VOLUME VII
Appendices H – K

Appendix H: Beneficial Use Assessment
Appendix I: Endangered Species Evaluation
Appendix J: Essential Fish Habitats
Appendix K: Proposed Monitoring Program

City of San Diego
Public Utilities Department

March 2022

LIST OF VOLUMES

Volume I	Executive Summary
Volume II	Part 1: Basis of Application Part 2: NPDES Application Forms Part 3: Antidegradation Analysis
Volume III	Large Applicant Questionnaire
Volume IV	Appendix A: Existing Metro System Facilities and Operations Appendix B: Planned Metro System Facilities Improvements
Volume V	Appendix C: Ocean Benthic Conditions *Appendix C1: Benthic Sediments, Invertebrates and Fishes* *Appendix C2: San Diego Benthic Tolerance Intervals* *Appendix C3: San Diego Sediment Quality Assessments* *Appendix C4: Assessment of Macrobenthic Communities off Point Loma* *Appendix C5: Bioaccumulation Assessment*
Volume VI	Appendix D: Point Loma Plume Behavior & Tracking Summary Appendix E: 2014-2020 Kelp Forest Ecosystem Monitoring Summary Appendix F: 2014-2020 Coastal Remote Sensing Summary Appendix G: 2016-2020 Summary of Remotely Operated Vehicle Surveys for Outfall Integrity
Volume VII	Appendix H: Beneficial Use Assessment Appendix I: Endangered Species Evaluation Appendix J: Essential Fish Habitats Appendix K: Proposed Monitoring Program
Volume VIII	Appendix L: 2020 Annual Biosolids Report
Volume IX	Appendix M: 2020 Annual Pretreatment Report Appendix N: 2020 Annual Local Limits Reevaluation Report
Volume X	Appendix O: Re-entrainment Appendix P: Oceanography Appendix Q: Initial Dilution Simulation Models Appendix R: Dissolved Oxygen Demand Appendix S: Analysis of Ammonia Appendix T: California Ocean Plan (2020 or most recent, 2019) Appendix U: Correspondence

APPENDIX H

BENEFICIAL USE ASSESSMENT

City of San Diego
Public Utilities Department

March 2022

Table of Contents

Section **Page**

List of Figures

List of Tables

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
AQUA	Mariculture
ASBS	Areas of Special Biological Significance