (Sojourner, pers. comm., 2014). Thus, this measure is unlikely to be implemented in the next 50 years in the absence of any major failure of Highway 1 infrastructure.

8.4 Waddell Beach and Lagoon

The current alignment of Highway 1 serves to constrict the position of the dynamic Waddell Creek mouth and limit sediment exchange between the open coast and lagoon on the land side of the highway. This infrastructure is currently vulnerable to wave attack and scour from the shifting Waddell Creek channel, and it expected to become increasingly vulnerable in the face of sea-level rise (ESA PWA and SWCA, 2012).

8.4.1 No Action

This approach assumes that Caltrans will continue maintenance of Highway 1 infrastructure. Maintenance activities have included placement of rock revetments to protect the bridge abutments, and Caltrans is currently developing plans to install monitoring equipment to assess scour below the bridge (Gorman, pers. comm., 2014). This approach offers the advantage of protecting infrastructure that provides access to this relatively remote reach of coast and popular recreational beach. However, this approach does not address the underlying reason for the vulnerability of this infrastructure or restore a more natural sediment exchange regime. Additionally, any expansion of revetment footprints will reduce usable beach area and could contribute to passive erosion and flanking effects.

8.4.2 Realignment of Infrastructure and Restoration

This approach involves a suite of measures that that would allow for more free sediment exchange between the lagoon and the ocean. These measures could include removal of fill that serves to constrain flow paths, and modifying the roadway with longer bridge spans (ESA PWA and SWCA, 2012). This improved sediment exchange offers the advantage of improved ecological function in the lagoon and increased resilience of marsh habitat and adjacent areas to sea-level rise (Langridge et al., 2014). The primary disadvantage is the high cost, with a representative from Caltrans indicating that there are no bridge replacement planning efforts underway at the time of this writing (Gorman, pers. comm., 2014).

8.5 Scott Creek Beach and Lagoon

The situation with respect to infrastructure and sediment management at the mouth of Scott Creek is similar to, but more urgent than that at the mouth of Waddell Creek. The Scott Creek roadway is "likely not sustainable in its existing location due to coastal hazards associated with sea-level rise", and the Scott Creek lagoon is more severely affected by the current infrastructure configuration (ESA PWA and SWCA, 2012). As a result, Caltrans has recently engaged local stakeholders and agencies to formulate a bridge-replacement and restoration plan, although no consensus on a plan has been reached to date (Gorman, pers. comm., 2014).

8.5.1 No Action

This approach assumes that Caltrans will continue to maintain the Highway 1 alignment with periodic placement of rock along the embankment and bridge abutments until bridge replacement becomes necessary. At that point, it is assumed that Caltrans will replace the bridge in kind, without any modifications to facilitate lagoon restoration (Gorman, pers. comm., 2014). This approach offers the advantage of maintenance of access to this relatively remote area and a lower cost than a significant infrastructure modification such as a longer bridge span. Disadvantages include continued degradation of the lagoon environment and impacts associated with continued placement of armoring adjacent to the beach.

8.5.2 Realignment of Infrastructure and Restoration

This approach would likely involve modifications of the roadway to allow for restoration of a more natural regime of sediment exchange between the lagoon and the open coast. In the case of Scott Creek, specific measures might include removal of the training berms and replacement of the bridge with a longer span that extends from the existing southern abutment to the northern hillside (ESA PWA and SCWA, 2012). Advantages to this approach include improved lagoon ecosystem function and increased resilience of the lagoon and adjacent areas to sea-level rise (Langridge et al., 2014). Disadvantages include high construction cost and difficulty of agency and stakeholder coordination because of concerns about sensitive species (Coho salmon) at this particular project site (Wilhelm, 2013; Gorman, pers. comm., 2014).

8.6 West Cliff Drive – Lighthouse Field State Beach

The sea cliffs that separate West Cliff Drive and other significant infrastructure from the ocean have been subject to significant erosion, which resulted in widespread placement of armoring (riprap) between Natural Bridges State Beach and the western end of Santa Cruz Main Beach. For the purpose of discussing potential sediment management approaches, this reach can be divided into two sub-reaches based on the predominant land use. The western sub-reach extends from Swanton Boulevard to the western border of Lighthouse Field State Beach, and is characterized by extensive residential development on the inland side of West Cliff Drive. The eastern sub-reach includes large areas of public open space and encompasses the world-class surf break at Steamer Lane and a number of highly popular beaches. There are an estimated nearly 3.8 million annual visitors at Lighthouse Field State

Beach (Table 7-2). As a result, any evaluation of potential sediment management measures in the eastern sub-reach will need to account for impacts to recreational activities.

8.6.1 No Action

This approach assumes that armoring to protect West Cliff Drive and associated infrastructure would be maintained on an emergency basis by the City of Santa Cruz. The primary advantage is that this approach would continue to offer some protection to infrastructure and public access (via the bike path) over the next 50 years. There are several locations in the western sub-reach, however, such as the Bethany Curve Bridge, which will continue to remain vulnerable to wave attack and overtopping in the absence of any additional measures (Griggs and Haddad, 2011). In addition, the continued maintenance of armoring presents the disadvantage of contributing to narrowing of popular beaches in both sub-reaches, such as Mitchell Cove and Its (Lighthouse) Beach, in response to anticipated sea-level rise (Griggs and Haddad, 2011)

8.6.2 Cliff Stabilization

This measure could involve construction of a continuous sea wall or soil nail wall, such as the one recently completed as part of the East Cliff Drive Bluff Protection and Parkway Project (Section 2.5.11). This measure could represent a comprehensive approach to addressing the vulnerability of infrastructure to erosion in both sub-reaches, and offers the potential for the enhancement of public access in this highly popular recreational area. This measure has several disadvantages including potential narrowing of beaches through passive erosion, changes to views, and potential changes in local hydrodynamics and surfing conditions.

8.6.3 Beach Nourishment

This measure involves the placement of sand on a number of the small pocket beaches front the sea cliff, such as Its (Lighthouse) Beach and Mitchell Cove. This placement of sand could be implemented as a stand-alone measure in front of unprotected sea cliffs or as a method to mitigate the impacts of passive erosion associated with measures that essentially fix the shoreline position. Beach nourishment could also be combined with removal of armoring if the beach profile is sufficiently wide to mitigate wave attack at the toe of the newly exposed sea cliff. Because this reach of coast is subject to high littoral drift rates, it would likely require fairly frequent nourishment to maintain a given beach width. In addition, any placement of sand in the surf zone could potentially affect marine habitats and surfing conditions.

8.6.4 Managed Retreat

This measure could involve removing or realigning vulnerable public infrastructure, such as West Cliff Drive, and perhaps some private residential parcels in the western sub-reach. This measure offers several advantages including opportunities for habitat restoration, enhancement of public access, and removal of armoring, which in turn can facilitate more natural erosion of the sea cliffs and maintenance of a given beach width. Disadvantages include high costs to relocate infrastructure, a high degree of uncertainty regarding real estate costs, political concerns related to the potential loss of residential parcels, and impacts to local traffic patterns. It is likely that this measure would be more feasible in the eastern sub-reach, as it would not require the acquisition of a large number of residential parcels.

8.7 San Lorenzo River and Main Beach

The construction of the Santa Cruz Harbor jetties in the 1960s resulted in significant growth of Seabright Beach and accumulation of excess sand at the mouth of the San Lorenzo River (Griggs, 2012). This has resulted in the formation of a sand bar, which often redirects the flow path of the San Lorenzo River west through Santa Cruz Main Beach to Beach Boardwalk infrastructure. Santa Cruz Main Beach and the Beach Boardwalk are popular recreational destinations, with an estimated 750,000 visitors to Main Beach in a given year (Table 7-2). Thus, addressing the issue of excess sand accumulation has become a priority of the City of Santa Cruz and other local stakeholders (Section 2.5.8).

8.7.1 No Action

This approach assumes that no action will be taken with the exception of temporary re-routing of the San Lorenzo River on an emergency basis (Section 2.5.8). This approach offers the advantage of little to no cost, except when emergency action is required. This approach, however, does not address the underlying cause of the of problem and can result in considerable impacts to public access and recreation if a large section of Main Beach becomes isolated by a westward shift in the river channel. In addition, the presence of heavy machinery on the beach may affect sandy habitats and pose a safety hazard to beach goers.

8.7.2 Stabilization of the River Mouth

This measure involves the construction of one or more jetties to stabilize the position of the river mouth so that it does not shift west away from San Lorenzo Point. The Jetties offer the advantage of providing a proven method to ensure that the river does not threaten to undermine Boardwalk infrastructure. In addition, one or more jetties could facilitate widening of the heavily used Main Beach and provide ancillary recreational benefits. Jetty construction, however, will not necessarily address the issue of excess sediment accumulation and may require considerable maintenance dredging to maintain an open river mouth. In addition, there is a surf break just offshore of the river mouth, and impacts on surfing conditions will need to be considered during design of the jetties. Jetty construction could also impact sandy habitats and create potentially unsafe swimming conditions.

8.7.3 Removal of Excess Sand

This measure would involve the removal of excess sand from the San Lorenzo River mouth and Seabright Beach. It has been estimated that up to 600,000 cy of sand have accumulated on Seabright Beach (Griggs, 2012), and a significant portion of this sand could be placed at a number of downcoast beaches such as Twin Lakes Beach, Capitola City Beach, or Seacliff State Beach. This measure offers the advantage of directly mitigating the impacts of the Santa Cruz Harbor jetties on mouth of the river, and could reduce maintenance dredging requirements in the harbor entrance channel as sand would be trapped in the newly excavated section of Seabright Beach. This measure also presents disadvantages, including reduced beach width at the heavily used Seabright Beach (Section 2.5.8), complex logistics for transporting sand to downcoast BECAs, and potential impacts to sensitive sandy habitats.

8.7.4 Non-Structural Measures

There are also several non-structural measures that can be taken to prevent the river from shifting to the west. These measures include periodic mechanical breaching of the sandbar immediately following closure or temporary placement of culverts during dry months. These measures offer the advantage of operational flexibility and minimizing impacts on recreational use of the east end of Main Beach. But, they do not provide a long-term solution to excess accumulation of sediment and would require continued maintenance. In addition, the CDFW effectively stopped breaching of the bar because of concerns regarding impacts to young fish (Griggs, 2012).

8.8 Twin Lakes State Beach

Twin Lakes State Beach, which is located just east of the Santa Cruz Harbor jetties, is the site of the largest ongoing beach-nourishment operation in the Santa Cruz Littoral Cell (Section 2.3.6). Twin Lakes Beach is a popular recreation destination, with an estimated annual attendance of over 500,000 (Table 7-2However, there is often significant (albeit temporary) erosion during winter storms that can expose infrastructure on the back beach to inundation and wave attack. As a result, the County of Santa Cruz is currently designing a beach and bluff stabilization project, which is likely to be implemented in the next few years (Section 2.5.10).

8.8.1 No Action

This approach assumes that current beach nourishment practices will continue, with approximately 200,000 to 300,000 cy of sand placed on the beach during dredging operations in the harbor entrance channel. Beach nourishment offers the advantage of returning most of the sand trapped in the harbor entrance to the littoral cell, and there is already existing infrastructure and funding to continue the effort. Beach nourishment, however, can result in impacts to recreation and public safety caused by the presence of construction equipment on the beach. There are also aesthetic and environmental concerns including the nuisance odor released by H_2S gas in some of the dredged sediments (Moffatt & Nichol at al., 2011) In addition, it is also assumed that the Twin Lakes Beachfront Improvement Project will be constructed within the next couple of years. This project offers the advantage of providing a comprehensive approach to protecting infrastructure and enhancing public access. Note that this project will result in temporary impacts to access and recreation during construction and will change the view of the beach.

8.9 Schwan Lagoon, Corcoran Lagoon, and Moran Lake

Infrastructure constructed over the mouths of these three coastal lagoons is at a relatively low elevation and is subject to wave overtopping, inundation, and erosion. As a result, riprap has been placed along the base of East Cliff Drive at the mouth of Schwan Lagoon and Moran Lake. In addition, culverts and gates under East Cliff Drive have effectively restricted movement of the lagoon mouths, and altered the natural regime of sediment exchange between the lagoons and the open coast.

8.9.1 No Action

In the absence of any action, it is assumed that the local government (e.g., Santa Cruz County) will continue to take the necessary action to maintain traffic access on East Cliff Drive. This approach presents the advantage of no additional cost beyond current maintenance activities. However, road closures and maintenance costs likely will increase in the face of sea-level rise. Thus, there could be significant long-term costs if some action is not taken in the near-term.

8.9.2 Realignment of Infrastructure and Restoration

This measure involves raising or otherwise relocating East Cliff Drive and associated infrastructure outside of the coastal erosion hazard zone. This measure could also facilitate restoration of the three coastal lagoons and a more natural sediment exchange regime between the lagoons and open coast. Realignment of infrastructure could also enable the removal of armoring and provide opportunities for improved public access and recreation. This measure will also likely have a high cost, particularly in the case of construction of bridges.

8.9.3 Managed Retreat

This measure involves the complete removal of infrastructure from the back beach and lagoon mouths, including the residential parcel at the mouth of Corcoran Lagoon. This measure, which presents similar advantages as realigning infrastructure, can greatly reduce or essentially eliminate future infrastructure maintenance costs. There are a number of disadvantages including a high initial implementation cost, impacts to traffic and beach access, and the loss of residential property. Removal of beach adjacent roads and parking lots could adversely impact local traffic and beach access, so careful planning will be necessary.

8.10 Beaches – Schwan Lagoon to Pleasure Point (Del Mar Beach)

The urbanized shoreline between Schwan Lagoon and Pleasure Point is heavily armored with nearly all of the bluffs fronted by riprap revetments. Much of this riprap was placed as an emergency response during the storms of 1983 with some parcels requiring frequent placement of riprap because of unfavorable foundation conditions (Griggs et al., 2005). As a result, the beach tends to be quite narrow in front of these revetments, so that water levels reach the toes of these structures during higher tides.

8.10.1 No Action

This approach assumes that the current practice of emergency placement of riprap will continue at the request of residential property owners. This approach provides the advantage of protecting existing infrastructure in place with minimal public investment. This approach does not provide a comprehensive solution to beach and bluff erosion, and will likely reduce public access as beaches fronting the revetments narrow in response to sea-level rise.

8.10.2 Beach Nourishment

This measure offers a number of advantages including wider beaches that can facilitate public access and offer some degree of protection to the revetments from wave energy. In addition, there is a promising source of nearby sand at Seabright Beach, where up to 600,000 cy of sand might be removed in an effort to address excess sediment accumulation at the mouth of the San Lorenzo River. Because sand from Seabright Beach would need to be transported 1 to 1.5 miles, beach nourishment in this reach will likely pose a number of logistical and cost challenges. In addition, any beach nourishment episode would need to be carefully planned to avoid potential impacts associated with excessive sand accumulation at the mouths of the three coastal lagoons in the reach.

8.10.3 Cliff Stabilization

This measure involves construction of one or more cliff-stabilization structures similar to the soil nail wall recently constructed below East Cliff Drive. This measure offers the advantage of a more comprehensive approach to addressing bluff erosion, and provides opportunities to remove riprap and improve public access to beaches. However, the construction of soil nail walls and other cliff stabilization structures has the potential to generate considerable political controversy, particularly if public funding is utilized to protect private assets (residential parcels). In addition, there could be temporary environmental impacts during construction, and any proposed design will need to be carefully scrutinized for potential impacts to surf-zone hydrodynamics and the popular surf breaks in the area.

8.10.4 Multipurpose Artificial Reef

This measure includes the construction of one or more multipurpose artificial reefs to reduce wave energy reaching the shoreline and provide recreational (surfing) and ecological benefits. But, the design and construction of these types of structures has yet to be successfully implemented in the Santa Cruz Littoral Cell, and there is considerable uncertainty regarding how this type of structure will perform in the local wave climate. These structures can also have impacts on benthic habitats, particularly if a structure is constructed over a sensitive sandy habitat.

8.10.5 Managed Retreat

This measure involves the relocation of public infrastructure and private residential parcels from vulnerable sections of the coastal bluff along with the removal of riprap and other armoring. This measure presents several advantages including greatly reduced future publicly and privately financed maintenance costs and the opportunity to restore natural bluff erosion (and beach building) processes. However, real estate acquisition costs are likely to be high, and there could be political concerns regarding the loss of private residential parcels.

8.11 East Cliff Drive

There is significant residential development and public infrastructure on top of the sea cliffs that extend from Pleasure Point to Capitola City Beach. The sea cliffs have been subject to considerable erosion, and a patchwork of erosion mitigation measures have been implemented throughout this reach. These measures include the recently constructed soil nail wall below East Cliff Drive from 33rd to 36th Avenues, various smaller seawalls, and patches of riprap and other forms of rock armoring (Perticcelli, 2013).

8.11.1 No Action

This approach assumes that the all existing armoring will remain in place, and public or private interests will place additional armoring on an emergency basis. This approach offers the advantage of requiring little in the way of public investment, and it can, at least temporarily, protect some of the infrastructure in place. This approach does not provide a comprehensive solution to the erosion problem in this reach, with some of the structures perhaps increasing the erosion risk to adjacent unprotected sections through flanking and passive erosion. In addition, much of the armoring at the base of the sea cliff limits public access during higher tides and has notable aesthetic impacts.

8.11.2 Beach Nourishment

This measure provides a wider beach, which could offer some protection to the sea cliffs from wave attack, and enhance public access. A wider beach could also provide additional time to plan a more comprehensive approach to addressing sea cliff erosion. Yet, beach nourishment alone might not be an effective strategy at this location because the coastline orientation and associated high littoral drift rates (Griggs, 2004). In addition, the placement of sand on previously rocky nearshore habitats presents significant environmental concerns, and any project that could affect the popular surf breaks in this reach will likely generate controversy.

8.11.3 Groins

This measure involves the placement of one or more relatively short (perhaps 200 ft), shore-perpendicular structures designed to retain sand. The structures could be designed to blend and tie into existing rock formations that extend into the surf zone, such as the formation below Larch Lane (USACE, 2003). Groins present the advantage of facilitating the formation of a wider beach, which can reduce future beach nourishment maintenance costs. Groins typically perform well in environments with relatively robust unidirectional net sediment transport, such as this particular reach. If not carefully designed, groins can also induce downcoast erosion by reducing sediment supply to downcoast beaches, and this could pose a major problem if there were any impacts to the popular Capitola City Beach. Finally, groins also have the potential to affect surf-zone hydrodynamics, which could alter the wave patterns at the adjacent surf breaks.

8.11.4 Cliff Stabilization

This measure involves constructing additional sections of a soil nail wall or similar structures along all or the most vulnerable sections of sea cliff in this reach. This measure provides a comprehensive approach to protecting public infrastructure and residential parcels, and could facilitate the removal of most if not all of the various armoring that currently impact access to the beaches. This measure also builds on the recent success of the East Cliff Drive Bluff Protection and Parkway Project, which eventually was implemented following extensive public and agency reviews. Cliff stabilization would likely be costly, and it might be difficult to secure public funding to provide protective benefits to sections with primarily private residential parcels. In addition, potential impacts to beach habitats, aesthetics, and surfing resources would need to be carefully considered during the design of a cliff stabilization project.

8.11.5 Managed Retreat

This measure involves the removal of public infrastructure and private development from parcels within the coastal erosion hazard zone. This measure could focus on development that is currently not protected by any large cliff stabilization structures, such as in the case of the section of the reach east of 41st Avenue. This measure provides a number of advantages including restoration of natural bluff erosion and reintroduction of sediment into the littoral cell, reduced property maintenance costs, and opportunities to enhance public access. As in the case of other reaches with significant private assets in the coastal erosion hazard zone, it is likely that acquisition of parcels will be costly and there could be political controversy.

8.12 Capitola Beach and Esplanade

The relatively small Capitola City Beach is the most intensively used beach per capita in the Santa Cruz Littoral Cell, and it provides a significant economic boost to businesses along the nearby Esplanade (Section 7.3.6). The beach and adjacent Esplanade are susceptible to significant erosion and damage during winter storms, particularly when heavy surf arrives in combination with high astronomical tides and high flows from Soquel Creek.

8.12.1 No Action

This approach assumes that the City of Capitola will continue current lagoon management practices at the mouth of the Soquel Creek (D.W. Alley and Associates, 2004), and that no additional maintenance will be performed on the 250-foot long rubble-mound groin that anchors the east end of the beach. This approach offers the advantage of little additional cost, but it does not address the threat of sea-level rise to low-lying sections of the Esplanade. In addition, there is the potential for the jetty to deteriorate to the point that it no longer effectively retains sand on Capitola City Beach, and there could be significant economic impacts if there is a reduction in usable beach area.

8.12.2 Beach Nourishment

Beach nourishment presents two advantages at Capitola City Beach. First, any increase in beach width would likely encourage additional beach visits to this popular destination and bring associated economic benefits to the Esplanade and Village area. Second, a wider beach could serve as a buffer between the Esplanade and the ocean, and potentially reduce the vulnerability of the Esplanade to coastal storm damage. However, the performance of a beach nourishment project at this location is contingent on the groin to the east adequately trapping sand in this high littoral drift environment. Thus, beach nourishment is likely to fail at providing a wide beach if the jetty significantly deteriorates. Direct beach nourishment could also prove to be costly, given that the nearest potential source of beach quality sand is over miles away at Seabright Beach and the Santa Cruz Harbor entrance.

8.12.3 Groin Rehabilitation

A representative from the City of Capitola has expressed interest in rehabilitating the groin that anchors the east end of this beach (Jesberg, pers. comm., 2013). Rehabilitation likely would result in the impoundment of additional sand on Capitola City Beach with potential recreational and associated economic benefits. However, there could be a decrease in sand supplied to the beaches to the east, including the narrow beaches at the base of the eroding sea cliffs at Depot Hill. In addition, construction activities could have an impact on access and recreation in this intensively used area.

8.12.4 Multipurpose Artificial Reef

This measure involves the placement of one or more multipurpose artificial reefs offshore of Capitola City Beach. This type of structure could reduce the wave energy that reaches the shore, resulting in a wider beach and potentially safer nearshore recreation conditions. A reef could also be designed to induce a pattern of wave breaking that is conducive to recreational activities such as surfing. On the other hand, construction of a reef could affect sandy habitats and could induce downcoast erosion if it is not designed to allow for adequate bypassing of sand.

8.13 Depot Hill

The largely unarmored sea cliffs along the Depot Hill reach are subject to significant erosion, which continues to threaten the extensive residential development on top of the sea cliffs. These sea cliffs are particularly vulnerable to wave attack as the fronting beach is quite narrow and often fully inundated during high tides. These sea cliffs also contain an important invertebrate fossil assemblage, which can only continue to be exposed for discovery if erosion is allowed to continue (Boessenecker, pers. comm., 2014)

8.13.1 No Action

This approach assumes that there will initially be no placement of armoring on or below the sea cliffs and no beach nourishment. The primary advantage of this approach is that it will allow for continued exposure of fossils and is consistent with the local community's resistance to sea cliff armoring in this location (City of Capitola, 2004). There is the possibility, however, that emergency placement of armoring will be necessary when erosion starts to pose an immediate threat to the residential parcels and associated infrastructure.

8.13.2 Beach Nourishment

Beach nourishment offers several advantages including a decrease in the potential for wave attack at the toe of the sea cliffs, and enhanced public access to fossil assemblages. Because there is the potential for the strong littoral drift in this reach to quickly remove sand placed on the beach (Griggs, 2004), beach nourishment will likely only be successful if combined with some type of sediment retention measure.

8.13.3 Groins

The placement of one or more groins could be combined with a beach-nourishment project to provide a wider, protective beach at the toe of the eroding sea cliffs. Groins should perform well along this particular reach because of the relatively strong unidirectional longshore transport (Griggs, 2004). Groins also offer the advantage of reducing the risk of sea-cliff erosion without requiring extensive armoring that would cover up the important fossil assemblages in the sea cliffs. Groins have the potential to induce downcoast erosion at New Brighton State Beach if they are not carefully designed and charged with sand immediately following construction (USACE, 2008). Groins can also alter wave breaking patterns and currents, which could have implications for surf spots in this reach. There will also be alterations of habitat in the construction footprint, and there could be safety and aesthetic concerns as well.

8.13.4 Cliff Stabilization

This measure involves construction of a seawall at the base of the sea cliff or a more extensive soil nail wall (or similar structure) like the one constructed as part of the East Cliff Drive Bluff Protection and Parkway Project. This measure offers the advantage of providing a comprehensive approach to the addressing cliff erosion and should provide considerable protection for the residential parcels and infrastructure atop the sea cliffs. A cliff stabilization project could also present the opportunity to enhance public access through the construction of stairwells. There are several disadvantages including aesthetic and environmental concerns, potential impacts to surf spots, and the potential to cover up the fossil assemblages. Previous attempts to construct reach-wide cliff stabilization projects have also been met with considerable opposition from the public and local agencies (City of

Capitola, 2004), and local stakeholders indicate that there is a high likelihood of significant opposition to any future implementation of this measure (Surfrider Foundation, 2015).

8.13.5 Multipurpose Artificial Reef

One or more offshore multipurpose reefs could be constructed to reduce the rate of littoral drift and facilitate beach widening. These reefs could also be designed to induce wave-breaking patterns conducive to surfing and other water-based recreational activities. Offshore reefs offer many of the same disadvantages as groins including potential downcoast impacts and environmental concerns. In addition, there is more uncertainty regarding the performance of offshore reefs when compared to groins, which are expected to perform well in this reach.

8.13.6 Managed Retreat

This measure involves the removal of infrastructure and residential parcels within the erosion hazard zone. The primary advantage of managed retreat is that it will eliminate the need for costly and potentially controversial sea cliff stabilization measures. Managed retreat will also facilitate the continued discovery of fossils, and could present the opportunity for creating an open space linkage between Capitola and New Brighton State Beach. Managed retreat has the potential to be a politically sensitive issue at Depot Hill given the large number of residential parcels at risk. In addition, the cost of real estate acquisition could prove to be cost prohibitive for a small municipality or agency with a limited budget.

8.14 New Brighton and Seacliff State Beaches, Rio Del Mar

The infrastructure and residential parcels located on the backbeach are subject to wave attack and inundation. In addition, the flow path of Aptos Creek is often directed downcoast by net littoral drift, where it can undermine residential development along Beach Drive (Griggs, 2012). As a result, a number of shoreline-armoring measures (often under emergency conditions) have been implemented at these beaches, including bulkheads, riprap revetments, and seawalls (Griggs et al., 2005).

8.14.1 No Action

This approach assumes that construction and maintenance of armoring to protect residential parcels will continue to occur on an emergency basis. However, there is uncertainty regarding whether California State Parks will replace damaged infrastructure in kind, because State Parks' policy is to avoid construction in the coastal erosion hazard zone. This approach presents the advantage of protecting residential parcels and infrastructure in place, but has several disadvantages. This approach can be costly to residential parcel owners, and it does not completely eliminate the risk of wave attack and inundation damage to the development on the backbeach. The current configuration of armoring may also induce beach narrowing through passive erosion if the shoreline recedes while the hardened structures remain in place.

8.14.2 Beach Nourishment

This measure could involve the placement of sand at the north end of this reach under the assumption that net littoral drift to the south will distribute the sand along Seacliff, Rio Del Mar, and Manresa beaches. The primary advantage will be a wider beach, which can buffer the infrastructure and residential parcels on the backbeach from wave attack and inundation. In addition, a wider beach should provide recreational benefits at the more popular beaches, such as Seacliff State Beach, which hosts over 500,000 visits per year (Section 7.4.2). Beach nourishment will likely be more costly at this location because of the relatively long distance between this reach and potential sand sources, such as Seabright Beach.

8.14.3 Stabilization of Aptos Creek

This measure involves the rehabilitation of the deteriorating timber and rock jetty on the southeast side of the mouth of Aptos Creek. This measure offers the advantage of reducing the risk of coastal flooding and undermining of infrastructure and residential parcels along Beach Drive. However, there could be an impact to longshore sediment transport with the potential for narrowing of beaches just downcoast of the structure. In addition, there could be additional regulatory concerns beyond those with the MBNMS (Section 6.3.1), particularly with respect to California State Parks policy (Section 6.4.5).

8.14.4 Realignment of Infrastructure and Restoration

This measure involves the realignment or relocation of infrastructure at the mouth of Aptos Creek such as the jetty, flood control structures, and bridge. This measure offers the advantage of reconnecting the lagoon to the open coast, which could in turn facilitate a more-natural, sediment-exchange regime and improve water quality and habitat diversity in the lagoon (Conrad and Dvorsky, 2003). The primary disadvantage of this measure is the high cost, which could be prohibitive for a small municipality if purchases of adjacent commercial and residential parcels are necessary to implement this measure.

8.14.5 Managed Retreat

This measure includes the partial or complete removal of public and private development from areas of the backbeach which are subject to inundation and wave attack. This measure presents the advantage of providing a sustainable long-term approach for reducing the risk of costly damage to infrastructure. In addition, this measure could facilitate the removal of armoring from the beach, which could in turn result in wider beaches and better public access. There are, however, considerable disadvantages to this measure, because the acquisition of residential parcels will likely be too costly and has the potential to become a controversial political issue.

8.15 Pajaro Dunes

Much of the residential development on the active sand dunes north of the mouth of the Pajaro River lies within the coastal erosion hazard zone. As a result, residential parcels on the ocean side of the dunes are subject to wave attack, so rock revetments have been placed along sections of the toe of the dune. In addition, several residential parcels are vulnerable to undermining when the flow path of the Pajaro River shifts to the north, and a training wall does offer some degree of protection.

8.15.1 No Action

This approach assumes that placement of armoring (primarily riprap) will continue on an emergency basis to protect residential parcels. The advantage of this approach is that it can provide at least some short-term protection to residential parcels with minimal cost to the public. There are, however, several disadvantages including potential decreases in beach width, impacts to dune habitats, and loss of public access.

8.15.2 Beach Nourishment

This measure involves placement of sand at the toe of vulnerable sections of the dunes. Advantages would include a wider beach with enhanced public access, and perhaps decreased need for emergency placement of armoring. However, there are no obvious potential sources of sand within several miles of this site, with the exception of coastal dunes, which would likely be off limits to sand harvesting because of ecological concerns. In addition, there is the potential that excess sand could accumulate at the mouth of the Pajaro River, which could alter the flow path and induce flooding of adjacent residential parcels.

8.15.3 Managed Retreat and Restoration

This measure involves the partial or complete removal of residential development from the active sand dunes. Advantages of this measure include the facilitation of restoration of natural processes with benefits to dune ecosystems. Disadvantages include the high costs associated with acquiring residential parcels, and the potentially controversial nature of a managed-retreat proposal at this well-established community.

8.16 MOSS LANDING AND ELKHORN SLOUGH

The entrance to Moss Landing Harbor sits at the head of the Monterey Submarine Canyon, which marks the southern boundary of the Santa Cruz Littoral Cell. There have been some minor beach erosion problems along the south spit, but much of the current infrastructure at risk has been protected by a number of measures, such as the seawall at the Monterey Bay Aquarium Research Institute (MBARI). There is also a significant coastal wetland restoration project underway in the Elkhorn Slough National Estuarine Research Reserve (ESNERR) that would restore 145 acres of vegetated tidal salt marsh, upland ecotone, and native grasslands.

8.16.1 No Action

This approach assumes that local interests will continue to implement measures to mitigate erosion at their respective properties, and that that Elkhorn Slough Tidal Restoration Project will be implemented over the next several years (Section 2.5.13). This approach offers the advantage of minimal expenditure of public funds. However, this approach is dependent on local (often private) interests to independently develop erosion mitigation strategies outside of a broader comprehensive approach. Thus, there is the possibility that a given measure may offer protection to one parcel while exacerbating erosion in adjacent parcels.

8.16.2 Sand Capture at Monterey Submarine Canyon

This measure involves capturing sand as it enters the Monterey Submarine Canyon, to make it available for beach nourishment in both the Santa Cruz and Southern Monterey Bay Littoral Cells. A preliminary study evaluated three potential sand capture concepts (Section2.4.3), but no additional plans for sand capture have been developed to date

(Moffatt & Nichol and Everts Coastal, 2009). This measure presents the advantage of beneficially reusing sand that would otherwise be lost from the littoral cell. The primary disadvantage of this approach is high initial construction costs, which could range from $7.5 to $50 Million depending on the selected concept. This measure may gain more attention in the coming years as the need for beach sand increases with sea-level rise.

9. IMPLEMENTATION AND GOVERNANCE STRUCTURE OPTIONS

9.1 Overview of RSM Plan Implementation

This Plan is a guidance document that provides a framework to regional stakeholders for using RSM to address issues associated with sediment imbalances within the Santa Cruz Littoral Cell and environs. This section of the report provides an overview of what Coastal RSM Plan implementation entails in general, and provides examples of how other CSMW-sponsored RSM Plans have approached it, as well as a range of potential options that could be pursued for implementing this specific Plan. It also provides a preliminary list of recommended next steps for initiating the implementation process as well as potential short-term, long-term, and ongoing implementation actions.

The Plan provides guidance to regional stakeholders by recommending a number of potential opportunities for regional sediment management. Simply put, implementation of the Plan would involve a coordinated effort among stakeholders to establish and maintain a RSM program and to evaluate and carry out these recommendations. The Plan recommends a diverse set of sediment management measures and planning processes, which are distributed widely throughout the various sub-regions, individual BECAs and SICHs. For example, some of the recommendations in the Plan involve continuation of existing activities, such as the ongoing Moss Landing and Santa Cruz Harbor dredging and opportunistic beach nourishment efforts, whereas others would be entirely new projects or planning processes that would require additional funding, staffing resources and additional feasibility studies. Although local jurisdictions would continue to independently plan and implement individual projects, implementation of this Plan would allow for a Coastal RSM program that provides many potential benefits from a regional perspective through stakeholder coordination and cross-jurisdictional collaboration.

This Plan's recommended activities would be located throughout a large and diverse geographical area, which includes upland streams and rivers and the entire 75-mile stretch of coast between Pillar Point and the Monterey Submarine Canyon. Full implementation of this Plan would require extensive coordination among numerous overlapping jurisdictions including close collaboration among state and federal agencies, local jurisdictions, and a variety of other stakeholders. One of the first steps necessary for initial Plan implementation is to connect the relevant stakeholders, including agencies and local municipalities, to begin collaborative discussions on options for long-term implementation of this Plan. These options include development of a governance structure, stakeholder coordination and outreach, funding opportunities, and a regional permitting program.

Since the success of this Plan depends on active stakeholder involvement and coordination, implementation would ultimately require the establishment of a governance structure to coordinate RSM activities and to provide strategic leadership for planning and stakeholder outreach efforts. A few possible mechanisms for governance are presented below in this section, and since the concept of RSM governance is difficult to conceptualize, some tangible examples are also provided on how other completed RSM plans have addressed governance structure.

9.1.1 Benefits of RSM Plan Implementation

Implementation of this Plan and consideration of its recommended actions could result in a wide range of potential benefits depending upon the specific types of RSM actions being pursued and the intensity of these efforts, the availability of funding, and level of stakeholder involvement and collaboration. The CSMW developed the Coastal RSM Plan program to provide local stakeholders with a means to formulate and implement strategies for RSM policy and guidance that will help in:

- restoring, preserving, and maintaining coastal beaches and other critical areas of sediment deficit;
- sustaining recreation and tourism, enhancing public safety and access, restoring coastal sandy habitats; and
- identifying cost-effective solutions for restoration of areas affected by excess sediment.

At a minimum this Plan can benefit agencies, local jurisdictions, and other stakeholders as a technical reference that contains the best-available and most-recent scientific information regarding the geology, geomorphology, physical and biological processes, coastal erosion threats, and RSM issues. The Plan can be referred to as a reliable source of information while making planning and permitting decisions at the local, state, and federal levels. For example, the Southern Monterey Bay CRSMP (PWA, 2008) is a widely used source of technical information that is often cited as a reference for planning and permitting decisions. With a better understanding of the geological, physical, and biological processes and the specific threats from coastal erosion and sediment impairment issues in the region, coastal decision makers can make improved sediment management decisions, and develop more effective policies and practices.

In addition to being a useful technical reference, this Plan can serve as a valuable planning resource providing local jurisdictions and agencies with a framework for using RSM to address sediment imbalance issues within the Santa Cruz Littoral Cell. It provides an inventory and assessment of sediment issues and coastal erosion threats, recommendations for RSM measures and stakeholder processes, and tangible next steps for initial implementation. Thus, it provides a framework that will allow local stakeholders to further evaluate, prioritize, and pursue specific projects on a cooperative basis. Moreover, the availability of information in the Plan, including identification and assessments of BECAs and SICHs, will provide the opportunity for sediment management issues to be addressed proactively and comprehensively rather than on an emergency, last-minute basis, which could allow for more effective solutions with fewer environmental impacts.

Another key benefit of implementation is improved agency and institutional collaboration, resulting in increased efficiency and effectiveness in addressing RSM issues. Such collaboration can provide new opportunities for information sharing and leveraging financial and manpower resources in data collection and analysis, tool development, and project implementation. The development of partnerships among permitting agencies, municipalities, researchers, and other stakeholders can lead to potential benefits including reduced study costs, enhanced protection of environmental resources, and the streamlining of regulatory processes.

In addition to the benefits described above, there are the actual benefits that could be accrued by implementing these RSM measures themselves. For example, implementation of this Plan would provide new opportunities for local RSM projects, such as beach restoration, to be pursued. These projects could provide several direct benefits to the region including: mitigating shoreline erosion and coastal storm damage; allowing for biological habitat restoration and protection; increasing natural sediment supply to the coast; and providing public safety, access and recreational benefits through beach restoration.

Finally, having an active RSM program in the region would increase the likelihood of receiving funding from a variety of sources. For example, a clear benefit of having an adopted this Plan in the region is that it provides new opportunities to cooperatively apply for grants and other funding from various state, federal, and private sources. An adopted CRSMP also demonstrates to potential funders that there is a serious regional commitment to pursue RSM along with a high level of stakeholder collaboration. Such commitment is anticipated to favorably incline funders who are increasingly forced to prioritize limited available funds.

9.1.2 Overview of RSM Plan Implementation Fundamentals

Although each RSM Plan is unique and tailored to a specific region and set of circumstances, there are several fundamental implementation elements that CRSMPs typically have in common. It is recommended that implementation of the Santa Cruz Littoral Cell Coastal RSM Plan include the following activities:

- develop a governance structure for RSM plan implementation,
- establish a process for RSM stakeholder coordination,
- develop and implement an outreach and education program,
- establish and maintain a dedicated funding source, and
- investigate and pursue options for a streamlined permitting program.

Each one of these recommended activities is described in more detail in this section and examples are also provided from CRSMPs that have been adopted in various regions in California.

9.2 Development of a Governance Structure for Plan Implementation

To fully implement this Plan, a governance structure that meets the specific needs of the Santa Cruz Littoral Cell region would have to be developed and adopted by local governments and stakeholders. Development of an RSM governance structure typically entails the establishment of a coordinated CRSMP implementation process led by an entity that has appropriate jurisdictional authorities. Such entity would need the ability to enter into contracts, oversee staffing resources, and facilitate a process for input and collaboration with local stakeholders as well as federal, state, regional, and local entities. Each CRSMP makes recommendations for a governance structure to implement RSM in the planning region. In some cases, such as the San Diego and Santa Barbara/Ventura County CRSMPs, lead RSM coordinating agencies and active sediment management programs were in existence prior to the development of those plans. In other cases, such as the Orange County CRSMP, the recommendation is to establish a new entity to oversee implementation and coordinate RSM activities. Examples are provided below of how other regions have addressed governance structure in their CRSMPs.

In certain cases, initial implementation involves formal adoption of a CRSMP by a lead planning and coordinating agency with appropriate jurisdictional authorities. In the Santa Cruz Littoral Cell region this is not possible because of the large number of jurisdictions potentially involved and the lack of an obvious candidate for the RSM coordinating agency. Nonetheless, several feasible options are available for potential governance structure models and lead agencies to implement RSM in the Santa Cruz Littoral Cell region. It is recommended, during the early phases of plan implementation, to engage in a coordinated stakeholder effort to further evaluate the range of available options and reach consensus in determining the most effective governance structure for the region.

Once a decision has been made on a governance structure and implementation model to pursue, the next steps would be:

1. officially adopting the Plan,
2. establishing and maintaining a coordination mechanism and an agreement among the participating stakeholders that clearly states roles and responsibilities and formalizes the process,
3. establishing a means to administer and seek funding and enter into contracts to conduct studies and collaborative planning efforts, and
4. establishing and overseeing the staff necessary to coordinate CRSMP implementation.

9.2.1 Staffing Needs and Options for Plan Implementation

Staffing resources are required to develop a CRSMP governance structure and sustain its ongoing efforts to support communities that want to carry out RSM measures in the Plan – or other actions. The completed CRSMPs in other regions of California have all concluded that plan implementation would require, at a minimum, a dedicated program manager to oversee plan implementation. The program manager would coordinate with stakeholders on a variety of recommended projects, studies, and management, and funding strategies. In addition to a program manager, several plans recommend additional support staff and technical specialists.

Accordingly, successful implementation of this Plan would depend on staffing resources. Near-term staffing is needed to coordinate initial stakeholder outreach efforts, assess funding needs and potential sources, oversee the process to develop and adopt a governance structure, establish an implementation committee or stakeholder advisory group, and begin work on a Strategic Implementation Plan (SIP). Over the long-term, staff responsibilities could include: establishing and facilitating a decision-making process and coordinating an advisory group to make recommendations to decision makers; coordinating, scheduling, and facilitating meetings; administering grants; overseeing studies and contracts; coordinating with local municipalities and pulling together specific project needs from each party; seeking funds for plan implementation; and developing a coordinated regional permitting process.

This Plan recommends that funding be sought in the near term to establish a new staff position to coordinate initial RSM Plan implementation. This interim CRSMP coordinator would be seated within an existing agency, municipality, or other organization. The coordinator would initiate and oversee plan implementation and outreach efforts, facilitate governance structure development, and carry out some of the initial planning activities identified in this Plan.

Long-term staffing requirements should also be identified, and a range of potential staffing scenarios should be evaluated. A long-term staffing plan with a specific scope of work should be developed as part of a SIP for this CRSMP.

Ideally, new positions would be established and overseen by the lead RSM coordinating agency with governance structure responsibilities. Even without the establishment of a formal governance structure and designated lead RSM agency, it would be possible to create one or more new RSM-focused staff positions within an existing entity or among several different entities. Another option would be to add RSM plan implementation and coordination responsibilities to the job descriptions of existing staff.

9.2.2 Other Governance Structure Responsibilities and Requirements

In addition to the range of roles and responsibilities described above, an effective governance structure should also include a system for periodically evaluating the effectiveness of the RSM program and its individual projects. This makes it possible to determine whether or not the goals of the Plan are being met and allows for adjustments to be made to improve the effectiveness of the program based on monitoring results.

As an adaptive management plan and living document, this Plan should also be updated periodically, as new information becomes available, to allow flexibility for the Plan to be responsive to emerging issues and adapt to changing circumstances. As part of the governance structure, a collaborative stakeholder process should be put into place to ensure that the Plan is updated as needed to add or modify data, information, processes, and recommended activities. For example, this Plan should be updated as new knowledge becomes available, as RSM measures are evaluated and prioritized, or changes in funding or other unforeseen circumstances occur.

9.2.3 Examples of Governance Structures from Completed Coastal RSM Plans

As of the writing of this Plan, there have been four completed CRSMPs in California: the Southern Monterey Bay CRSMP, the Santa Barbara and Ventura Counties CRSMP, the San Diego Region County CRSMP, and the Orange County CRSMP. Each of these plans was developed and adopted by a regional partner such as an existing Joint Powers Authority (JPA) or municipality. In most cases some form of governance structure and an active beach-restoration program were in existence prior to the development of the CRSMP.

9.2.3.1 The Southern Monterey Bay CRSMP

The Southern Monterey Bay CRSMP was completed in 2008. The Association of Monterey Bay Area Governments (AMBAG) was the regional partner in developing the plan and the Southern Monterey Bay Coastal Erosion Workgroup (SMBCEW) – which was facilitated by the MBNMS – served as the Stakeholder Advisory Group (SAG).

This CRSMP recommended that AMBAG, as an existing JPA, should take on governance structure responsibilities and act as the lead planning and coordinating agency. Their efforts would include adopting the CRSMPs, seeking funds, administering grants and studies, assisting with implementation activities as deemed necessary by the local implementing agencies, and maintaining and updating the Coastal RSM Plan. In this structure, AMBAG would play a coordinating role in overseeing plan implementation, whereas the local, land-use decision making and RSM project implementation would remain with the local agencies and jurisdictions. Under the model proposed in the CRSMP, the SMBCEW would continue to act as the main SAG to make recommendations to the AMBAG Board of Directors and local jurisdictions on RSM issues and CRSMP implementation. The plan recommended creating one full-time staff position at AMBAG to coordinate CRSMP implementation and to advise the AMBAG Executive Director on RSM-related issues.

The Southern Monterey Bay CRSMP recommended four major management strategies for the littoral cell:

- investigate beach nourishment and other beach-restoration strategies to ameliorate erosion in a 3-mile stretch of shoreline within the Cities of Sand City, Seaside, and Monterey where the vast majority of critical erosion areas are located,

- reduce or eliminate sand removal from the beach at Marina by the existing sand mining operation,

- allow dune erosion to continue without human intervention north of Sand City to the Salinas River, where there is little development and a major source of sand to feed the littoral cell,

- use the CRSMP as a baseline to build a regionally comprehensive erosion-abatement approach through the ongoing efforts of the SMBCEW.

The CRSMP also recommended seven management and policy changes for the Southern Monterey Bay shoreline. These include activities such as formalizing the governance structure for coastal RSM projects with staff from the AMBAG member agencies, investigating other 'soft' erosion control technologies in the region, and developing a streamlined permitting program modeled after the pilot Sand Compatibility and Opportunistic Use Program (SCOUP) established in the San Diego region. Funding strategies include working with the local Chambers of Commerce to develop a dedicated source of local funding as the local match to state and federal funding that would be required for any beach-nourishment projects. Funding sources identified for further evaluation in the plan include real estate transfer taxes, general sales taxes attributable to sporting goods, and beach-user parking and fees.

Specific policy recommendations in the plan included: working with the local municipalities to identify how to reference the CRSMP in the general plans and Local Coastal Programs (LCPs), exploring the feasibility of adding CRSMP-related items to the version of the CEQA checklist that is used in this region, and investigating whether RSM activities benefiting the entire region can be streamlined through a regional general permit from the California Coastal Commission.

Implementing the Southern Monterey Bay CRSMP would require close coordination with local cities, Monterey County, DPR, CCC, MBNMS, and other relevant agencies. The SMBCEW, which served as the stakeholder advisory group for the development of the CRSMP, is a multidisciplinary workgroup comprising representatives from federal, state, and local agencies, local municipalities, academia, conservation organizations, elected officials, and other stakeholders. Specifically, the workgroup includes geologists, coastal engineers, hydrologists, regulatory agency staff, local governmental representatives, local and regional planners and public works staff, conservation interests, residents of private structures threatened by erosion, and other local experts. The workgroup was established to make recommendations on and to facilitate the development of a regional planning approach addressing coastal hazards associated with erosion and sea-level rise along the shoreline between Moss Landing Harbor and Wharf II in Monterey.

AMBAG adopted the CRSMP once it was finalized; however, the agency's Board of Directors later made a decision to decline taking on RSM responsibilities. Consequently, the agency never played an active role in CRSMP Implementation.

9.2.3.2 The Santa Barbara and Ventura Counties CRSMPs

This CRSMP was completed in January 2009. The regional partner that led plan development efforts was the Beach Erosion Authority for Clean Oceans and Nourishment (BEACON), a JPA consisting of Santa Barbara and Ventura Counties and the cities of Goleta, Santa Barbara, Carpinteria, Ventura, Oxnard, and Port Hueneme. The BEACON's Board of Directors adopted the plan following its release in 2009. Recently, it has prepared a SIP for the CRSMP, which was developed to prioritize projects and activities across the region. Unlike Southern Monterey Bay and AMBAG, the region had an existing beach-restoration program, and BEACON was responsible for coordinating RSM activities before the CRSMP process began. Rather than establishing new programs, the intent of the CRSMP is to provide BEACON with an opportunity to revisit its past and ongoing programs, fine tune its goals and objectives, and map practical implementation strategies into the future.

BEACON was established for the limited purposes of dealing with coastal erosion, beach nourishment, and beach problems in Ventura and Santa Barbara Counties. As such, the JPA is involved in an array of coastal studies and projects within its jurisdiction and works in close coordination with the parks, planning, and public works departments of each municipality and agency. Funding for BEACON comes through annual agency membership dues and grant funding from state and federal agencies.

The CRSMP recommends an array of studies, management strategies, policy changes, and capital projects that BEACON intends to implement over the next twenty years. Some recommendations are at the regional level, and others are made within the individual reaches. Since there is not enough funding to implement all activities, the plan prioritizes the proposed activities and recommends a specific top-priority activity for each reach and for the overall region. Examples of top priority activities in the individual reaches include: establishing a fluvial and sea-cliff sediment-management preserve for the entire Conception reach, implementing the Goleta County Beach shoreline preservation project, implementing a regional harbor maintenance plan for the harbors in the Oxnard Plain Reach to include RSM for beneficial use, improving nourishment longevity at west Hueneme Beach, and establishing an RSM stockpile and processing center within the Rincon Parkway Reach for use in a temporary winter berm sand placement program. The top-priority regional activity recommended in the CRSMP is to coordinate with the USGS and UC Santa Barbara to establish long-term monitoring of the shoreline and sediment delivery processes within the BEACON coast.

The BEACON CRSMP is intended to develop a comprehensive road map that addresses how to conserve and restore the valuable sediment resources along its coastline. The CRSMP aims to reduce shoreline erosion and coastal storm damages, protect sensitive environmental resources, increase natural sediment supply to the coast, preserve and enhance beaches, improve water quality along the shoreline, and optimize the beneficial use of material dredged from ports, harbors, and other opportunistic sediment sources. The BEACON JPA and the CRSMP efforts undertaken in that region provide an excellent case study and a roadmap for potential RSM efforts in San Mateo and Santa Cruz Counties.

9.2.3.3 The San Diego Region CRSMP

San Diego Association of Governments (SANDAG) completed and adopted the San Diego CRSMP in 2009. Prior to the CRSMP, SANDAG was responsible for coordinating RSM activities including administering an active and well-established beach restoration program consisting of large beach nourishment programs such as the San Diego Regional Beach Sand Project, and individual opportunistic beach fill projects throughout the region. The CRSMP addresses sediment management issues for a San Diego County-wide planning area consisting of three individual littoral cells.

SANDAG is a JPA made up of 18 cities and county governments and, in contrast to the narrower focus of the BEACON JPA model, is a forum for decision-making on a wide array of issues. A Board of Directors of mayors, council-members, and county supervisors, as well as non-voting advisory members from the Department of Defense, Caltrans, San Diego Port District, and San Diego Water Authority governs SANDAG. In addition to the Board, the JPA also has a staff of professional planners, engineers, and research specialists. SANDAG builds consensus; makes strategic plans; obtains and allocates resources, plans, engineers, and builds public transportation; and provides information on a wide variety of topics.

SANDAG's Shoreline Preservation Working Group (SPWG) advises the Regional Planning Committee on issues related to the Shoreline Preservation Strategy. It is identified in the CRSMP as the appropriate stakeholder coordination group for RSM issues. Its members consist of one elected representative from each coastal city and the County, staff of the Port of San Diego and the U.S. Navy, technical advisory members of appropriate resource agencies, and stakeholder groups. A working staff representative from each coastal city assists the SPWG. The voting members of the SPWG deliberate on coastal issues within the region and makes CRSMP-related recommendations to the SANDAG Regional Planning Committee for consideration. The JPA's Board of Directors will take final action.

The SANDAG CRSMP leverages and improves upon existing SANDAG plans and processes such as such as the Shoreline Preservation Strategy, the Regional Shoreline Monitoring Program, and the SPWG. It also seeks to integrate with and improve coordination among other policies, management plans and processes including the California Sediment Master Plan, USACE Regional General Permit 67, the California Coastal Act, opportunistic beach fill programs, and various monitoring and coastal observation programs. The SANDAG CRSMP is also associated with the development of the original SCOUP pilot program that has served as a model for other regions.

The plan describes several options for SANDAG implementing the Coastal RSM Plan including:

- adding CRSMP considerations to the local CEQA Initial Study Checklist,
- relying on the California Coastal Act,
- amending Local Coastal Programs to reflect the CRSMP,
- adding CRSMP requirements to City/County Grading Permits,
- providing incentives through reduced developer fees including CRSMP provisions in local zoning ordinances and general plans,
- establishing "sandsheds/littoral cell" planning agencies,
- securing general permits from each agency,
- conducting programmatic environmental review, and
- coordinating with state regulatory programs.

The CRSMP recognizes that these options would be contingent upon availability of funding that could potentially be obtained through economic incentives, bonds, legislation, or fees.

The SANDAG CRSMP recognizes the need for coordination, and identified the following stakeholders that should be involved in RSM planning efforts: SANDAG, the CSMW, resource agencies not included in the CSMW, the County, DPR, the coastal cities, and local stakeholders (local Watershed Planning Groups, Scripps Institution of Oceanography, lobster and other fishermen, the Surfrider Foundation, Homeowner Groups, City Beach Erosion Committees, and others).

9.2.3.4 The Orange County CRSMP

This plan was completed in May 2013, and the Orange County Department of Parks is the regional partner. As a governance structure for the region, the CRSMP recommends establishing a new JPA focused on implementing RSM in Orange County. This JPA would employ a similar governance structure to the model used by BEACON. For example, the JPA would act as the lead planning and coordinating agency that adopts, seeks funds, administers grants and studies, assists with implementation activities as deemed necessary by the local implementing agencies, facilitates collaboration on coastal issues, works to fill data gaps, and maintains and updates the Plan. Consistent with the other three completed CRSMPs, the JPA would receive funds, complete environmental documentation, acquire regional permits as appropriate, and plan coastal projects, as appropriate. But, local land-use decision-making and implementation would remain with the local agencies. In addition to being the lead planning agency for regional sediment management, the JPA would also oversee what is referred to in the plan as “other erosion control measures” such as seawalls, sand retention reefs, perched beaches, groins, revetments, breakwaters, and headland enhancement.

Similar to the other CRSMPs, the Orange County CRSMP recommends that the JPA hire a dedicated staff member to assist its executive director to specifically manage coastal RSM issues and coordinate with other staff. The plan recommends establishing a committee comprising of representatives from regional and local governments, academic institutions, industry, and non- profit organizations to provide guidance on RSM issues to the executive director. The JPA would include a Board of Directors as a decision making body that the executive director would report to. The CRSMP recognizes that, similar to the BEACON and SANDAG RSM programs, one or more technical staff members may be desirable to help local agencies to implement particular projects that require special capabilities in coastal engineering, construction contract administration, or monitoring. It also recommends that the JPA establish a dedicated funding process for implementing coastal RSM projects.

The Orange County CRSMP recommends that a long-term outreach program be developed by the JPA to ensure coordination with the local and regional jurisdictions and special districts in implementing the Plan. Specific outreach recommendations include: updating stakeholder contact lists; engaging in a focused outreach campaign to encourage collaboration amongst the stakeholder groups; hosting public meetings to seek public input on RSM issues and plan implementation; and publishing brochures, fact sheets, and other information on the JPA and CSMW web pages.

The Orange County CRSMP makes specific recommendations for CRSMP implementation tasks to be carried out by the JPA. The following plan excerpts provide examples of recommended tasks for aligning the CRSMP with other local plans and policies:

> *"In order for the Plan to be considered when coastal RSM activities are being planned or implemented, the JPA should promote referencing of the Plan in individual LCPs or Land Use Plans. The JPA could pursue implementation of the Plan by requesting that the local office of the CCC begin requiring all coastal RSM projects in Orange County be consistent with the Plan by beneficially re-using surplus sediment for nourishment."*
>
> *"The JPA should coordinate with all local agencies (city and county level) to pursue consistency with specific activities of the Plan in their zoning ordinances and municipal codes in their general plans."*

9.2.4 Governance Structure Options for the Santa Cruz Littoral Cell

The uniqueness of the physical features, coastal development patterns, and geopolitical structures of the Santa Cruz Littoral Cell region requires development of an individualized approach to RSM that best meets the needs of local jurisdictions and agencies in addressing a diverse and specific set of issues spread throughout approximately 75 miles of coastline. The Santa Cruz Littoral Cell Region presents a unique situation that differs from the planning regions of the other CRSMPs that have been completed or are currently underway. Consequently, the governance structures developed for the other regions probably would not work for this Plan.

Because of the complexities involved with the Santa Cruz Littoral Cell region and the lack of an obvious governance structure model and lead agency, further discussion among stakeholders and a more-detailed assessment of alternatives are needed before informed decisions can be made by local jurisdictions on determining the appropriate governance structure and implementation model. Therefore, rather than recommending a specific governance model, this Plan identifies a range of potential scenarios and encourages local jurisdictions, agencies, and other stakeholders to engage in a collaborative effort to further evaluate the options and make an informed decision on the most appropriate governance structure for the region.

To determine the most effective approach, several factors must be taken into consideration – e.g., the degree of funding and staffing available for coordinating RSM activities and the level of stakeholder commitment and participation. An initial list of potential governance structure options for this Plan could include: 1) a status-quo approach with no coordinated Plan implementation, 2) a minimal effort to implement the plan with increased levels of stakeholder coordination but without designating a lead RSM coordinating agency or formal governance structure, 3) the development of a governance structure led by an existing agency or municipality, and 4) the establishment of a new Joint Powers Authority (JPA) to serve as the lead RSM coordinating agency. It is recommended that, during initial plan implementation efforts, these four potential options be further evaluated and the possibility of additional options be explored.

9.2.4.1 Scenario 1: Status Quo – No Coordinated RSM Plan Implementation

This scenario is provided for reference, but it is not a recommended option for this Plan. It could be considered the “no action” alternative, because it would involve zero implementation efforts being undertaken after the Plan is finalized and no future updates would be made to the plan. This would mean that certain preexisting RSM-related projects (e.g. dredging and opportunistic nourishment at harbors) would continue to be carried out on an individual basis; however, none of the recommendations for collaborative planning processes and new RSM measures from this plan would likely come to fruition.

Because of significant ongoing coastal erosion issues and threats to existing coastal development, some degree of intervention will be required. However, with the lack of a coordinated RSM program it is likely that these issues would continue to be dealt with individually – often using a case-by-case emergency response approach. Under this option there would be no formal agreements, public outreach process or stakeholder working group. Although it will be readily available, many potential decision makers will not be aware of this Plan’s existence and potential uses and benefits.

9.2.4.2 Scenario 2: Minimal Implementation Efforts – Increased Levels of Stakeholder Coordination but Without a Lead RSM Agency or Formal Governance Structure

In contrast to the status-quo scenario, this option would involve a minimal degree of Plan implementation. This could include a commitment by local jurisdictions and stakeholders to develop an RSM approach and a basic stakeholder outreach program consisting of occasional public workshops and meetings of decision makers to discuss RSM coordination opportunities. Although this scenario would include some means of RSM coordination and plan implementation, it would not involve a formal agreement and establishment of an official governance structure with a decision-making body. Instead, decision-making and project planning and implementation would remain at the local level.

This scenario would include a facilitated workgroup of local experts and stakeholders, such as the SAG that was established for the development of this Plan. The stakeholder workgroup would be an informal, non-legal entity that meets as needed to provide recommendations to decision makers and individual jurisdictions on the implementation of the plan and advise on RSM issues. The SMBCEW is a stakeholder coordination model that should be studied and potentially adopted for use in the Santa Cruz Littoral Cell region. This workgroup was established by the MBNMS, the California Coastal Commission, and the City of Monterey, and was coordinated and facilitated by a part-time contractor position overseen and funded by MBNMS between 2005 and 2010. The SMBCEW met regularly to provide recommendations and guidance on coastal erosion issues in the region, and provided input and expertise in developing the Southern Monterey Bay CRSMP and several other regional studies. The SMBCEW is an example of an effective approach with an informal, minimally funded, collaborative workgroup that lacks an official decision making capacity or regulatory authority. The SMBCEW also lacks an official agreement among the participating stakeholders.

This option would require a limited degree of funding and staffing resources to meet the needs for a minimal implementation of the Plan. Most likely it would rely on limited time commitments of staff that are designated by the participating jurisdictions. If a small amount of funding could be obtained, however, either through cost-sharing contributions or a grant, it would be possible to hire a part-time or full-time coordinator position within one of the participating jurisdictions. That person would oversee Plan implementation, ensure cross-jurisdictional coordination, facilitate a stakeholder workgroup, and organize public outreach efforts.

RSM coordination activities under this scenario could include: applying jointly for grant funding opportunities for new RSM projects or regional planning efforts, developing strategies for information sharing, integrating CRSMP aspects into local and regional plans and policies, collaborating on studies and projects, holding public workshops, and making future updates to the Plan. Implementing prioritized plan activities would be done opportunistically as funding or staffing resources become available.

9.2.4.3 Scenario 3: Moderate Implementation Efforts – Includes Developing a Governance Structure with an Existing Agency or Municipality as the Lead RSM Agency

This option, which involves a more formal process than the previous scenario, would require a higher degree of stakeholder cooperation, funding, and staffing resources. It would, however, be a less involved and complex process than the JPA-led governance structure described in the next scenario. This is a potentially feasible model for the Santa Cruz Littoral Cell region that would involve an existing agency, with CRSMP-appropriate mandates and authorities, taking on a stakeholder coordination and governance role. The lead agency would have the ability to enter into contracts, administer funding, oversee staff, and convene key stakeholders and decision makers. In the scenario, having a single entity that is tasked with Plan implementation and stakeholder coordination would provide for more focused and intensive efforts, through dedicated staff and funding resources and commitments from stakeholders to support and participate in the process.

RSM coordination activities under this scenario could include: applying jointly for grant funding opportunities for new RSM projects or regional planning efforts, developing strategies for information sharing, integrating Plan aspects into local and regional plans and policies, collaborating on studies and projects, holding public workshops, and making future updates to the Plan. Although activities would be similar to Scenario 2, under this option there would be a higher level of stakeholder commitment, funding, and staff resources, resulting in more-focused and effective efforts and an accelerated timeline. Similar to the other implementation options, recommended actions in the Plan would be implemented based upon availability of funding. These activities would be prioritized and pursued in order of their rank as funds become available (and based upon the individual contributors or grant recipients).

The lead agency would develop and oversee a cooperative agreement – e.g., a Memorandum of Understanding (MOU) – among participating stakeholders that clearly states roles and responsibilities and formalizes the process. The lead agency would also be responsible for coordinating updates to the Plan and evaluating the success of the program and its individual projects. Under this scenario there would be a SAG similar to the one established for the development of this Plan (or the SMBCEW, which was coordinated and facilitated by MBNMS staff) that would serve as a non-legal entity. The SAG would provide expertise and recommendations to local jurisdictions regarding Plan implementation and specific recommended RSM measures. The SAG and lead agency would focus on coordination at the regional level and would develop a SIP and prioritize the recommended RSM measures in the plan. Decision-making and project planning and implementation responsibilities would remain with the local municipalities and jurisdiction.

This scenario would require individual obligations from local jurisdictions and stakeholders and a significant commitment from the lead agency. It would require new sources of funding and a high level of stakeholder collaboration. The lead agency would be responsible for pursuing additional staff resources to lead the coordination efforts. If no single agency or local jurisdiction is willing or able to make a commitment and take on the lead role for RSM coordination, then other potential organizations should be explored. For example, there are several local academic and research institutions in the region that have established coastal science and policy programs and could potentially administer funds and staff to coordinate Plan implementation. Examples in the region include Moss Landing Marine Labs, California State University at Monterey Bay, Monterey Institute of International Studies, UC Santa Cruz, and MBARI. Another option, in lieu of a single lead agency, would be the development of a governance committee with responsibilities split among multiple agencies and jurisdictions. This could include a chair and lead coordination responsibilities that rotate between participating jurisdictions.

9.2.4.4 Scenario 4: Intensive Implementation Efforts – Establish a New Joint Powers Authority to Serve as RSM Lead Agency

A JPA is an institution permitted under the laws of many states whereby two or more public authorities can operate collectively. They are permitted under Section 6500 of the State of California Government Code. JPAs may be used where an activity naturally transcends the boundaries of existing public authorities. It is distinct from the member authorities; the JPA has a separate operating board of directors, and the board can be given any of the powers inherent in all of the participating agencies. Also, the JPA can employ staff and establish policies independently of the constituent authorities. JPAs are flexible and can be tailored to meet specific needs, and there are many differences among individual JPAs.

Under this scenario, full implementation of the Plan would occur under the direction of a newly established JPA. One of the major benefits of having a new JPA is that it is a highly customizable and flexible entity that could be developed to fit the needs of the local jurisdictions and stakeholders within the Santa Cruz Littoral Cell region. Moreover, as a legal entity it could establish authorities that allow for the agency to play a more involved role in carrying out RSM projects and planning efforts. For example, the JPA could potentially enter into contracts for studies, planning efforts, environmental review, permitting, feasibility studies, and engineering as needed. It also could administer contracts for RSM projects and even own and maintain equipment and fund and oversee project construction. The disadvantages of this model include high costs and time commitments from local stakeholders. For example, funding and staff time, contributed by local jurisdictions, would be necessary for the formation of the JPA and for ongoing participation in the entity's decision-making process.

Governance structures for other completed RSM plans have typically been the responsibility of an existing JPA such as SANDAG, BEACON, or AMBAG. Because no existing JPAs encompass both Santa Cruz and San Mateo Counties, the only possibility for a fully regional JPA-led governance structure for implementation of this Plan would require the formation of a new JPA. The new JPA, similar to the BEACON JPA model, would be established for the specific purpose of coordinating RSM activities and overseeing the implementation of the Plan. Although this is a feasible option, it is not likely that this level of effort would be necessary for successfully implementing the Plan in the Santa Cruz Littoral Cell region. However, it is still recommended that this option be further evaluated and considered by the stakeholder agencies and municipalities.

This option would require dedicated staffing resources including an executive director for the JPA as well as a RSM Coordinator position and potentially other support staff. It would also involve a Board of Directors as an official decision-making body and a non-regulatory SAG to provide recommendations to the decision-makers on addressing sediment-management issues and implementing RSM in the region. The Board of Directors would include representatives from local municipalities, agencies, and other jurisdictions that are involved in an official capacity in RSM-related planning, project implementation, or permitting decisions. This entity would formally adopt the Plan by issuing a resolution, and an agreement such as an MOU would be developed that clearly describes the roles and responsibilities of the participating parties. The stakeholder working group could be modeled after the SANDAG or BEACON programs, and would require a coordinator or facilitator to convene the group and maintain communication with workgroup members and an official set of rules and protocols.

9.3 Establish a Process for RSM Stakeholder Coordination

Successful implementation of this Plan is not possible without the direct cooperation and participation from the local municipalities, regulatory agencies, and numerous other potential stakeholders that are responsible for addressing sediment issues or involved in planning or implementing RSM projects within the Santa Cruz Littoral Cell Region. The CSMW considers the cooperation and coordination of RSM stakeholders within each region to be a fundamental component for a successful RSM program and requires that each CRSMP include a stakeholder outreach program.

There are many potential options available for a process to ensure stakeholder coordination and involvement in the implementation of this Plan. These options would vary depending on the financial and staffing resources available and the level of local commitment and participation by stakeholders. Examples of mechanisms to achieve successful coordination include: establishing a stakeholder or technical advisory group convened to solicit expertise and provide recommendations to decision makers, implementing cooperative agreements among agencies and municipalities to formalize the RSM program, creating mechanisms for cooperative funding and cost-sharing for studies and projects, holding public meetings and workshops to educate and solicit input from stakeholders, and developing a coordinated permitting program to increase efficiency and better address agency concerns. These potential stakeholder coordination processes are described in more detail throughout this section of the CRSMP.

Near-term and ongoing implementation of this Plan would also require convening and facilitating meetings of a SAG and potentially a decision-making body such as an implementation committee to bring together the numerous stakeholders and experts in the region to solicit input and guidance on RSM matters. Examples and recommendations are provided in the governance structure section. Below is an initial list of potential stakeholders and partners with a description of their roles in implementing the Plan.

It is recommended that the options for stakeholder coordination mechanisms described in this Plan be further evaluated as part of the process to develop an RSM governance structure. Following the evaluation process the local jurisdictions involved in plan implementation should then agree upon and pursue an individualized stakeholder program for the Plan. Once the Plan has been finalized, the stakeholders – identified below – should be contacted individually to discuss potential opportunities for collaboration and to assess their interest in participation. This Plan recommends that in addition to connecting individually with each party, the SAG that was established for the development of this Plan be reconvened for additional meetings to provide recommendations on and assist with Plan implementation. In addition to the multi-stakeholder SAG, it may be necessary to establish a decision-making committee comprising local jurisdictions and agencies for initial implementation of the Plan and development of a governance structure. Finally, as a means of reaching out to the general public, local residents, and property owners, this Plan recommends partnering with CSMW to host at least two public workshops once the Plan has been finalized, one in Santa Cruz and another in the Half Moon Bay area, to present the final Plan and obtain input on initial implementation.

9.3.1 California Coastal Sediment Management Workgroup

The CSMW is a collaborative taskforce consisting of federal, state, and local agencies and non-governmental organizations (NGOs) working to address California's coastal sediment management needs on a regional and system-wide basis. One of the workgroup's main goals is to pursue innovative ways to solve coastal erosion problems along the California coast, often through placement of sand to augment eroding beaches at locations determined as appropriate for such placement.

State membership includes the CNRA, DBW, DPR, CCC, CGS, San Francisco Bay Conservation and Development Commission (BCDC), SCC, CDFW, and the CSLC. Federal membership includes USACE, NOAA/MBNMS, USGS, and the U.S. Environmental Protection Agency (US EPA). NGO membership includes the California Coastal Coalition (CalCoast) and the California Marine Affairs and Navigation Conference (CMANC).

The CSMW sponsored and supported the development of this Plan and should also serve as a key partner in its implementation. It is recommended to coordinate with CSMW on all aspects of plan implementation and stakeholder outreach strategies and to establish a list of prioritized next steps for the early stages of implementation.

9.3.2 State and Federal Regulatory Agencies

State and federal regulatory and natural resource agencies would play a range of potential roles, all of which are essential to fully implement this Plan. Potential agency roles and responsibilities include: project planning, permitting, environmental review, management of natural resources and public lands, protection of coastal infrastructure and roads, funding of planning for and construction of RSM projects, and conducting a variety of necessary scientific research and studies.

Federal agencies with potential involvement in the implementation of this Plan that should be contacted during initial outreach efforts include USACE, NOAA's MBNMS and GFNMS, and the USGS. State agencies include the CCC, CSLC, SCC, CGS, DPR, and DBW. More detailed information on the specific roles and regulatory and statutory authorities of these agencies is included in Section 6 of this Plan.

9.3.3 Local Jurisdictions

Coordination with and among local jurisdictions is essential for successful implementation of this Plan because RSM measures are typically planned and carried out at the local level and because all of the recommended actions in this Plan would require some level of local engagement and collaboration. Included among local jurisdictions are municipalities (counties and cities), local agencies, special utility districts, Geologic Hazard Abatement Districts (GHADs), and harbor and port districts. Each of these entities would play a specific role in the Plan implementation process. Some are involved in project planning, review, and permitting, whereas others may be responsible for protecting coastal properties or infrastructure, managing public lands, or actual construction and implementation of RSM measures. Municipalities are involved in planning and permitting (planning or community development departments) and project implementation (Public Works Departments).

An initial list of local jurisdictions existing within the boundaries of the Santa Cruz Littoral Cell that should be contacted during the initial outreach process includes the counties of Santa Cruz, and San Mateo; the cities of Capitola, Santa Cruz and Half Moon Bay; Moss Landing Harbor District; Santa Cruz Port District (Santa Cruz Harbor) and San Mateo County Harbor District (Pillar Point Harbor); San Mateo County Parks; AMBAG; San Mateo and Santa Cruz County Resource Conservation Districts; Santa Cruz County Regional Transportation Commission; and Depot Hill and Pajaro Dunes GHADs.

9.3.4 Non-Governmental Organizations

There are numerous environmentally focused NGOs that are active within the region encompassed by the Plan. Several of these organizations have provided input on the development of this Plan. Since each individual organization has its unique set of mandates and objectives and is focused on addressing specific issues and concerns, each of these would play a unique role in Plan implementation. Many NGOs could be involved in commenting on local coastal planning processes and proposed coastal development projects and in reviewing coastal CEQA and NEPA documents, whereas others could provide resources and support to local jurisdictions.

These NGOs should be contacted early on in the Plan implementation process to inform them of the Plan's availability and provide opportunities for involvement and input. NGOs should also be engaged in the planning and implementation of specific RSM measures that are proposed in this Plan. An initial list of active NGOs in the area includes the Center for Ocean Solutions, Elkhorn Slough Foundation, Peninsula Open Space Trust, Save Our Shores, Save the Waves, Sierra Club (Santa Cruz and Loma Prieta Chapters), Surfrider Foundation (Santa Cruz and San Mateo Chapters), and the Nature Conservancy.

9.3.5 Other Stakeholders

There are a number of other stakeholders that should be engaged in the implementation process including local researchers and academic institutions, coastal engineers and consultants, private landowners, and local residents. These stakeholders can provide valuable input to the Plan implementation process through a variety of means. Local researchers and academic institutions can provide scientific expertise and complete studies that support planning for and implementation of the recommendations in this Plan. Coastal engineers and consultants that are involved in planning and carrying out of local coastal protection and beach restoration projects can provide relevant expertise and project-specific information. The involvement from the local residents and recreational beach users can provide very useful site-specific information and a perspective that agencies and local jurisdiction may not otherwise be aware of.

9.4 Develop and Implement an Outreach and Education Program

Education and outreach is a crucial component of Plan implementation that usually consists of a program to inform stakeholders of emerging issues, proposed RSM measures, and opportunities for involvement. It also should include a system for distributing newly available scientific information pertaining to the Santa Cruz Littoral Cell. The first recommended step associated with implementing this Plan would be to initiate focused outreach efforts on the Plan itself, including an explanation of what constitutes the Plan, why it was developed, and how it could be carried out. This could include public workshops to introduce the Plan, presentations to local governmental organizations, and individual meetings with stakeholders. This Plan recommends partnering with the CSMW on these initial education and outreach efforts including holding at least two public workshops and individual meetings with key stakeholders and decision makers.

In addition to the initial outreach efforts, it is also recommended to assess options for and to establish a long-term ongoing outreach and education program to ensure stakeholder coordination and input. Determining which options for education and outreach are feasible depends on the degree of available funding and staffing resources. For example, at the very basic end of the scale, there could be a modest effort that involves maintaining a stakeholder outreach list and distributing new information as it becomes available (e.g., new reports and studies and announcements for opportunities for public involvement). At the more involved end of the scale, there could be a staffed program that includes a process for convening stakeholder meetings and workshops and developing and distributing an array of outreach products (e.g., fact sheets and brochures).

As is the case with the other recommended activities in the Plan, outreach will require funding and staffing resources that are currently not available. As part of the process to develop a governance structure, funding and staffing requirements should be evaluated for a variety of different education and outreach options.

9.5 Establish and Maintain a Dedicated Funding Source

Funding can be obtained from local, regional, state, federal, or private sources. Because state and federally funded projects will almost always require local matching funds from the project proponent, developing a local funding source for Plan implementation is critical to leveraging these state and federal resources.

Local governments in the Santa Cruz Littoral Cell region currently do not budget for significant RSM projects and programs. Therefore, any level of implementation of the Plan will require a dedicated source of funding to carry out its recommended activities. Near-term funding would need to be acquired for initial implementation of this Plan, including stakeholder outreach efforts and coordinating with local municipalities on developing a governance structure. Funding would also be required on an ongoing basis for staffing resources, conducting feasibility and engineering studies, environmental review and permitting costs, outreach and stakeholder coordination, and the actual construction of RSM projects.

A recommendation of this Plan is to work with local jurisdictions to identify and assess funding options for RSM activities and implementation of this Plan. Once options have been evaluated and prioritized, it is also recommended to collaboratively pursue those sources that are most promising and establish a dedicated fund and administrative process for implementing this Plan.

9.5.1 Federal Funding Sources

The USACE is the primary federal agency constructing shoreline-protection projects. Funds are available for a wide array of projects that are not limited to beach nourishment or large-scale structural alternatives. For example, USACE can participate in managed retreat projects. Funding mechanisms within USACE consist of two major programs. One is the Continuing Authorities Program (CAP), which allows USACE to study and construct projects without additional authorization from Congress. Project costs are generally capped at $5–10M federal expenditure. The other is the General Investigation (GI) Study, whereby USACE conducts a feasibility study that may recommend a larger project for authorization (i.e., a project costing more than CAP program funding limits). All projects constructed by USACE will require a non-federal sponsor, a feasibility study prior to implementation (unless directed by a member of Congress to move ahead with the project), and the required NEPA environmental documentation.

The USFWS is another potential federal funding source. It administers a variety of natural resource assistance grants to governmental, public and private organizations, groups, and individuals. One possible source of funding assistance for projects that restore wildlife habitat (e.g., beach restoration) is the Cooperative Conservation Initiative. This program provides funding for projects that restore natural resources and establish or expand wildlife habitat. A 50% match is required of the project sponsor. Another potential source is the Cooperative Endangered Species Conservation Fund, which provides funding for implementation of conservation projects or acquisition of habitat that will benefit federally listed threatened or endangered species. The required match by the local sponsor for this program is 25% of estimated project cost (in-kind contributions are accepted).

9.5.2 State Funding Sources

Most state funding for beach restoration projects comes from DBW, which is the agency in California with principal responsibility for protecting public coastal infrastructure and restoration of eroded beaches. Grant funding is available from DBW for beach restoration projects, although there are usually only limited funds available. When state funding is available, DBW issues grants under two programs: Public Beach Restoration (PBR) and Beach Erosion Control (BEC). The program allows for 100 percent funding of project construction costs for beach nourishment at state parks and state beaches and up to 85 percent for projects at non-state beaches (local sponsor provides 15 % match, either money or in-kind services). The BEC Program focuses more on structural solutions such as groins or breakwaters, but the newer PBR focuses more on restoration projects such as beach nourishment. The PBR program can fund beach restoration and nourishment projects, or feasibility or research studies. Grant amounts entirely depend on fund availability at the state level. A local match is usually required and can be either cash or in-kind services. CEQA documentation must be submitted with grant applications, and public beach access must be adequately addressed by the project.

The SCC is a state agency that uses entrepreneurial techniques to purchase, protect, restore, and enhance coastal resources, and to provide access to the shore. The SCC works in partnership with local governments, other public agencies, nonprofit organizations, and private landowners. It has carried out more than 1,000 projects along the California coastline and in San Francisco Bay. The SCC funds shoreline protection projects that are consistent with the goals of California's Coastal Act. Similar to DBW grants, the availability of SCC grant money depends entirely on the availability of funds (i.e., recent bond measures). The SCC can fund pre-project feasibility studies, property acquisition, planning (for large areas or specific sites), environmental review, construction, monitoring, and maintenance – in limited cases. Funding from SCC grants ranges from $10,000 to several million dollars depending upon fund availability and the "need, significance, and urgency of the project." Potentially relevant funding programs include: Urban Waterfronts, Wetlands, Site Reservation, Resource Enhancement, and Case Studies. One example of SCC funding for CRSMP implementation includes providing BEACON with a $200,000 grant to complete engineering feasibility studies, site reconnaissance, permitting, and related administrative tasks, of a beach restoration project in Goleta Beach.

Another potential source of future funding for CRSMP implementation is fees collected by the CCC through the CDP process (from special conditions on individual permits requiring mitigation fees). For example, in the San Diego region the CCC and SANDAG entered into a cooperative agreement by which a Public Recreation Beach Impact Mitigation Fund (seawall fees) was developed to make money available for projects that enhance public recreation access. It is possible that a similar fund could be established within the Santa Cruz Littoral Cell Region to help fund certain beach restoration projects.

9.5.3 Local Funding Sources

Securing any major state and federal funding for CRSMP implementation requires a local source of matching fund. There are several options available, and a local funding strategy could consist of any combination of the following possibilities.

Cost sharing among project beneficiaries: In this strategy the local share of the cost of a project is distributed among the various entities that benefit from that project. In this case the cost could be divided in proportion to the total benefits attributed to each group (e.g., by the value of the property and the risk being averted). For example, for a project in the Santa Cruz Littoral Cell Region, the local costs may be borne by a city or cities, a county, the private landowners, and other potentially affected parties (e.g., DPR, Caltrans, and Harbor Districts).

Ad Valorem Taxes: These are taxes levied on the price of a good or service that are equal to a certain percentage of the price. These taxes are typically assessed on real estate such as with Real Estate Transfer taxes when a property exchanges hands. Ad Valorem taxes are commonly used in the State of Florida.

Special Assessments: The local government would place assessments on properties that would receive a higher proportion of the benefits derived from the project. For example private property at high-risk of erosion damage would be required to pay a special fee that would not be required of other properties that are not at risk and proportionally higher than those that are at moderate or low risk. In Florida, for example, the state assesses a tax based upon the distance of the structure from the beach.

City or County General Revenue Funds: Funds may also be available from the general funds of the local jurisdictions or counties.

Transient Occupancy Taxes: TOTs are hotel taxes that are levied on visitors. These taxes in fact are the primary source of local funding in several East Coast states that have well-established beach nourishment programs (e.g., Florida and New Jersey), and have recently been implemented by some municipalities in Southern California.

User Fees: Many local municipalities on the East Coast and in Southern California have turned to user fees as a source of funding for beach restoration projects. This can include parking or beach use fees, which are often levied on visitors but not required of local residents. For example the City of Del Mar charges for parking in most areas near the beach.

9.5.4 Private Funding Sources

In addition to government funding there are opportunities for private sources of funding. A number of private foundations may provide funding for CRSMP planning efforts and shoreline restoration projects. An initial list of potential private non-profit funding sources includes: the Resources Legacy Fund (RLF); Packard Foundation; Alfred P. Sloan

Foundation; Kresge Foundation; Moore Foundation, and; the William and Flora Hewlett Foundation. These, and other private sources, should be investigated as a source of funding for initial Plan implementation and outreach as well as ongoing RSM projects and coordinated planning efforts.

Geologic Hazard Abatement Districts (GHADs) and Homeowners Associations (HOAs) are two types of private property owner organizations that could be involved in planning and funding of local RSM projects that protect private property under their sphere of influence. GHADs were created to enable local residents to collectively mitigate geological hazards, such as coastal erosion, which pose a threat to their properties. HOAs are organizations comprised of local property owners within a designated planned unit development, neighborhood, or other self-designated entity, which have been chartered as an organization subject to certain bylaws and mandatory membership.

9.6 Investigate and Pursue Options for a Streamlined Permitting Program

The permitting system for RSM projects can be lengthy and complex, involving numerous federal and state agencies that issue permits or other legal approvals. This Plan recommends developing a strategy with USACE, the MBNMS, the CCC, local jurisdictions, and other regulatory agencies to identify options for and pursue a regional streamlined permitting program. Such a program would benefit parties that are seeking permits for proposed RSM projects as well as the permitting and resource agencies that are reviewing these projects and making permitting decisions. It would minimize duplication of effort and allow agencies to better address their concerns and develop mitigation measures to ensure that projects do not result in significant impacts.

Developing a streamlined permitting program has been a common recommendation in each of the completed CRSMPs. As such, many of the corresponding regions have implemented or are in the process of developing such a program. For example, the San Diego CRSMP recommended pursuing General Permits for all agencies and has since adopted a pilot SCOUP for the region. The Southern Monterey Bay CRSMP recommended developing a SCOUP for the region; however, to date, progress has not been made on this effort.

Because of the large size of the Santa Cruz Littoral Cell region and the overlapping of multiple geopolitical boundaries and jurisdictions, developing a streamlined permitting program is no easy task. Developing such a program would involve clarifying roles and level of involvement of each agency in projects and planning and developing review thresholds, identifying consistent permit conditions and authorization criteria, preparing the appropriate studies and environmental documentation, and obtaining needed agreements and permits from each agency. A variety of different mechanisms for permitting coordination could potentially be pursued for the region and the costs and benefits of these should be further explored. Options include developing a SCOUP, and pursuing a USACE Regional General Permit or a regional permit from the CCC. To develop a streamlined RSM permitting program for the Santa Cruz Littoral Cell region it is recommended, during the initial plan implementation phase, to meet individually with each of the permitting and resource agencies described in this Plan. The purpose of these initial meetings would be to identify and further assess the mandates, resource protection concerns, and permitting requirements of each agency and discuss opportunities for permitting collaboration. This information would be used to develop a detailed permitting roadmap for the various potential RSM measures being recommended in this Plan. To facilitate this collaborative process, regional jurisdictions should consider establishing a committee made up of the permitting and resource agencies and local jurisdictions to assess options, define roles, and agree upon and pursue a regional permitting program that meets the specific needs of the region.

The regional permitting program should also address performance monitoring and program evaluation to determine the effectiveness of individual RSM projects and the RSM program as a whole. Pre- and post-implementation project monitoring would help to determine whether any adverse impacts have occurred as a result of the project. Those findings could then be used to help guide future project planning and permitting decisions.

As part of the permitting streamlining efforts, this Plan also recommends collaborating with the MBNMS, the CCC, and other state and federal resource agencies to develop science-based resource protection guidelines aimed at avoiding and mitigating potential environmental impacts of sediment management projects in the region. Through the regional permitting program, these guidelines could be applied to projects in the region as permit conditions to avoid environmental impacts. The guidelines would address site evaluations including sediment grain sizes, sand transport patterns, and potential impacts that may result from beach nourishment and other RSM measures. As part of an adaptive management approach, these guidelines would be updated as needed based on new scientific data, operational practices, and monitoring results from local RSM projects implemented as part of this Plan.

9.7 Potential Plan Implementation Tasks

A partial-list of specific work tasks that could be pursued as part of the Plan-implementation process is included below. This list includes recommended next steps that would be required in the near term during the initial phases of implementation and outreach efforts, as well as potential options for short-term, long-term, and ongoing implementation actions. Many of these potential tasks identified below are described in more detail above in this section and throughout this Plan.

9.7.1 Recommended Next Steps

The following tables (Table 9-1 to Table 9-6) provides a partial-list of recommended next steps that would be required in the near term during the initial phases of implementation and outreach efforts, as well as potential options for short-term, long-term, and ongoing implementation actions. The options identified in these tables should not be considered a complete inventory of potential implementation actions. Rather the tables should be viewed as initial lists of potential options that can provide a basis for discussion during initial outreach and stakeholder collaboration efforts.

Table 9-1: Tasks for developing a governance structure for RSM plan implementation

Recommended Next Steps	Potential Short Term Implementation Tasks
Begin an evaluation of options for governance structure, including considerations for potential lead agencies and partners, and processes for decision-making and information sharing.	Work with local jurisdictions to review and assess options for a proposed governance structure.
--	Reach agreement among key players on a preferred RSM governance structure.
--	Establish the roles of each participating party as well as any advisory workgroups or decision-making committees.
--	Develop a coordination mechanism among participating stakeholders that clearly states roles and responsibilities and a decision making process.
--	Formally adopt regional governance structure, or implementation strategy, by executing an agreement among collaborators.

Table 9-2: Tasks for establishing a process for RSM stakeholder coordination

Recommended Next Steps	Potential Short Term Implementation Tasks	Potential Long Term and Ongoing Implementation Tasks
Develop a comprehensive list of potential partners and stakeholders and identify their possible roles in plan implementation.	Begin discussions with the key partners and local jurisdictions involved in plan implementation to evaluate options and pursue a stakeholder coordination program for the Plan.	Maintain cross-jurisdictional coordination with agencies and municipalities, and continue to coordinate and facilitate meetings of advisory groups.
Connect with the relevant stakeholders, including agencies and local municipalities, to provide information about the Plan, discuss potential opportunities for collaboration, and assess their interest in participation.	Establish commitments from local jurisdictions and other potential stakeholders that decide to actively participate in Plan implementation, and articulate the responsibilities of each participant.	--
Reconvene the SAG that was formed for the development of this Plan for meetings to: present the final Plan; initiate discussions on RSM options; solicit recommendations on initial plan implementation, and; discuss the possibility of and options for the workgroup playing a permanent role in ongoing implementation of the Plan.	Coordinate with RSM project planners, regulatory permitting agencies, natural resource agencies, and researchers to plan for project implementation, monitoring, and evaluation.	--

Table 9-3: Tasks for developing and implementing an outreach and education program

Recommended Next Steps	Potential Short Term Implementation Tasks	Potential Long Term and Ongoing Implementation Tasks
Coordinate with the CSMW on initial plan implementation and stakeholder outreach strategies.	Develop an ongoing education and outreach program to ensure stakeholder coordination and input, to present new scientific information about RSM issues such as coastal erosion and sedimentation, to provide updates on the CRSMP process, and to solicit public comments	Maintain, and update, as needed, a long-term ongoing outreach and education program to ensure stakeholder coordination and input on Plan implementation.
Establish a list of prioritized initial outreach actions and identify existing CSMW outreach products and tools that could be used to support initial implementation of the Plan.	--	Continue outreach efforts to inform and educate decision makers, natural resource management agencies, planners, recreational users, and the general public of RSM issues and recommended RSM actions.

RECOMMENDED NEXT STEPS	POTENTIAL SHORT TERM IMPLEMENTATION TASKS	POTENTIAL LONG TERM AND ONGOING IMPLEMENTATION TASKS
Initiate focused outreach efforts by providing presentations to local governmental organizations, and holding individual meetings with stakeholders. Provide an explanation of what the Plan consists of, why it was developed, and how it could be carried out.	--	--
Partner with the CSMW to host at least two public workshops once the Plan has been finalized – one in Santa Cruz and another in Half Moon Bay – to present the final Plan and obtain input on initial implementation.	--	--
Develop and implement an initial outreach and education strategy to get the Plan into the hands of stakeholders that will use it and to ensure their input on RSM issues and plan implementation.	--	--

Table 9-4: Tasks for establishing and maintaining a dedicated funding source

RECOMMENDED NEXT STEPS	POTENTIAL SHORT TERM IMPLEMENTATION TASKS	POTENTIAL LONG TERM AND ONGOING IMPLEMENTATION TASKS
Seek near-term funding to establish a new staff position within an existing agency, municipality, or other organization to coordinate initial plan implementation.	Undergo a coordinated process to assess funding options for implementing the Plan recommendations.	Maintain a dedicated source of funding and seek funds for ongoing plan implementation. Secure funding for ongoing implementation of the actions in the Plan.
--	Develop a funding strategy and establish a means to administer and seek funding and enter into contracts to conduct studies and collaborative planning efforts.	--

Table 9-5: Tasks for developing a streamlined RSM permitting program

RECOMMENDED NEXT STEPS	POTENTIAL SHORT TERM IMPLEMENTATION TASKS	POTENTIAL LONG TERM AND ONGOING IMPLEMENTATION TASKS
Begin to develop a detailed permitting roadmap and explore options for a streamlined regional RSM permitting program.	Meet individually with each of the permitting and resource agencies described in this Plan to identify and further assess the mandates, resource protection concern, and permitting requirements of each	Work with USACE, the MBNMS, the CCC, local jurisdictions, and other regulatory agencies to address permitting issues and establish a streamlined regional permitting program.

	agency and discuss opportunities for permitting collaboration.	
--	--	Collaborate with the MBNMS, the CCC, and other state and federal resource agencies to develop science-based resource protection guidelines aimed at avoiding and mitigating potential environmental impacts of sediment management projects in the region.

Table 9-6: Miscellaneous RSM plan implementation tasks

RECOMMENDED NEXT STEPS	POTENTIAL SHORT TERM IMPLEMENTATION TASKS	POTENTIAL LONG TERM AND ONGOING IMPLEMENTATION TASKS
Meet with resource management and permitting agencies, local municipalities, and other jurisdictions to discuss options for integrating aspects of the Plan with other local and regional plans, policies, and processes and to ensure that recommended RSM actions are consistent with existing policies, regulations, and missions.	Review scientific information compiled for this Plan and identify information gaps and potential additional studies that would support the CRSMP process or would be required for implementation of the specific RSM recommendations in the Plan. Then prioritize and pursue studies if necessary.	Identify ongoing information needs and oversee studies and grants as required.
Identify short-term and long-term staffing requirements necessary for Plan implementation, and coordinate with key stakeholders to evaluate and prioritize options and develop a staffing plan addressing immediate needs and ongoing Plan implementation	Conduct physical and biological monitoring prior to project construction to develop a baseline for comparison of potential effects, and during and after construction to quantify changes and identify potential issues.	Continue ongoing phased implementation of the Plan by implementing specific Plan activities, as prioritized, when funding is available.
Consider establishing an interim CRSMP implementation committee consisting of representatives from agencies and jurisdictions that are directly involved in RSM project planning, implementation, or permitting within the Santa Cruz Littoral Cell region, to provide guidance and make decisions on the initial implementation process	Begin discussions with decision makers from each stakeholder group on collaborative options for long-term implementation of the CRSMP, including development of a governance structure, stakeholder coordination and outreach, funding opportunities, and a regional permitting program	Continue to track and assess emerging technologies and RSM practices for addressing coastal erosion hazards and update plan and background documents as necessary.
--	Collaborate with key players to develop a Strategic Implementation Plan for this CRSMP.	Conduct ongoing project monitoring and periodically evaluate the effectiveness of the RSM program and its individual projects to identify successes, potential issues, and areas for improvement.

Recommended Next Steps	Potential Short Term Implementation Tasks	Potential Long Term and Ongoing Implementation Tasks
--	--	Monitor critical erosion areas and corresponding threats to development, and add new sites or remove old ones from list as necessary.
--	--	Track recent research and data and update the Plan as needed to reflect the best available science. Also update related resources, if necessary, such as background reports, GIS databases, outreach materials, and decision-making tools
--	--	Integrate Plan considerations into local policies and plans as they are revised or updated as well as coastal planning processes and operations of agencies and jurisdictions

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A. APPENDIX A: SPECIAL STATUS SPECIES

A.1. FISH

Several special status fish are present in the littoral cell, included resident tidewater gobies managed by the USFWS and anadromous fish (i.e., sturgeon and salmonids) managed by NMFS. In addition, the entire littoral cell is considered EFH for commercially-fished species, including certain species of salmonids, groundfish, and pelagic fish. The NMFS administers EFH in the littoral cell.

A.1.1. Tidewater Goby (*Eucyclogobius newberryi*) (FE, CH)

Tidewater goby is a short-lived, small (2 inches long), elongate, gray-brown fish found in brackish water along the California Coast. They typically only live one year.

Listing Status: The USFWS listed the tidewater goby as endangered in February 1994 (59 Fed. Reg. 5494); however, downgrading the designation to threatened is currently being considered (79 Fed. Reg. 14340). Critical habitat was initially designated in November 2000 (65 Fed. Reg. 69693), and revised in 2008 (73 Fed. Reg. 5920) and February 2013 (78 Fed. Reg. 8745).

Range: Tidewater goby ranges from the mouth of the Smith River in Del Norte County south to Cockleburr Canyon in northern San Diego County.

Life Cycle and Habitat Use: The majority of stable populations are found in lagoons and estuaries, ranging from 5 to 125 acres, with little human interference. They are found in salinities ranging from fresh water to salinities of about 28 parts per thousand. But, they prefer salinities ranging from 10 to 12 parts per thousand (78 Fed. Reg. 8745). Although they can tolerate a wide range of salinity and water-quality conditions, they flourish in calm waters closed off to the ocean by sandbars.

In the littoral cell, it is believed that two metapopulations[4] exist from Baldwin Creek south to Moore Creek, just north of Natural Bridges State Beach (southern half of Reach 5, Figure 5-4) and Corcoran Lagoon and Moran Lake (Reach 6, figure 5). They are also found in Pescadero Creek in San Mateo County, Waddell Creek in Santa Cruz County, and the San

[4] Metapopulation is basically a population of subpopulations. It is defined as a group of distinct populations that are genetically interconnected through occasional exchange of animals. While individual populations may be periodically extirpated, metapopulations are likely to persist through colonization or recolonization to establish new populations (USFWS 2007).

Lorenzo River system and may be present in other areas of the littoral cell, such as the Elkhorn Slough system.

Spawning occurs year round, peaking in late April or May, through July; however, they are not known to spawn in December. Spawning takes place in waters ranging from 9 to 25 degrees Celsius (48 to 77 degrees Fahrenheit) and salinities ranging from 2 to 27 parts per thousand (USFWS 2007). In April or May, prior to spawning, males dig breeding burrows in clean, unconsolidated sand after lagoons close to the ocean from sandbar formation.

Prey and Foraging: The Tidewater goby feeds on macroinvertebrates, such as shrimp and aquatic insects.

Threats: Tidewater gobies are threatened by habitat destruction and modification, including loss of coastal wetland habitat; drought; and hydrologic changes including channelization, water diversions, and groundwater pumping. Sandbar breaching, disease, and predation also adversely affect gobies (USFWS, 2007).

Critical Habitat: Critical habitat was initially designated in 2000 and revised in 2013. Designated critical habitat includes 65 units totaling 12,156 acres in California, spanning from Del Norte to San Diego Counties (78 Fed. Reg. 8745). Thirteen critical habitat units totaling 940 acres are present in the littoral cell, all of which are currently occupied by gobies. The units are listed in Table A-1.

Table A-1: Tidewater goby critical habitat

County	Reach	Unit Name	Area (acre)	Figure
San Mateo County	3	SM-1: San Gregorio Creek	45	Figure 5-2
	3	SM-2: Pomponio Creek	7	Figure 5-2
	3 and 4	SM-3: Pescadero-Butano Creek	245	Figure 5-2 and Figure 5-3
	4	SM-4: Bean Hollow Creek	10	Figure 5-3
Santa Cruz County	5	SC-1: Waddell Creek	75	Figure 5-4
	5	SC-2: Scott Creek	74	Figure 5-4
	5	SC-3: Laguna Creek	26	Figure 5-4
	5	SC-4: Baldwin Creek	24	Figure 5-4
	5	SC-5: Moore Creek	15	Not shown
	6	SC-6: Corcoran Lagoon	28	Figure 5-5
	7	SC-7: Aptos Creek	9	Figure 5-6
	7	SC-8: Pajaro River	215	Figure 5-6
Monterey County	7	MN-1: Bennett Slough	167	Figure 5-6

Source: 78 Fed. Reg. 8745

Critical-habitat primary constituent elements include aquatic habitats with persistent, shallow (0.3 to 6.6 feet deep), still-to-slow-moving waters in lagoons, estuaries, and coastal streams with salinities up to 12 parts per thousand. These areas must have suitable substrates for burrow construction, submerged and emergent aquatic vegetation cover, and a sandbar across the mouth of the water body in the late spring, summer, and fall that either closes or partially closes thereby providing relatively stable water (78 Fed. Reg. 8745)

A.1.2. Southern DPS Green Sturgeon (*Acipenser medirotris*) (FT, CH, SSC)

Listing Status: On April 7, 2006, the Southern Distinct Population Segment (DPS) of the North American green sturgeon (*Axipenser medirostris*) was listed as threatened by NMFS (71 Fed. Reg. 17757). Critical habitat for green sturgeon was designated on October 9, 2009 (74 Fed. Reg. 52300). Green sturgeon is also considered a species of special concern by the CDFW (CDFG 2009b).

Range: Green sturgeon are found in nearshore marine waters ranging from Mexico to the Bering Sea. They are common in bays and estuaries along the west coast of the Americas. The North American green sturgeon comprise two genetically distinct population structures (DPS), the Northern DPS (Klamath and Rogue River spawning populations) and Southern DPS (Sacramento River spawning populations) (68 Fed. Reg. 4,433; NMFS, 2005). The range of Southern DPS green sturgeon was thought to be within the coastal waters south of the Eel River through Mexico. But, adults travel as far north as Canada (NMFS 2008a). San Francisco Bay and its tributaries are thought to contain a majority of the Southern DPS green sturgeon populations.

Life Cycle and Habitat Use: Green sturgeon are long-lived, slow growing and iteroparous. They spawn every three to five years. Adults typically migrate to freshwater in the upper Sacramento River beginning in late February, and spawning occurs from March through July. Peak spawning occurring from mid-April through mid-June in freshwater. Green sturgeon generally spawn in their natal stream and appear to have high homing capabilities for spawning grounds. Historically, spawning occurred in areas above Shasta Dam and in the Feather River. Following the construction of Shasta and Oroville Dams, green sturgeon were not able to migrate farther upstream (NOAA Fisheries, 2005a). Spawning occurs in deep pools with large cobble substrate; however, spawning also occurs on clean sand and bedrock substrate.

Mature males range from 55 to 78 inches fork length at 15 to 30 years of age; mature females, on the other hand, range from 62 to 92 inches fork length at 17 to 40 years of age. Generally, spawning occurs at 63 to 67 inches fork length for males (17 to 18 years old) and 72 to 76 inches fork length for females (27 to 28 years old) (68 Fed. Reg. 4433). Females produce approximately 60,000 to 140,000 eggs that are spawned over cobble substrate where they settle in the spaces between cobbles. Water temperatures must be less than 68 °F for the eggs to be viable.

After spawning, adults may hold between June and November in deep pools near spawning grounds and outmigrate in the late fall to early winter, or they may directly outmigrate in the late spring to early summer after spawning. In the Sacramento River, adult green sturgeon may be present through November and December before moving downstream with increased flows (68 Fed. Reg. 4433).

Green sturgeon larvae begin feeding approximately 10 to 15 days after hatching, and approximately 35 days later metamorphose into juveniles.

Juveniles spend approximately one to three years in freshwater before moving to the ocean. Following outmigration from freshwater, green sturgeon disperse widely in ocean waters and coastal estuaries. Tagging studies indicate that the Southern DPS green sturgeon migrate extensively in ocean waters and are located in waters off the Oregon and Washington coasts.

Prey and Foraging: Juveniles in the San Francisco-San Joaquin Delta feed on opossum shrimp and amphipods (68 Fed. Reg. 4433). Adult green sturgeon feed on benthic invertebrates including shrimp, mollusks, amphipods, and small fish (68 Fed. Reg. 4433).

Threats: The biggest threat to green sturgeon is loss of spawning habitat in the upper Sacramento River. Insufficient freshwater flows in spawning areas, contaminants, bycatch in fisheries, poaching, entrainment in water projects, exotic species, impassable barriers at other locations, and elevated water temperatures may also pose a threat to green sturgeon.

Critical Habitat: Critical habitat for green sturgeon was designated on October 9, 2009 (74 Fed. Reg. 52300) (Figure 5-2). Critical habitat includes freshwater riverine systems, including the stream channels and the lateral extent defined by the ordinary high-water line (33 C.F.R § 329.11) or bankfull elevation, where the ordinary high water mark is not defined and all United States coastal marine waters out to the 60 fathom (360 foot) depth boundary line (relative to MLLW), from Monterey Bay, California north and east, including the Straits of Juan de Fuca, Washington. Riverine stream systems include areas within the Sacramento River, including waters encompassed by the Yolo Bypass and Sutter Bypass areas, and the lower American; portions of the Lower Yuba River and Lower Feather River; the Sacramento–San Joaquin Delta waterways up to the elevation of mean higher high water, San Francisco Bay, San Pablo Bay, Suisun Bay, and Humboldt Bay, California; Coos Bay, Winchester Bay, Yaquina Bay, Nehalem Bay, and the Lower Columbia River Estuary, Oregon; and Willapa Bay and Grays Harbor, Washington. The marine areas of the entire littoral cell are within green sturgeon critical habitat.

Green sturgeon primary constituent elements include various components of freshwater, estuarine, and nearshore marine habitats. Components include food resources, substrate for spawning, water flow, water and sediment quality, water depth, and migratory corridor. Nearshore coastal marine areas are the only primary constituent element within the littoral cell. This habitat includes coastal marine areas with adequate migratory corridors, water quality, and food resources.

A.1.3. Pacific Salmonids

All marine salmonid species are managed by NMFS and the CDFW. The EFH of commercially fished species of salmonids (i.e., coho, Chinook, chum, and pink) is managed under the Magnuson-Stevens Fishery Conservation and Management Act. In addition, many species of salmonids are listed as threatened or endangered under the federal and state ESAs.

Salmonids have similar life strategies – they are anadromous fish that migrate from ocean waters to freshwater rivers and streams to spawn. Eggs hatch in freshwater spawning grounds as larvae. Once larvae mature, they migrate downstream to estuarine rearing grounds, and ultimately to the ocean to grow. Although these fish share similar life strategies, salmonids are grouped into evolutionary significant units (ESU). An ESU is a Pacific salmon population or group of populations that is substantially reproductively isolated from other salmon populations. It represents an important part of the evolutionary legacy of the species. In concept, an ESU is a distinct population segment of a larger population of the same species.

A salmonid population could be reproductively separated by two mechanisms: their spawning grounds are geographically separated (i.e., fish spawn in different rivers and creeks), or fish are grouped into separate ‘runs’, which migrate or ‘run’ to freshwater spawning grounds at various times of the year. Different runs of salmonids typically do not spawn with other runs because they are temporally removed (i.e., one run is spawning in freshwater while other runs are still at sea).

Three salmonid runs are present in the littoral cell, including south-central California coastal steelhead, central California coastal steelhead, and central California coastal coho. Because salmonid life cycles are similar, this section presents an overview of the typical salmonid life cycle, habitat use, prey and foraging, threats, and critical habitat. Specific differences between the salmonid species are discussed under the respective section of the species.

Range: Pacific salmonids are present throughout the Pacific Coast of the Americas. They range from Alaska south to Baja California, Mexico. Specific ESUs may be present in waters throughout the Pacific Ocean off the west coast of the Americas; however, each ESU has a much smaller range where spawning occurs.

Life Cycle and Habitat Use: Once at spawning grounds, adults pair to lay and fertilize thousands of eggs in gravel or cobble nests, or redds. With the exception of steelhead, adult salmonids typically die after spawning. Steelhead may spawn more than once. Eggs incubate for several weeks to months, depending on temperature, before hatching. Newly hatched larvae, or alevins, remain in the gravel nests feeding on food stored in yolk sacs. When the yolk sacs absorb, the alevins emerge from their gravel nests as young juveniles, or fry.

Juveniles spend anywhere from a few hours to several years in freshwater rearing grounds before migrating to the ocean (steelhead may spend up to 7 years in freshwater). As fish migrate from freshwater to saltier water, physiological and behavior changed take place allowing fish to tolerate saltier water—at this point, fish are called smolts.

Juveniles and young adults spend anywhere from 1 to 5 years foraging and maturing in marine waters before migrating back to their native freshwater spawning grounds to spawn. Spawning migrations occur year round and different spawning migrations are known as runs (e.g., spring runs, winter runs, summer runs, and fall runs).

Estuarine and riparian habitats are important components of salmonid habitat. A productive estuarine habitat is necessary for juvenile rearing and feeding. Riparian habitat is important because it provides shade for juveniles and migrating adults, both of which are sensitive to high temperatures. Juveniles also need adequate cover to hide from predators, such as downed logs, root wads, and boulders in streams. They also need areas of slow-moving water to seek refuge from high flows.

Prey and Foraging: Larvae (alevins) salmonids feed on yolk sacs attached to their bodies. When the yolk sac absorbs, young juveniles (fry) begin feeding on insects, crustaceans, and other small fish. Adult fish feed on fishes in the ocean. During freshwater migration, adults do not typically feed; rather, they subsist on stored energy.

Threats: Salmonids have experienced dramatic population declines for a variety of reasons. Construction of dams, which has drastically reduced spawning habitat, is considered one of the biggest threats. Other threats include: modification of natural flows and resource extraction, both of which has altered temperatures, gravel supply, and other physical features have also adversely affected salmonids. Disease, predation, and overfishing have also reduced populations.

Critical Habitat: Critical habitat for Pacific salmonids includes streams, rivers, and estuarine habitat necessary for all life stages of salmonids. The lateral extent of streams and rivers is the ordinary high water line as defined by the USACE in 33 C.F.R. § 329.11. If the ordinary high water line is not delineated, critical habitat includes the width of the stream channel defined by its bankfull elevation. In estuarine waters, the lateral extent of critical habitat is extreme high water (70 Fed. Reg. 52488).

Primary constituent elements of salmonid critical habitat include:

- Freshwater spawning sites with adequate water quality, quantity, and substrate to support spawning, incubation, and larval development.

- Freshwater rearing sites with adequate water quality and floodplain connectivity to provide suitable physical and foraging conditions. This includes riparian habitat, submerged and overhanging woody debris, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

- Freshwater migration corridors free of obstruction, with suitable water quality and quantity, as well as riparian habitat and other cover structures (e.g., woody debris, aquatic vegetation, etc.).

- Estuarine areas free from obstruction, with adequate water quality, quantity, and salinity conditions to support juvenile and adult physiological transitions between freshwater and saltwater.

- Nearshore marine areas free of obstruction with suitable water quality, quantity, and forage conditions.

- Offshore marine areas with suitable water quality and foraging conditions.

A.1.3.1. South-Central California Coastal Steelhead ESU (*Oncorhynchus mykiss)* (FT) (CH)

South central California coastal steelhead grow up to 45 inches long and 55 pounds, but are typically, much smaller. They live up to 11 years and are sexually mature between 2 and 3 years. Unlike other salmonids, not all steelhead migrate to the marine environment. Some steelhead spend their entire life in freshwater; these steelhead are referred to as rainbow trout. In addition, they are iteroparous as they spawn more than once.

Listing Status: South Central California Coastal (SCCC) steelhead was originally listed as endangered in August 1997 (62 Fed. Reg. 43937); this listing was downgraded to threatened in January 2006 (71 Fed. Reg. 834). Critical habitat was initially designated in February 2000 (65 Fed. Reg. 7764), and updated in September 2005 (70 Fed. Reg. 52488).

Range: South-central California coastal steelhead inhabit waters in the North Pacific Ocean, from the Kamchatka Peninsula in Asia to the northern Baja Peninsula (79 Fed. Reg. 42687). They are known to spawn in creeks and rivers in Monterey Bay to southern San Luis Obispo County. Fish are found in major rivers throughout this region, including the Big Sur, Carmel, Little Sur, Pajaro, and Salinas Rivers.

Spawning Migration Run: There are two types of steelhead spawning runs, summer and winter. Summer run adults, referred to as stream-maturing steelhead, enter freshwater between May and October, and require several months to mature before spawning. Winter run adults, referred to as ocean-maturing steelhead, enter freshwater between November and April. They have well-developed gonads and spawn shortly after. Coastal streams are dominated by winter-run steelhead. The South-Central coastal steelhead is considered winter-run.

Critical Habitat: Critical habitat includes streams, rivers, and estuarine habitat necessary for all life stages of salmonids. The lateral extent of streams and rivers is the ordinary high water line as defined by the United States Army Corps of Engineers in 33 C.F.R. § 329.11. If the ordinary high water line is not delineated, critical habitat includes the width of the stream channel defined by its bankfull elevation. In estuarine waters, the lateral extent of critical habitat is extreme high water (70 Fed. Reg. 52488).

South-Central California coastal steelhead critical habitat includes 1,249 miles of streams and 3 square miles of estuarine habitat, from the Pajaro River (inclusive) to the Santa Maria River, which is not included in the critical habitat designation. Rivers within the littoral cell which are considered critical habitat include:

Pajaro River (adjacent to BECA 19: Pajaro Dunes) and

Elkhorn Slough (BECA 20: Moss Landing / Elkhorn Slough).

A.1.3.2. Central California Coastal Steelhead ESU (Oncorhynchus mykiss) (FT, CH)

Listing Status: The central California coastal steelhead ESU was originally listed as threatened in August 1997 (62 Fed. Reg. 43937), and reaffirmed in January 2006 (71 Fed. Reg. 934). Critical habitat was initially designated in February 2000 (65 Fed. Reg. 7764), and updated in September 2005 (70 Fed. Reg. 52488).

Spawning Migration Run: The Central California coastal steelhead is considered winter-run; fish enter freshwater between November and April.

Range: Central California coastal steelhead ESU inhabits waters in the North Pacific Ocean, from the Kamchatka Peninsula in Asia to the northern Baja Peninsula (79 Fed. Reg. 42687). They are known to spawn in rivers and creeks from the Russian River to Aptos Creek. Major populations are found in the Russian and San Lorenzo Rivers (70 Fed. Reg. 52488).

Critical Habitat: Central California coastal steelhead critical habitat includes 1,465 miles of streams and 386 square miles of estuarine habitat. This includes all naturally spawned populations of steelhead in coastal streams from the Russian River to Aptos Creek (inclusive), and includes the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers. Critical habitat in the littoral cell includes all creeks and rivers with migratory access from the ocean, including:

- Pescadero and Butano Creeks (sediment impaired coastal habitat 1: Pescadero Marsh);
- Waddell Creek (BECA 5: Waddell Bluffs and sediment impaired coastal habitat 2: Waddell Creek);

- Scott Creek (BECA 6: Scott Creek Beach and sediment impaired coastal habitat 3: Scott Creek);
- San Lorenzo River (sediment impaired habitat 4: San Lorenzo River); and
- Aptos Creek (sediment impaired coastal habitat 8: Aptos Creek).

A.1.3.3. Central California Coastal Coho Salmon ESU (*Oncorhynchus kisutch*) (FE, CH, SE)

Coho salmon grow up to 24 inches long and 35 pounds; however, the average weight is about 8 pounds. Coho salmon spawn only once in natal streams and rivers before they die. They spend the first half of their lives rearing and feeding in freshwater habitats before migrating to the ocean.

Listing Status: Central California coastal coho was listed as threatened in November 1996 (61 Fed. Reg. 59028); this listing was upgraded to endangered in June 2005 (70 Fed. Reg. 37160). Critical habitat was designated in January 1999 (64 Fed. Reg. 24049). The CDFW listed coho salmon populations south of Punta Gorda, Humboldt County, as endangered in March 2005 (CDFW, 2015a).

Range: Central California coastal coho inhabits waters in the North Pacific Basin, from Alaska to California, and to Russia and Japan (79 Fed. Reg. 42687).

Critical Habitat: Central California coastal coho critical habitat includes accessible reaches of all rivers and creeks, including estuarine areas and tributaries, from Punta Gorda, Humboldt County, to the San Lorenzo River, Santa Cruz County (64 Fed. Reg. 24049). In the project area, the following rivers are considered critical habitat:

- Pescadero and Butano Creeks (sediment impaired coastal habitat 1: Pescadero Marsh);
- Waddell Creek (BECA 5: Waddell Bluffs and sediment impaired coastal habitat 2: Waddell Creek);
- Scott Creek (BECA 6: Scott Creek Beach and sediment impaired coastal habitat 3: Scott Creek);
- San Lorenzo River (sediment impaired habitat 4: San Lorenzo River)

A.2. Marine Invertebrates

A.2.1. Black Abalone (*Haliotis cracherodii*) (FE)

Black abalone is a marine invertebrate gastropod with a smooth, circular, black to slate blue colored univalve shell and a muscular foot which allows it to stick tightly to rock surfaces without being dislodged by waves.

Listing Status: The USFWS manages the black abalone and designated it as endangered in January 2009 (74 Fed. Reg. 1937). Critical habitat was designated in October 2011 (76 Fed. Reg. 66806)

Range: Black abalone inhabit rocky tidal and subtidal habitat along the coast of North America, from Point Arena, California, to Bahia Tortugas and Isla Guadalupe, Mexico. Black abalone are rare north of San Francisco and South of Punta Eugenia.

Life Cycle and Habitat Use: Black abalone inhabit intertidal and subtidal rocky habitat, typically in areas of moderate to high surf. They have separate sexes and are broadcast spawners. They typically spawn in the summer, when they are about 3 years old. During spawning, they release millions of eggs or sperm into the water column. Fertilized eggs hatch as free-swimming larvae. Larvae spend about 5 to 14 days before they metamorphose into adults. After metamorphosis, they settle onto hard substrates in intertidal and subtidal areas. Black abalone use their foot to move freely over rocks when submerged. When exposed in intertidal areas during low tide, they wedge themselves into crevices, cracks, and holes where they are concealed and protected from drying out.

Prey and Foraging: Black abalone typically feed on giant kelp, bull kelp, and feather boa kelp. Certain bacteria and algae are also important food resources.

Threats: The primary factors which have lead to decline and continue to threaten black abalone include overfishing and illegal harvest, habitat destruction, disease (withering syndrome), predation, and competition.

Critical Habitat: Critical habitat includes approximately 88,960 acres of rocky intertidal and subtidal habitat from the mean higher high water line to a depth of about 20 feet within five segments of the California coast between Del Mar Point, Sonoma County, and Palos Verdes Peninsula, near Long Beach, California. It also includes the Farallones Islands, Año Nuevo Island, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Islands.

Only one unit of abalone critical habitat is present in the littoral cell, Unit 2: South of San Francisco Bay in San Francisco County to Natural Bridges State Beach in Santa Cruz County, California (i.e., Reaches 1 through 5). The rocky intertidal and subtidal habitat, and all waters from mean higher high water to a depth of 20 feet are included in black abalone critical habitat. In addition, Año Nuevo Island is critical habitat. However, abalone are not found in sandy substrates, rather, they inhabit rocky intertidal and tidal habitat. During the summer months, when spawning occurs, larvae may be present in waters over both rocky and sandy bottoms.

Primary constituent elements of critical habitat include suitable rocky substrate, adequate food resources, rocky substrate for larval recruitment and juvenile growth, and suitable water quality.

A.3. Marine Reptiles

A.3.1. Leatherback Sea Turtle (*Dermochelys coriacea*) (FE, CH)

The leatherback sea turtle is the largest, deepest diving, and most migratory sea turtle. Adults can reach between 4 and 8 feet long and weigh between 500 and 2,000 pounds. Leatherback shells are composed of leathery, oil-saturated connective tissue overlaying loosely interlocking bones. Leatherback skin is mostly black with some pale spotting.

Listing Status: The leatherback turtle is managed by the NMFS. NMFS listed the leatherback turtle as endangered in June 1970 (35 Fed. Reg. 8491). Critical habitat was designated in September 1978 (43 Fed. Reg. 43688), and updated in March 1979 (44 Fed. Reg. 17710). Additional critical habitat along the west coast of the United States was designated in January 2012 (77 Fed. Reg. 4170).

Range: Leatherback turtles have the most extensive range of any living reptile. They are reported throughout the oceans of the world, including cold temperature regions (77 Fed. Reg. 4170). Although turtles may utilize habitat in colder waters, nesting is limited to tropical and subtropical latitudes. In the Pacific Ocean, nesting typically occurs in Mexico, Costa Rica, Indonesia, the Solomon Islands, and Papua New Guinea (77 Fed. Reg. 4170). The only known nesting grounds in the United States are in Florida; no nesting occurs on the west coast of the United States. The largest nesting grounds are found along the coasts of northern South America and West Africa.

Life Cycle and Habitat Use: Leatherback turtles utilize much of the world’s marine habitat. They are known to migrate very long distances between foraging and nesting grounds. Turtles forage widely in temperate and tropical waters; however, as mentioned, nesting only occurs in tropical and subtropical regions. Nesting is seasonal and typically occurs every 2 to 3 years. Nesting occurs during different months, depending on the nesting location. In Mexico, nesting typically occurs from November through February. In the western Pacific, nesting occurs in May through July in China and Malaysia, and December and January in Australia.

Eggs are laid in body pits and nest chambers excavated by females. Once pits are excavated, the female fills the nest chamber with eggs and then covers and conceals the pit. Once complete the female returns to the sea. The number of eggs laid by females also differs, depending on the location. In Mexico, females lay about 1 to 11 clutches per season at intervals of 9 to 10 days, with clutch sizes averaging about 64 yolked eggs. In Malaysia, clutch sizes average between 85 and 95 yolked eggs, 83 in Australia, and 90 to 150 in China (NMFS and USFWS 1998). Hatchlings tunnel out of the nest, emerging at night. Juveniles orient themselves to the ocean by following lights on the open ocean horizon.

Prey and Foraging: In the littoral cell (which is located entirely within Area 1 critical habitat unit), the preferred prey of leatherback sea turtles is brown sea nettles. Brown sea nettles are found in high densities in the littoral cell, particularly within upwelling shadows and retention areas. Area 1 is the principle foraging area off the coast of California for leatherbacks (77 Fed. Reg. 4170). Leatherbacks have high caloric requirements, consuming about 20 to 30 percent of their body weight each day. Their preferred prey (jellyfish) is rather low in nutritional value; however, nutritional requirements are met when consumed in large amounts.

Threats: Threats include harvest of eggs and turtles and incidental bycatch in fishing gear.

Critical Habitat: In 2012, additional leatherback turtle critical habitat was designated along the west coast of the United States. The 2012 designated includes nine areas, totaling approximately 41,914 square miles of marine habitat from the ocean surface down to a maximum depth of 262 feet. This designation includes approximately 16,910 square miles stretching along the California coast from Point Arena to Point Arguello east of the 3,000 meter depth contour; and 25,004 square miles stretching from Cape Flattery, Washington to Cape Blanco, Oregon, east of the 2,000 meter depth contour. The entire littoral cell is within Area 1 (approximately 3,807 square miles) of leatherback turtle critical habitat (77 Fed. Reg. 4170).

Primary constituent elements of leatherback critical habitat include the occurrence of prey species, of sufficient condition, distribution, abundance, and density to support individual and population growth, reproduction, and development.

A.4. Marine Mammals

Several marine mammals utilize the littoral cell for all or some portions of their life cycle. Many species of whales migrate through and forage in coastal waters of the littoral cell. Several species of pinnipeds (seals and sea lions) breed on sandy beaches of the littoral cell, whereas others use sandy and rocky areas as haul outs. The NMFS considers the littoral cell a hot spot for several marine mammals. Figure A-1 provides an overview of marine mammal hot spots and haulout areas. Additionally, gray whales, humpback whales, blue whales, and several species of dolphins and porpoises utilize habitat close to shore in the littoral cell.

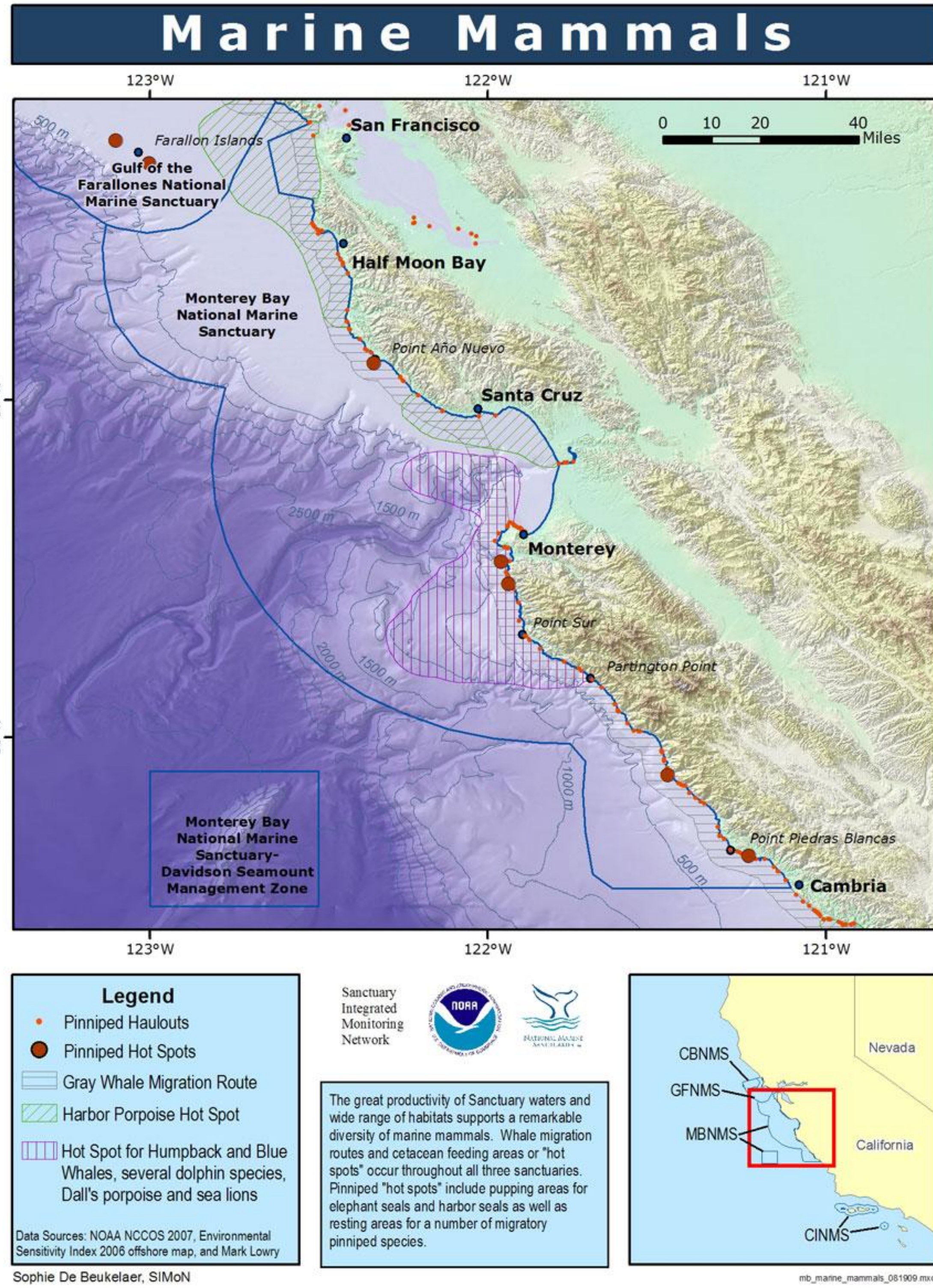

Figure A-1. Marine Mammal Hot Spots in the Santa Cruz Littoral Cell. Source: SiMON: http://www.sanctuarysimon.org/monterey/sections/marineMammals/overview.php?sec=mm

A.4.1. FISSIPEDS

A.4.1.1. Southern Sea Otter (*Enhydra lutris nereis*) (FT, MMPA, FP)

Unlike most marine mammals, which are managed by NMFS, the southern sea otter is managed by the USFWS. Sea otters are the smallest marine mammal; they grow to about 4 feet long. Females weigh an average of 45 pounds and males about 65. Pups are about 2 feet long and weight 4 to 5 pounds at birth. Sea otter fur is typically brown and turns silver and grey as they age.

Listing Status: The Southern sea otter was listed as threatened in January 1977 (42 Fed. Reg. 2965). This species is also fully protected by the State of California; therefore, the CDFW cannot issue an incidental take permit for take of southern sea otters.

Range: Historically, sea otters ranged from northern California to Baja California, Mexico; however, their current range is reduced to Half Moon Bay, San Mateo County, south to Point Conception, Santa Barbara County. Southern sea otters are common in the littoral cell, particularly in Monterey Bay and Elkhorn Slough.

Life Cycle and Habitat Use: Southern sea otters inhabit shallow nearshore coastal waters. They are typically associated with rocky marine habitats where kelp forests grow. They also utilize sandy bottom and coastal wetland habitats. Unlike other mammals, sea otters do not have a thick layer of blubber; instead, they rely on water resistant fur for insulation and warmth.

Sea otter breeding takes place between September and November, with females giving birth to a single pup almost every year. Pupping season is typically from January through March, with a secondary pupping season in late summer or early fall. Pups nurse for about 6 to 12 months, before they are weaned.

Prey and Foraging: Southern sea otters forage on invertebrates such as crabs, clams, barnacles, abalones, and sea urchins. They are known for using various tools, such as rocks or shells of other mollusks, to open shells of mollusks. Sea otters eat about 25 percent of their body weight each day.

Threats: Threats include habitat degradation entanglement in fishing gear, pollution, disease, and illegal human interference.

Critical Habitat: Critical habitat is not designated for this species.

A.4.2. PINNIPEDS

Pinnipeds (seals and sea lions) are protected under the MMPA, and several are also protected under the state or federal ESA. Several species are present in the littoral cell. They utilize offshore waters and also come ashore in several areas. Several beaches, rocks, and jetties within the littoral cell serve as pinniped rookeries and haulout sites. Many of these areas are isolated from predators and human harassment; however, some haulout areas, such as Moss Landing, are located in areas where recreation and other human disturbance are prevalent. Rookeries and haulout sites are considered some of the most important pinniped habitat, particularly because reproduction, rest, and molting occur at these sites (MBNMS, 2014). In addition, some species of pinnipeds may utilize habitat within or adjacent to BECAs and sediment impaired coastal habitat areas.

Prior to conducting sediment management activities, project planners should contact the NMFS to ensure that project activities would not adversely affect pinnipeds and obtain authorization to conduct sediment management activities under the MMPA and/or the federal ESA. Additionally, project planners should contact the MBNMS, as this agency has regulatory authority to protect pinnipeds in the sanctuary.

A.4.2.1. Northern Elephant Seal (*Mirounga angustrirostris*) (MMPA, FP)

The northern elephant seal is the largest seal in the world. Female northern elephant seals can grow to be 10 feet long and weigh up to 1,300 pounds. Males grow to about 13 feet long and can weigh up to 4,400 pounds. Pups weight about 4 feet long and 75 pounds at birth. Adults are dark brown or gray and pups are black until they are weaned (at about 6 weeks old). After weaning, they molt and turn light silver. Males develop a large inflatable nose, or proboscis, when they reach puberty, at about 7 years old. Northern elephant seals live to be about 13 to 19 years old, with females living longer than males.

Populations of northern elephant seal have increased, and continue to increase, in the United States. It is estimated that there are approximately 73,400 northern elephant seals in the United States stock, with about 5,000 breeding at Año Nuevo (Barlow et al. 1995, as cited in MBNMS, 2014).

Listing Status: Northern elephant seal is protected under the MMPA. This species is also fully protected by the State of California; therefore, the CDFW cannot issue an incidental take permit for take of northern elephant seals.

Range: Northern elephant seals are distributed the eastern and central portions of the northern Pacific Ocean. They range from north Alaska to Mexico, where they feed in waters off Alaska, Washington, and Oregon. They typically breed in the Channel Islands, California, and Baja California, Mexico.

In the littoral cell, seals may be present in waters off the coast. During the breeding season, they are present at Año Nuevo State Park (on the island and mainland), and more recently, Piedras Blancas. Males arrive at breeding grounds in December and females arriving shortly afterward. Elephant seals return to Año Nuevo to molt. Females and juveniles molt between April and May; sub-adult males between May and June; and adult males between July and August.

Life Cycle and Habitat Use: Northern elephant seal inhabit near shore islands and coastal beaches during the spring mating season, and are found in the open ocean during the rest of the year. Northern elephant seals are polygamous, with males establishing dominance over large groups of females. Breeding occurs between December and March. Following an approximately 11-month gestation period, pups are born in early winter, between December and January.

Prey and Foraging: Northern elephant seals feed on squids and fishes, including rays and sharks. During breeding and molting, they typically fast. Fasting results in individuals losing about half their body mass.

Threats: Threats include entanglement in marine debris, bycatch in fishing gear, and boat collisions.

A.4.2.2. Stellar Sea Lion (*Eumetopias jubatus*) Eastern DPS (MMPA)

The stellar sea lion population is divided into eastern and western distinct populations segments. Only the western DPS is present in the littoral cell. Male stellar sea lions (known as bulls) are about 10 to 11 feet long and weigh up to 2,500 pounds. Females (known as cows) are about 7.5 to 9.5 feet long and weigh up to 750 pounds. Pups are typically about 3.3 feet long and weigh about 35 to 50 pounds. Adults are light blond to reddish brown, with a dark belly.

Listing Status: The eastern DPS of stellar sea lion was originally listed as threatened in April 1990 (55 Fed. Reg. 12645); however, recovery led to this DPS being delisted in July 2014 (79 Fed. Reg. 42687).

Range: The western DPS of stellar sea lion ranges from the Gulf of Alaska and Aleutian Islands, to central California. Stellar sea lion breeding occurs along the North Pacific Rim, from Año Nuevo Island to the Kuril Islands in Japan. Most breeding occurs in the Gulf of Alaska and Aleutian Islands. Año Nuevo is thought to be this species most southern extent (NMFS, 2013).

Life Cycle and Habitat Use: Stellar sea lions are polygamous, colonial breeders. Males are sexually mature between 3 and 8 years old. At about 9 or 10 years of age, they aggressively defend their territory and mate with females. Females are sexually mature at about 4 to 6 years of age. They give birth to a single pup. Pups are born on islands from about mid-May through mid-July. Mothers stay with pups for about 2 weeks before foraging at sea. Typically, mothers spend about equal time nursing pups and foraging. As pups nurse for about a year, but can nurse for up to 3 years. Females are ready to mate again shortly after pups are born, within 10 to 14 days (NMFS, 2013).

Prey and Foraging: Stellar sea lions forage in nearshore and pelagic waters, typically at night. As opportunistic predators, they feed on a variety of fish, bivalves, cephalopods, and gastropods. Males do not eat during the breeding season.

Threats: Threats include boat and ship strikes, contaminants and pollutants, habitat degradation, illegal hunting, interactions with fishing gear, and offshore oil and gas exploration.

A.4.2.3. California Sea Lion (*Zalophus californianus)* (MMPA)

The California sea lion is the most abundant pinniped in the littoral cell. At minimum, there are about 12,000 are likely present at any time within the Monterey Bay National Marine Sanctuary, where the littoral cell is located (Barlow, et al. 1995, as cited in MBNMS, 2014). At Año Nuevo, there are about 7,000 California sea lions (Barlow, et al. 1995, as cited in MBNMS, 2014). Populations appear to be to be increasing (NMFS, 2011b).

California sea lions are dark brown with broad fore-flippers and a long, narrow snout. Males are about 7.5 feet long and weigh about 700 pounds. Females are about 6 feet long and weigh about 240 pounds. They live to be 20 to 30 years old.

Listing Status: California sea lion is protected under the MMPA.

Range: Sea lions reside in the eastern North Pacific Ocean in shallow coastal and estuarine waters., from British Columbia, south to central Mexico. In the littoral cell, sandy beaches are the preferred haul out locations in the littoral cell.

Life Cycle and Habitat Use: California sea lions are social animals, forming groups of several hundred individuals. Males establish breeding territories that may include up to 14 females. Breeding season lasts from May to August, and pups are born between May and July. Pups are weaned at 10 months of age. Females can mate in 3 weeks after giving birth.

Prey and Foraging: California sea lions feed on squid, anchovies, mackerel, rockfish, and sardines.

Threats: Threats include entanglement and incident bycatch in fishing gear and other anthropogenic activities.

A.4.2.4. Pacific Harbor Seal (*Phoca vitulina*) (MMPA)

Harbor seals are some of the most commonly seen marine mammals in the littoral cell, particularly in the Monterey Bay region. They have spotted coats in various shades of white, silver, gray, black and dark brown. Their coats are often spotted or mottled. Adults can reach lengths of 5 to 6 feet and weigh up to 300 pounds, with males being slightly larger than females.

Listing Status: Pacific harbor seals are protected under the MMPA.

Range: Pacific harbor seals are present in both the Atlantic and Pacific Oceans. In the Pacific, they range from Alaska to Baja California, Mexico.

Life Cycle and Habitat Use: Harbor seals utilize nearshore coastal waters and haul out on rocky islands, sandy beaches, mudflats, and docks. Breeding and pupping occurs in the spring and summer, generally in March through May in the littoral cell, and pups are typically born between February and April. When not actively feeding, they typically haul out to rest. Known haul out areas occur on Moss Landing Harbor’s northern spit across from the northern jetty, and on a dock adjacent to restaurant—both on the north side of the harbor. They are common throughout the littoral cell.

Prey and Foraging: Pacific harbor seals are opportunistic feeders, foraging on sole, flounder, hake, cod, squid, and other marine organisms.

Threats: Threats include ship strikes, entanglement and capture in fishing gear, pollution, and human harassment.

A.4.3. CETACEANS

Cetaceans include whales, dolphins, and porpoises. Several species of cetaceans migrate through and forage in the offshore waters of the littoral cell or in Monterey Bay. Some species may migrate rather close to shore. In-water activities, such as dredging, may result in noise which could affect whales, dolphins, and porpoises. However, dredging activities in the littoral cell typically occur very close to the coast in bays and river areas (e.g., Moss Landing Harbor and Santa Cruz Harbor). Sediment management activities would occur in areas that are upland from coastal waters where whales, dolphins, and porpoises migrate and forage. Because the sediment management activities are not expected to adversely affect these species, these species are only briefly described in Table A-2. Should any offshore activities be conducted as part of regional sediment management activities (e.g., offshore dredging), additional coordination and/or consultation with the appropriate resource agencies would be required.

All whales, dolphins, and porpoises are protected under the MMPA and several species are also protected under the federal or state endangered species act. The species listed below are managed by the NMFS; however, the CDFW does not provide additional special protections.

Table A-2: Cetaceans in the Littoral Cell

Species Common name	Scientific Name	Federal ESA [1]	Critical Habitat Designated	Critical Habitat in the Littoral Cell	Habitat Use in the Littoral Cell
Blue whale	Balaenoptera musculus	FE (35 Fed. Reg. 6069, June 1970)	None	--	Migrating through and foraging along the coastline and in Monterey Bay in the summer and fall.
Eastern North Pacific gray whale	Eschrichtius robustus	Delisted (59 Fed. Reg. 31094, June 1994)	None	--	Found in shallow coastal waters in the North Pacific Ocean. The coastal areas of the littoral cell are considered hotspots for gray whale migrations, particularly in the spring and summer.

Species Common name	Scientific Name	Federal ESA [1]	Critical Habitat Designated	Critical Habitat in the Littoral Cell	Habitat Use in the Littoral Cell
North Pacific Humpback whale	Megaptera novaeangliae	FE (35 Fed. Reg. 18319, June 1970) Reviewed for delisting (79 Fed. Reg. 36281, June 2014)	None	--	Monterey Bay and areas south are known as humpback whale hot spots
Killer whale (southern resident DPS and transient)	Orcinus orca	FE (70 Fed. Reg. 69903, Nov. 2005) CH (71 Fed. Reg. 69054, Nov. 2006) (only the southern DPS is listed)	Waters in the Puget Sound and Straits of Juan de Fuca, and off the San Juan Islands	No	Whales have been observed feeding and attacking juvenile gray whales in Monterey Bay (NMFS 2008)
Minke whale	Balaenoptera acutorostrata	None	None	--	Present in the nearshore waters of the littoral cell year round; but, less common in the winter.
Pacific white-sided dolphin	Lagenorhynchus obliquidens	None	None	--	Most commonly sighted dolphins in the littoral cell, especially during the fall.
Risso's dolphin	Grapus griseus	None	None	--	Common in the littoral cell year-round.
Common long-beaked dolphin	Delphinus capensis	None	None	--	Common in the littoral cell.
Bottlenose dolphin	Tursiops truncatus	None	None	--	Common in the littoral cell; stays close to shore.
Dall's porpoise	Phocoenoides dalli	None	None	--	Common in the littoral cell.
Harbor porpoise	Phocoena phocoena	None	None	--	Common in the littoral cell; stays close to shore.

Species Common name	Scientific Name	Federal ESA [1]	Critical Habitat Designated	Critical Habitat in the Littoral Cell	Habitat Use in the Littoral Cell

Notes:
[1] Marine mammals listed in this table are not protected under the state ESA. All are protected under the MMPA.
Source: Monterey Bay National Marine Sanctuary. Available at: http://montereybay.noaa.gov/visitor/whalewatching/whales.html.

A.5. Birds

A.5.1. Western Snowy Plover (*Charadrius nivosus* spp. nivosus) (FT, CH, SSC)

The western snowy plover is a small shorebird about 6 inches in length, with dark legs, dark bills, a white belly, and partial dark banding on its neck and eyes, and sometimes on its forehead. Their coloring provides shelter, as they are difficult to notice against the background of their habitat. They are long lived, sometimes living as long as 20 years.

Listing Status*:* The United States Fish and Wildlife Service listed the western snowy plover as threatened in March 1993 (58 Fed. Reg. 12864) along the western United States and portions of Mexico, within 50 miles of the Pacific Ocean. Critical habitat was originally designated in December 1999 (64 Fed. Reg. 68508), and revised in June 2012 (77 Fed. Reg. 36728).

Range: Western snowy plovers inhabit beaches, lagoons, and salt ponds along the coast of the western United States and Mexico. Their breeding and winter ranges are from southern Washington to Baja, Mexico. Birds can be either resident or migratory. Migratory plovers may nest in one part of its range and winter in another part. Breeding populations in Oregon have been found wintering in California, and California populations have migrated both north and south of breeding grounds.

Life Cycle and Habitat Use: Western snowy plovers nest on barren or sparsely vegetated sandy beaches and dry salt flats and adjacent levees near coastal lagoons, lakes, rivers, bays, and estuaries. In the littoral cell, nests are typically constructed on dune backed beaches, barrier beaches, and salt ponds. Nests are constructed as depressions in the substrate lined with bits of debris or shell. In the winter, plovers typically form roosting flocks and disperse.

Breeding plovers arrive in the littoral cell from early March through late April, and most vacate nesting areas from late June to late October. The typical breeding season is from early March to late September and the winter season is from October to February. Adults breed when they are about 1 to 3 years old. Young fledge after about 29 to 47 days. Snowy plovers may nest more than once during a breeding season. Plovers typically nest in the same area, sometimes in the same nest or in adjacent areas.

Prey and Foraging: Snowy plovers forage on coastal beach above the MHW line. They feed on invertebrates found on the sand, marine wrack, marine carcasses, and foredune vegetation. Plover diet consists of small invertebrates, such as small crabs, flies, beetles, and brine shrimp.

Threats: The biggest threat to plovers is degradation and decline of habitat, typically caused by beach front development. Other threats include loss of habitat from dune stabilization (planting beach grass), beach grooming, recreationists disturbing nesting and roosting birds, and predation.

Critical Habitat: Critical habitat was originally designated in 2005 and revised in 2012. The 2012 designation provided for a total of 60 units totaling approximately 24,527 acres of critical habitat along the west coast (77 Fed. Reg. 36728). As shown on Table A-3, there are 6 units in the littoral cell totally approximately 750 acres.

Table A-3: Western snowy plover critical habitat in the littoral cell

COUNTY	REACH	UNIT NAME	AREA (ACRE)	FIGURE	NOTES
San Mateo County	2	CA-16: Half Moon Bay	36	Figure 5-1	It stretches for approximately 1.25 miles along Half Moon Bay State Beach within California Department of Parks and Recreation land.
Santa Cruz County	5	CA-17: Waddell Creek Beach	25	Figure 5-4	Located at the mouth of Waddell Creek, approximately 20 miles north of Santa Cruz. This unit is stretches approximately 0.6 miles along the coast. BECA 5 (Waddell Bluffs) and sediment impaired coastal habitat 2 (Waddell Creek) are within this unit.
	5	CA-18: Scott Creek Beach	23	Figure 5-4	Located approximately 13 miles north of Santa Cruz. Includes the mouths of Scott and Molino Creeks. The unit stretches about 0.7 miles along the coast. BECA 6 (Scott Creek Beach) and sediment

County	Reach	Unit Name	Area (acre)	Figure	Notes
					impaired coastal habitat 3 (Scott Creek) are within in this unit.
	5	CA-19: Wilder Creek Beach	15	Figure 5-4	Located approximately 1 mile west of Santa Cruz within Wilder Ranch National Park.
	7	CA-20: Jetty Road to Aptos Creek	369	Figure 5-6	Extending approximately 8 miles along the coast from immediately south of Manresa State Beach to Elkhorn Slough, this is the largest unit in the littoral cell. This unit includes Sunset State Beach, Zmundowski State Beach, and Moss Landing State Beach. The mouth of the Pajaro River runs through this unit. BECA 19 (Pajaro Dunes) is within this unit).
Monterey County	7	CA-21: Elkhorn Slough Mudflats	281	Figure 5-6	Located along the north side of Elkhorn Slough, east of Highway 1. BECA 20 (Moss Landing / Elkhorn Slough) is adjacent to this unit.
Source: 77 Fed. Reg. 36728					

Primary constituent elements of snowy plover critical habitat include sparsely vegetated areas above daily high tides that are relatively undisturbed by human activities and pets. These areas may include sandy beaches, dune systems immediately inland of active beach faces, salt flats, seasonally exposed gravel bars, dredge spoil sites, and artificial salt ponds and adjoining sites. Sparsely vegetated area which are daily inundated, but not under water and support invertebrate prey. Organic beach wrack on open substrates, which provide food and shelter are also included as primary constituent elements (70 Fed. Reg. 56994).

A.5.2. Marbled Murrelet (*Brachyramphus marmoratus*) (FT, CH, SE)

The marbled murrelet is a small seabird. Their plumage changes during the winter and breeding seasons. During the winter, the under parts are grey with dark marks on the sides of the breast and white around the eyes. During the breeding season, they have dark brown to blackish under parts with white bellies, and their throats are mottled. They live to be about 15 years old.

Listing Status: The USFWS listed the marbled murrelet as threatened in October 1992 (57 Fed. Reg. 45328). Critical habitat was initially designated in May 1996 (61 Fed. Reg.

26256) and revised in October 2011 (76 Fed. Reg. 61599). The CDFW listed the marbled murrelet as endangered in March 1992 (CDFW, 2015a).

Range: Marbled murrelets range along the Pacific coast of the United States, from Alaska to approximately central California, south of Monterey Bay; however, some birds winter farther south in southern California to Baja California, Mexico. This species spends the majority of its time on the ocean and heads inland to nest. It is known to nest approximately 50 miles inland (USFWS 1997).

Life Cycle and Habitat Use: Marbled murrelets spend a great majority of their time in nearshore waters, about 5 miles from the shore, resting and foraging. The move inland to nest, primarily in old growth and mature forests with large trees, multi-storied vegetation, and moderate to high canopy closure. They nest on large branches of old-growth conifers; however, they do not build nests. Therefore, nesting branches must have natural depressions and substrate (e.g., moss, needles) to lay an egg. Adults first nest at age 2 or 3, forming monogamous bonds with their partners. Nesting occurs between April and mid September. Typically, a female lays only one egg every year and both the male and female incubate it. Once hatched, the chick is left alone, except for when the parents bring it food. Young fledge in about 28 days and fly directly to the sea.

Nesting was documented several miles north of Moss Landing at the mouth of the Pajaro River, as early as 1939 to 1954 (USFWS, 2005).

Prey and Foraging*:* Marbled murrelets are opportunistic feeders, foraging in nearshore marine waters and, to a lesser degree, in inland mature forests. Their diet consists of small prey, such as fish and invertebrates. Fish prey includes sand lance (*ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea harengus*), Pacific sardine (*Sardinops sagux*), juvenile rockfish, and surf smelt. They also feed on crustaceans, such as squid, euphausiids, mysid shrimp, and amphipods.

Threats: The primary threat to marbled murrelet is destruction, loss, and fragmentation of nesting habitat, particularly through logging and land use changes. Oil spills, gill-net fishing, marine pollution, and predation are also threats to this species.

Critical Habitat: Critical habitat was originally designated in 2006 and revised in 2011. The 2011 designation provided for approximately 3,698,100 acres of critical habitat along the in Oregon, Washington, and California (76 Fed. Reg. 61599). In the littoral cell, approximately 61,196 acres of critical habitat is present in the Santa Cruz Mountains (Santa

Cruz Mountain Unit) in southern San Mateo County and northern and central Santa Cruz County.

Primary constituent elements of marbled murrelet critical habitat includes forest stands containing large trees more than 32 inches diameter at breast height, at least 33 feet high, and containing potential nesting platforms; surrounding forested areas with suitable canopy cover within 0.5 mile of large trees. The forested stands must be within the inland range of marbled murrelets and have large, contiguous blocks of nesting habitat.

A.5.3. California Least Tern (*Sternula antillarum browni*) (FE, SE, FP)

The California least tern is a small bird characterized by long, narrow, grey wings with black-tips and a broad, forked tail. They have a black-capped head, white body, and yellow bill.

Listing Status: As one of the first projected species under the ESA, the USFWS designated the California least tern as endangered in June, 1970 (35 Fed. Reg. 8491). The CDFW listed the California least tern as endangered in June 1971 (CDFW, 2015a), and as a fully protected species. The CDFW cannot issue an incidental take permit for take of this species.

Range: California least terns range along the Pacific Coast, from San Francisco Bay Area south to Baja California, Mexico. They breed along the Pacific Coast and inland areas in the San Francisco Bay and Sacramento-San Joaquin River Delta region. A majority of the nesting sites are documented in southern California (USFWS, 2006).

Life Cycle and Habitat Use: California least terns forage, roost, and nest in colonies of about 25 pairs on open beaches free of vegetation. California least terns exhibit some site fidelity; however, they are also known to move among colonies. Nests are constructed by scraping depressions in the sand or shell fragments. The breeding season is from late April through late July/early August. Eggs are laid starting in mid-May, after courtship and selection of mates. Typically breeding begins at age 3, and females lay about two eggs. If eggs are lost, adults may re-nest up to two times during a breeding season. Both adults incubate the eggs and rear the young. Adults and fledging begin their southern migration in late July or early August (USFWS, 2006).

In California, nesting sites are documented in the San Francisco Bay Area and Sacramento-San Joaquin River Delta, as well as along the coast of San Luis Obispo, Santa

Barbara, Ventura, Orange, and San Diego Counties. According to USFWS' 2006 5-year review (USFWS, 2006), nesting birds are not documented in the littoral cell.

Prey and Foraging: California least terns primarily forage in nearshore waters up to 2 miles from shore and estuaries. They prey on small fish and crustaceans, including anchovy, smelt, silversides, and surfperch.

Threats: Threats include destruction and loss of nesting habitat, particularly in southern California where breeding populations are the largest and recreation is very high; loss and fragmentation of wintering habitat, and predation.

Critical Habitat: Critical habitat is not designated for this species.

A.5.4. Bank Swallow (*Riparia riparia*) (ST, MBTA)

Listing Status: The CDFW listed the bank swallow as threatened on June 11, 1989 (CDFG 2009b). It is also protected under the MBTA.

Range: Banks swallows are migratory birds that arrive in California from South America in early March, peaking in early May; they migrate south in July and August. It is thought that approximately 75 percent of the current breeding population in California exists along the banks of the Sacramento and Feather Rivers in the northern Central Valley. Other colonies inhabit areas along the central coast from Monterey and San Mateo counties, and northeastern California in Shasta, Siskiyou, Lassen, Plumas, and Modoc counties (Garrison 1998).

Life Cycle and Habitat Use: Bank swallows inhabit riparian and other lowland habitat in California during the spring and fall in areas with vertical banks, bluffs, and cliffs with fine-textured or sandy soils. During migration, the bank swallows flock with other swallows over open habitat to interior portions of California. They are colonial breeders in colonies ranging from 10 to 1,500 nesting pairs; however, most colonies have approximately 100 to 200 pairs. Breeding generally begins in early May and persists though July, peaking in mid-May to June. Clutch size ranges from three to eight (Garrison 1998).

Prey and Foraging: Bank swallows predominately prey on flying or jumping insects. Terrestrial and aquatic larvae are also consumed.

Threats: Threats include predation by rats, skunks, house cats, snakes, and raptors, but the main threats are channelization of banks and other habitat loss and destruction.

A.5.5. California Brown Pelican (*Pelecanus occidentalis*) (FP)

California brown pelicans have a big, dark body; long, white, sinuous neck; and an oversized bill. Adults are grayish-brown with yellow beaks.

Listing Status: California brown pelican was listed as endangered under the federal ESA in November 1970 (74 Fed. Reg. 5944) and state ESA in June 1971 (CDFW, 2015a). This species has recovered and was delisted under both ESAs in 2009 (CDFW, 2015a). Regardless, the brown pelican is considered fully protected by the CDFW, and take of this species is prohibited.

Range: Brown pelicans are distributed across portions of the United States and Latin America, including California, Texas, Louisiana, Mississippi, Mexico, the Caribbean, and Central and South America (USFWS, 2007).

Life Cycle and Habitat Use: Habitat includes the open ocean, bays, estuaries, and other coastal habitats. They nest in colonies, typically on islands. Females build simple nests on the ground or in trees with material gathered by the male. Birds are sexually mature between 3 and 5 years of age. Females lay about 2 to 4 eggs, which are incubated by both sexes. Eggs hatch in about 30 days and both parents feed and rear the young. Young leave ground in about 5 to 9 weeks; but, don't fly until about 9 to 12 weeks. Adults continue to feed the young even after they leave the nest. Following breeding, pelicans may migrate southwards to warmer climates.

California brown pelican are present in many areas of the littoral cell. They may be foraging or roosting in coastal waters.

Prey and Foraging: Prey consists entirely of fish, including smelt and anchovies. They may also forage on crustaceans. They forage by diving from the air, plunging head first into the water and surfacing with a bill full of water and fish. They empty the water from their bills and swallow the fish.

Threats: Thinning of egg shells resulting from pesticide contamination, oil spills, and habitat destruction.

A.5.6. White-tailed Kite (*Elanus leucurus*) (FP)

White-tailed kites have gray upperparts, a white head, bold black shoulders, and a white tail.

Listing Status: White tailed kite is designated as a fully protected species by the State of California and take of this species is prohibited.

Range: White-tailed kites range along the west coast of the United States and in Mexico, Central America, and portions of South America.

Life Cycle and Habitat Use: White tailed kites may be present in open fields and marsh areas throughout the littoral cell. They are present year-round in Elkhorn Slough, where they are known to nest (ElkhornSlough.org, accessed January 8, 2015). Kites form monogamous pairs and the pair stays together year-round. They nest in scattered trees that are about 20 to 50 feet high. Nest building begins in January. The male and female both construct the nest with twigs, grass, weeds, and leaves. Females lay 4 eggs, which are incubated for 30 to 32 days. The male brings food to the females while she incubates the eggs. Young begin to fledge at 30 to 35 days, but do not start foraging for about 60 days post hatching. Outside of the nesting period, they roost in groups.

Foraging and Prey: Prey consists of small mammals, such as voles and mice. Reptiles and amphibians may also be prey for this species. It searches for prey by hovering over open fields and kiting its wings.

Threats: Historic threats include hunting and egg collecting.

A.5.7. Burrowing Owl (*Athene cunicularia*) (CDFG Code § 3503.5)

Burrowing owls are a small owl with a round head, white feathers above the eyes, yellow eyes, and long legs. Its head, back, and upper wings are light brown, and its chest and belly are white. They are approximately 8.5 to 11 inches long with a wingspan of 20 to 24 inches. Adults weigh approximately 6 to 8 ounces. Juveniles molt after during their first summer.

Listing Status: The CDFG considers the burrowing owl a species of special concern and the USFWS considers the owl a bird of conservation concern (CDFG 2009). Additionally, this species and their nests are protected under section 3503.5 of the California Fish and Game Code.

Range: Historically, western burrowing owls ranged from Canada, through the western United States, and throughout Mexico.

Life Cycle and Habitat Use: The burrowing owl (*Athene cunicularis*) occupies open, dry grasslands, deserts, and scrubland characterized by low-growing vegetation. They depend on old burrows of other animals, especially the California ground squirrel (CNDDB, 2009). Some burrowing owls are known to nest in loose colonies. They are generally active during the day and are relatively easy to see, as they are somewhat bold and approachable. The burrowing owl is vocal and has a wide range of calls.

The breeding season begins in March and persists through August. The owls are monogamous, and males court females with display flights and calls. Males usually call to attract females. Females generally lay 6 to 9 eggs—occasionally as many as 12—and incubate them for 28 to 30 days. Males bring food to the female, guard the burrow, and provide overall care for the owlets. Juveniles leave their burrow after approximately 44 days. When approached by predators, juveniles generally give a rattlesnake-like buzz, and adults give a short cluck call (CNDDB 2009).

Prey and Foraging: Adults feed on a wide variety of prey, including large arthropods, such as beetles and grasshoppers; small mammals, such as mice, rats, gophers, and ground squirrels; and reptiles and amphibians.

Threats: Conversion of grasslands to agriculture and other habitat destruction; however, the burrowing owls are tolerant of human-altered open spaces (Technology Associates, 2009). Poisoning of ground squirrels has also contributed to a reduction in owl population (CNDDB, 2009).

A.6. Terrestrial Reptiles and Amphibians

A.6.1. California Red-legged Frog (*Rana Draytonii*) (FT, CH)

The California red-legged frog is the largest native frog in the western United States and is one of two subspecies of red-legged frogs (61 Fed. Reg. 25813). Its posterior abdomen and hind legs are typically red or pink, which is where the frog gets its name.

Listing Status: The USFWS listed the California red-legged frog as threatened in May 1996 (61 Fed. Reg. 25813). Critical habitat was initially designated in March 2001 (66 Fed. Reg. 14626) and revised in April 2006 (71 Fed. Reg. 19244) and again in March 2010 (75 Fed. Reg. 12816).

Range: The California red-legged frog is endemic to California and Baja Mexico. It was historically distributed throughout most of California in areas below 5,000 feet (CDFG 2002), along the coast from Point Reyes National Seashore in Marin County, California, inland from Redding in Shasta County, California, southward to northwestern Baja

California, Mexico (61 Fed. Reg. 25813). It is thought to have disappeared throughout 70 percent of its historic range (CDFG 2002).

Life Cycle and Habitat Use: California red-legged frogs utilize a variety of habitats with adjacent aquatic breeding sites, riparian forest, and upland dispersal habitat. Adults typically prefer areas with dense emergent riparian vegetation and are associated with still or slow moving water in pools that are greater than 2 feet deep. Well vegetated terrestrial areas within riparian corridors may serve as winter shelter (CDFG 2002). Adults are nocturnal and may inhabit small mammal burrows and moist leaf litter during the day. Upland riparian corridors are often used when creeks dry up in mid to late summer. They are known to travel up to 98 feet from aquatic in adjacent riparian habitat, and up to 300 feet from riparian habitat to estivate (61 Fed. Reg. 25813).

California red-legged frogs breed from November through April; and may start earlier in the southern areas of its habitat. Most mating typically occurs in February or March, but varies depending on seasonal climate (75 Fed. Reg. 12816). Breeding occurs during or shortly after large rainfall events in late winter and early spring. Females deposit eggs masses on emergent vegetation and the egg masses float on the surface of the water.

The frogs disperse upstream and downstream of breeding habitat to forage and find estivation habitat. Estivation habitat can include boulders, rocks, downed trees or logs, industrial debris, drains, watering troughs, abandoned sheds, or other features (61 Fed. Reg. 25813). Egg masses contain about 2,000 to 5,000 eggs; which are attached to vertical emergent vegetation (e.g., cattails and bulrushes). Eggs are unable to tolerate high salinities, and are known to die when salinities are greater than 4.5 ppt. Eggs hatch in 6 to 14 days.

Larvae are also unable to tolerate salinity and die when salinity reaches 7 ppt. Larvae undergo metamorphosis in about 3 to 7 months post hatching, typically in July through September. Larvae generally experience the highest mortality rate, compared to other stages; less than 1 percent of the eggs reach metamorphosis stages. Juveniles are active diurnally and nocturnally, feeding actively along the shoreline and surfaces of water. Juveniles become sexually mature at 3 to 4 years of age (61 Fed. Reg. 25,813).

Adult frogs may disperse from breeding sites at any time of the year, depending availability and environmental conditions of habitat. Frogs may disperse long distances; in northern Santa Cruz County tagged frogs have traveled more than 2 miles to suitable habitat (75 Fed. Reg. 12816). However, not all frogs travel this far.

Prey and Foraging: California red-legged frogs prey on a variety of items; larvae eat algae and adults eat invertebrates. Larger frogs can eat Pacific tree frogs (*Hyla regilla*) and California mice (Peromyscus californicus).

Threats: The California red-legged frog is threatened by urban encroachment, construction of reservoirs and water diversions, contaminants, agriculture, and livestock grazing (USFWS 2002). These activities can destroy, degrade, and fragment fog habitat. In addition, predation and competition from non-native species threatens frog populations.

Critical Habitat: The current California red-legged frog critical habitat was designated in March 2010 (75 Fed. Reg. 12816). The designation includes 1,636,609 acres in 27 California counties, including San Mateo, Santa Cruz, and Monterey Counties. There are 5 units for critical habitat in the littoral cell, totaling 207,915 acres. According to the 2002 Recovery Plan (USFWS 2002), red-legged frogs are present in 22 streams in San Mateo County, 17 in Santa Cruz, and 32 in Monterey, many of which flow through the littoral cell.

Table A-4: Red-legged frog critical habitat in the littoral cell

County	Reach	Unit Name	Area (acre)	Figure	Notes
San Mateo County	1 and 2	SNM-1: Cahill Ridge	34,952	Not shown	Unit is approximately 1 mile inland. Coastal projects are not expected to affect this unit.
	3 and 4	SNM-2: Pescadero	96,138	Figure 5-1 and Figure 5-2	Critical habitat is adjacent to the coast and spans approximately 15 miles inland. Its northern boundary is just north of Tunitas Creek and continues south to approximately Big Basin Redwoods State Park. Sediment impaired coastal habitat 1 (Pescadero Marsh) is included in this unit.
Santa Cruz County	4, 5, and 6	SCZ-1: North Coastal Santa Cruz County	72,249	Figure 5-1 and Figure 5-2	Located along the coastline of northern Santa Cruz County, from approximately the center of Año Nuevo State Park to Wilder Creek. It includes BECAs 4 (Año Nuevo State Reserve), 5 (Waddell Bluffs), and 6 (Scott Creek Beach), as well as sediment impaired coastal habitats 2 (Waddell Creek) and 3 (Scott Creek). Only a very small portion is in Reach 6.
	7	SCZ-2: Watsonville Slough	4,057	Figure 5-6	This unit is located along the coast plain in Southern Santa Cruz County, north of the mouth of the Pajaro River. It includes the Watsonville Slough system and portions of the Corralitos Lagoon and mouth of the Pajaro River.
Monterey County	7	MNT-1: Elkhorn Slough	519	Figure 5-6	This unit is located along the coastal plain in northern Monterey County, inland from Moss Landing. It includes the eastern edge of the Elkhorn Slough watershed.

County	Reach	Unit Name	Area (acre)	Figure	Notes
Source: 75 Fed. Reg. 12816					

Primary constituent elements of California red-legged frog critical habitat include:

- Aquatic habitat for breeding - standing bodies of fresh water with salinities of less than 4.5 parts per thousand. This habitat includes natural and manmade ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that are inundated during winter rains and hold water for at least 20 weeks in all by the driest of years.

- Aquatic non-breeding habitat - freshwater ponds and streams (as described for breeding habitat) that may not hold water long enough for the species to complete its aquatic life cycle, but provide for shelter, foraging, cover, predator avoidance, and aquatic dispersal. This habitat includes plunge pools within intermittent creeks, seeps, quite water refugia, springs, and other similar aquatic sites.

- Upland habitat - upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mile. Upland habitat includes various vegetation types, such as grassland, woodland, forest, wetland, or riparian areas.

- Dispersal habitat - dispersal habitat is accessible upland or riparian habitat within and between occupied or previously occupied sites that are within 1 mile of each other and that support movement between such sites. Dispersal habitat includes natural habitats and altered habitats, such as agricultural fields, that do not have barriers.

A.6.2. Santa Cruz Long-toed Salamander (*Ambystoma macrodactylum croceum*) (FE, SE, FP)

Six metapopulations of Santa Cruz long-toed salamander are known to exist: Valencia-Seascape, Ellicott-Buena Vista, Freedom, Larkin Valley, McClusky, and Elkhorn. These are the only known occurrences of Santa Cruz long-toed salamander. All metapopulations are located in the littoral cell adjacent to the coast in Reach 7.

Listing Status: Santa Cruz long-toed salamander was listed as endangered in March 1967 (32 Fed. Reg. 4001). Following the passage of the federal ESA, additional protections were provided for this species. Critical habitat was proposed in June 1978 (43 Fed. Reg. 26759); however, it was not designated. This species is fully protected by the State of California; the CDFW cannot issue an incidental take permit under the state ESA for take of this species.

Range: The Santa Cruz long-toed salamander is restricted to southern Santa Cruz and northern Monterey Counties.

Life Cycle and Habitat Use: The Santa Cruz long-toed salamander utilizes terrestrial and aquatic habitats. Upland habitats include mesic coastal scrub and woodland areas of coast live oak (*Quercus agrifolia*) and Monterey pine (*Pinus radiata*) and riparian vegetation. This species spends most of its live in burrows of other small mammals or under vegetative debris (e.g., leaf litter, downed logs, and fallen branches), particularly in the dry season (May to October). Salamanders breed in shallow freshwater ponds, most of which are ephemeral (USFWS 2009).

In November through March, as rains begin to fill streams, males and females migrate to breeding ponds. Males typically arrive 1 to 2 weeks before females. Once both sexes are at breeding grounds, nighttime courtship ensues. Following courtship, males deposit a spermatophore in the water, which the female retrieves and uses to fertilize her eggs. Females lay approximately 100 to 400 eggs in shallow water. Eggs usually hatch after 15 to 30 days. Larvae stay in aquatic habitat for about 90 to 145 days, before metamorphosing, usually in March, when ponds begin to dry out. Adults seek shelter in upland burrows.

In 1999, 24 breeding sites were identified, 17 in southern Santa Cruz County and 7 in northern Monterey County (USFWS 2009). The 2009 Santa Cruz long-toed salamander 5-year review identified that only 19 of these sites still had breeding (USFWS 2009). Populations in Bennett Slough/Struve Pond (North of Elkhorn Slough, Reach 7), Monterey County, and Rancho Road Pond, Santa Cruz County, are thought to be extirpated. Breeding in Lower Moro Cojo Slough (Monterey County) has not been documented since 1990 (USFWS 2009).

Prey and Foraging: Santa Cruz long-toed salamander larvae feed on aquatic invertebrates, such as mosquito larvae and worms.

Threats: Habitat degradation, fragmentation, and loss of aquatic and upland habitats through agricultural land conversion, urbanization, road construction, and non-native vegetation (e.g., eucalyptus trees, jubata grass, and pampas grass). Vehicles are also known to kill salamanders attempting to cross roads and highways. Pesticide and herbicide, disease, and predation use also adversely affects salamanders.

Critical Habitat: Critical habitat was proposed in 1978; however, it was not designated.

A.6.3. California Tiger Salamander (*Ambystoma californiense*), Central DPS (FT, CH, ST)

The California tiger salamander is a large, stocky, terrestrial salamander with a broad, rounded snout. Adult males grow to about 8 inches long and females about 7 inches. It is black with white or pale yellow spots or bars on its back and sides. Its belly is white or pale yellow and black.

Listing Status: The central population of California tiger salamander was listed as threatened in August 2004 (69 Fed. Reg. 47212). Critical habitat was designated in August 2005 (70 Fed. Reg. 49380).

Range: California tiger salamander occurs from near Petaluma, Sonoma County, east through the Central Valley to Yolo and Sacramento counties, and south to Tulare County. They are found in aquatic and adjacent terrestrial environments in the littoral cell management area. Generally, they inhabit elevations below 3,200 feet.

Life Cycle and Habitat Use: California tiger salamanders spend most of their lives in underground burrows of small mammals. They migrate from the burrows to breed in ponds during rain events (USFWS 2014). Breeding ponds are typically vernal pools, ephemeral or permanent bodies of water. Tiger salamander has two main types of movements is either breeding migration or inter-pond dispersal. Breeding migration is the movement of salamanders to and from a pond from the surrounding upland habitat. Upland movement is the movement of juveniles (after metamorphosis) from breeding ponds to upland habitats. Juveniles remain in upland habitats an average of 4 years, until they reach sexual maturity. After reaching sexual maturity, individuals typically return to natal ponds to breed; however, some may disperse to other ponds. Following breeding, adults stay in upland habitats for one or more years before breeding again (Trenham et al. 2000, as cited in 70 Fed. Reg. 49380).

Tiger salamanders breed and lay eggs in shallow vernal pools (and other temporary wetland or ponded areas) on submerged and emergent vegetation or submerged debris following warm rains in November through February. Breeding occurs from December though early February. Post-breeding adults can remain in breeding ponds for a few days up to 2 weeks. Larvae remain in the water, seeking cover in turbid water, vegetation, or debris until they metamorphosis into juveniles. Post-metamorphic juveniles retreat to small burrows in the spring or early summer after spending a few hours or days in mud cracks or tunnels near water.

Tiger salamanders prefer grassland habitats with seasonal ponds or vernal pools but sometimes utilize permanent ponds or reservoirs for habitat. They inhabit subterranean refugia, especially burrows of ground squirrels, and breed in shallow wetlands or ponds. Migrations between breeding grounds and upland habitats generally occur at night during periods of sustained rainfall. During breeding migrations, individuals can be found under rocks, logs, or other objects. Migrations are typically short, generally not exceeding 3,300 feet; however, a small percent may move farther distances (70 Fed. Reg. 49380).

Prey and Foraging: Adult and juvenile salamanders feed on earthworms, snails, insects, fish, and even small mammals. Larvae feed on zooplankton, amphipods, mollusks, and insect larvae.

Threats: Threats include urban development, loss of natural habitat, competition, non-native predators (e.g., bullfrogs, crayfish, and other fish), and anthropogenic habitat destruction or direct loss of individuals.

Critical Habitat: The USFWS designated 31 units, totaling approximately 199,109 acres, as critical habitat for the central population of California tiger salamander (70 Fed. Reg. 49380). Critical habitat is designated in four general regions: Central Valley, Southern San Joaquin, East Bay, and Central Coast. Only Reach 7 is within central California tiger salamander critical habitat. Reach 7 is located within the northern portion of the Central Coast region, in Monterey County; however, critical habitat units are not located in the littoral cell.

Primary constituent elements include breeding and non-breeding habitat, as well as room for dispersal between these habitats. Breeding habitat includes standing bodies of fresh water (e.g., ponds, vernal pools, ephemeral or permanent bodies of water) which hold water for a minimum of 12 weeks in a year of average rainfall. Upland habitats must be adjacent and accessible to and from breeding ponds, and contain small mammal burrows or underground habitat for cover and shelter. Essential upland dispersal habitat is habitat adjacent to aquatic habitats, which do not have dispersal barriers.

A.7. Invertebrates

A.7.1. Smith's Blue Butterfly (*Euphilottes enoptes smithi*) (FE)

Smith's blue butterfly is a small insect with a wingspan of less than an inch. Males are vivid blue with black edges and females are brown with a thin white fringe and an orange bar across the wing.

Listing Status: Smith's blue butterfly was listed as endangered in June 1976 (41 Fed. Reg. 22041). Critical habitat was proposed in February 1977; however, it was not designated (42 Fed. Reg. 7972).

Range: Smith's blue butterfly is endemic to inland and coastal sand dunes, serpentine grasslands, and Cliffside chaparral communities along the coast of central California in San Mateo, Santa Cruz, and Monterey Counties (USFWS 1984). They spend their entire lives associated with tow buckwheat plants, Coast buckwheat (Eriogonum latifolium) and dune buckwheat (Eriogonum parvifolium), typically found in coastal dune habitat (PWA 2008).

Life Cycle and Habitat Use: Smith's blue butterfly emerges in late August through September. Within a week of emerging, butterflies mate and females lay a single egg in the buckwheat flowers. Eggs hatch shortly after being laid and larvae feed on the flowers of the plant. Several weeks later, butterflies emerge from the host plant, coinciding with the blooming of the plant (approximately 4 to 6 weeks in late summer-early fall) (PWA 2008). Adult butterflies live approximately one week to mate and lay eggs (PWA 2008).

Prey and Foraging: Adults feed on the nectar of host plants and larvae feed seeds and flowers.

Threats: Threats include urban development; destruction of dune habitat; and invasion of and competition from non-native plants, particularly beach grass and ice plan (Arnold 1983).

Critical Habitat: Critical habitat was proposed for this species in 1977; however, it was not designated.

A.7.2. Mertle's Silverspot Butterfly (*Speyeria zerene myrtleae*) (FE)

Mertle's silverpoint butterfly is a medium sized butterfly with a wingspan of about 2.1 to 2.3 inches. The upper surface, hind, and forewings are golden brown with black spots, lines, and other markings. The undersides are light tan, reddish brown, and brown with black lines and silver and black spots.

Listing Status: Mertle's silverspot butterfly was listed as endangered in June 1992 (57 Fed. Reg. 27848).

Range: Historically, Mertle's silverspot butterfly ranged from northern California coastal dunes and bluffs from the Russian River, Sonoma County, south to Point Año Nuevo, San Mateo County. Mertle's silverspot butterfly is restricted to foredune and dune scrub communities adjacent to sandy habitats, typically in coastal scrub or coastal prairie habitat. It inhabits areas in coastal grasslands and scrub in marine terraces and stabilized coastal sand dunes, where its host plant, western dog violet (Viola adunca), is present (USFWS 1998). They typically range from sea level to about 1,000 feet elevation and as far as 3 miles inland (USFWS 1998).

Life Cycle and Habitat Use: The host plant for Mertle's silverspot butterfly is a violet, Viola adunca. It is the only known food larval food source for the butterfly. Adults emerge from their pupae between mid-June and mid-July, living up to 5 weeks. Females oviposit one egg on the dried leaves and stems of the host violet. Larvae emerge a few weeks later and find suitable foliage of the host violet where they spin a silk web and remain dormant (known as diapauses) through the fall and winter. In spring, larvae begin feeding on fresh violet leaves for about 7 to 10 days. After feeding, they form a pupal, where they stay for up to two weeks before emerging as adult butterflies (USFWS 1998).

Prey and Foraging: Adults forage on the nectar a variety of flowering plants. Larvae, however, only feeds on its host plant, Viola adunca (USFWS 1998).

Threats: Threats include competition from non-native plants, urban development, off-road vehicle use, recreation, and cattle grazing. Loss of the host plant, the only larvae food, is of particular concern.

Critical Habitat: Critical habitat is not designated for this species.

A.8. PLANTS

A.8.1. Santa Cruz Tarplant (*Holocarpha macrandenia*) (FT, CH, SE)

Santa Cruz tarplant is an aromatic annual herb in the aster family. The plant grows to between 4 to 20 inches high. It is rigid with lateral branches that grow as high as the main stem. The lower leaves are broadly linear and grow up to 5 inches long. The upper leaves are smaller. The flower head is yellow and daisy like, and is surrounded by individual bracts from beneath.

Listing Status: The Santa Cruz tarplant was listed as threatened in March 2000 (65 Fed. Reg. 14898). Critical habitat was designated in October 2002 (67 Fed. Reg. 63968). This species is also listed as endangered under the state ESA (CDFW 2015b).

Range: Santa Cruz tarplant is restricted to coastal terrace prairie habitat along the central California coast.

Life Cycle and Habitat Use: Santa Cruz tarplant habitat consists of grasslands and prairies on coastal terraces below approximately 330 feet in elevation. In Santa Cruz, plants are typically found on flat to gently sloping marine terrace platforms. This plant is typically associated with nonnative wild oat (*Avena fatua*), rattlesnake grass (*Briza maxima*), vulpia species, bromus species, rushes (juncus species), and California oatgrass (*Danthonia californica*). Of these, only the rushes and California oatgrass are native. The plant is occasionally found with other rare or sensitive species.

Similar to other plants in this genus (*Deinadra*), Santa Cruz tarplant is does not produce viable sees without cross pollinating with other individuals (i.e., it is self incompatible). As a result, populations grow and are more viable when genes are transferred between individuals. However, cross pollination typically occurs in very small distances (less than 0.3 miles), as individual plants are typically pollinated by insects. Because this plant is self incompatible, conservation of small occurrences is likely critical to the plant's survival (67 Fed. Reg. 63968). Plant populations vary widely and depend on seed bank production, the amount and timing of rainfall, temperature, and soil conditions.

Threats: Threats include livestock grazing, competition from non-native species, and habitat fragmentation, largely due to urbanization. The range of this species is severely reduced because of coastal prairie habitat destruction.

Critical Habitat: Santa Cruz tarplant critical habitat was designated in October 2002 (67 Fed. Reg. 63968). The designation includes 11 units, totaling approximately 1,175 acres of land in Contra Costa, Santa Cruz, and Monterey County, California.

Primary constituent elements include soils associate with coastal terrace prairies, particularly in the Watsonville, Tierra, Elkhorn, Santa Inez, and Pinto series; plant communities that support associates species, and physical process which maintain the soil structure and hydrology of seasonally saturated soils.

All but one of the critical habitat units are located in the littoral cell; however, only two units are close enough to the coast to possibly be affected by projects identified in this document. Units D: Arana Gulch (65 acres) and E: Twin Lakes (26 acres) are both located less than 0.75 mile from Monterey Bay near East Cliff Drive. Unit D is located adjacent to the northeast portion of Santa Cruz Harbor (i.e., Woods Lagoon) and Unit E is located immediate north of Schwan Lagoon at Twin Lakes State Beach (both in Reach 6, figure 5). Plants may be present in suitable habitat in the entire littoral cell.

A.8.2. Monterey Spineflower (*Chorizanthe pungens* var. pungens) (FT, CH)

Monterey spineflower is an annual species in the buckwheat family. It is a low-growing grayish herb with soft hairs and rose-colored flowers.

Listing Status: Monterey spineflower was listed as threatened in February 1994 (59 Fed. Reg. 5499). Critical habitat was initially designated in May 2002 (67 Fed. Reg. 37498) and revised in January 2008 (73 Fed. Reg. 1525).

Range: Monterey spineflower is restricted to foredune and dune scrub communities and adjacent sandy habitats occupied by coast scrub or coastal prairie.

Life Cycle and Habitat Use: Monterey spineflower occurs on sand soils in active dunes, interior fossil dunes, and flood plain alluvium (73 Fed. Reg. 1525). It prefers sandy, well-drained soils in maritime chaparral, valley oak woodlands, and grasslands.

Monterey spineflower is an opportunistic plant, with most seeds germinating in the winter. It produces only one seed per flower; however, plants may have several flowers, each of which can produce seeds. Seeds are dispersed within and between plant colonies by wind or attaching to animals (73 Fed. Reg. 1525). Monterey spineflower depends on successful seed set each year from December through September; therefore, protection of plants from germination through the seed set is important.

Threats: Human disturbances and competition for space are the primary threats to Monterey spineflower.

Critical Habitat: The current critical habitat was designated in January 2008. The designation includes nine units of critical habitat, totaling approximately 11,055 acres in Santa Cruz and Monterey Counties. Of these, three units, totaling approximately 429 acres, are within the littoral cell adjacent to the coast. Table A-5 provides details of the Monterey spineflower critical habitat units in the littoral cell.

Table A-5: Monterey Spineflower Critical Habitat in the Littoral Cell

County	Reach	Unit Name	Area (acre)	Figure	Notes
Santa Cruz County	7	Unit 6: Manresa	94	Figure 5-6	Includes coastal bluffs along the immediate coast, south of Seacliff State Beach and north of Sunset State Beach. It is completely within the boundaries of Manresa State Beach.
	7	Unit 1: Sunset	85	Figure 5-6	Includes coastal beaches, dunes, and bluffs within Sunset State Beach. Unit 1 supports a large population of Monterey spineflower.
Monterey County	7	Unit 2: Moss Landing	250	Figure 5-6	Consists of coastal beaches, dunes, and bluffs north and south of Moss Landing. The areas north of Moss Landing are within the littoral cell. This area includes portions of Zmudowski State Beach and Moss Landing State Beach, between the mouth of the Pajaro River and Elkhorn Slough. The southern portion is within the Salinas River State Beach.

Source: 73 Fed. Reg. 1525

Primary constituent elements of Monterey spineflower critical habitat include suitable sandy substrate with minimal competition for space. These areas can be suitable coastal dune, coastal scrub, grassland, maritime chaparral, oak woodland, and interior floodplain dune communities. Areas should have sufficient size and spatial arrangement to maintain plant communities.

A.8.3. Robust Spineflower (*Chorizanthe robusta* var. robusta) (FE, CH)

Robust spineflower is a low-growing herb with a branched from the base and a cluster of leaves arising from the base of the stem. It has soft hairs that are grayish or reddish in color. It reaches up to 20 inches tall. It is distinguished by white, or at times, pinkish, translucent margins on the lobes of the leaves surrounding the flower cluster. Its flowers are white- to rose-colored.

Listing Status: Robust spineflower was listed as endangered in February 1994 (59 Fed. Reg. 5499). Critical habitat was designated in May 2002 (67 Fed. Reg. 37336).

Range: Robust spineflower is endemic to sandy soils in central California. They are found in southern Santa Cruz County (67 Fed. Reg. 37336).

Life Cycle and Habitat Use: Robust spineflower is a short-lived annual species. It germinated during the winter and flowers between April and June. Seeds mature by August. Seed dispersal is facilitated by spines that attached to animals. In the summer months, plants dry out and turn a rusty hue (67 Fed. Reg. 37336).

Threats: Threats include habitat loss and fragmentation.

Critical Habitat: Critical habitat includes six units, totaling 469 acres, along the coast or at inland sites that currently sustain the species. Unites A, B, C, D, and E are about 1 mile from the coast. Unit F, Sunset, is located within the boundaries of Sunset State Beach.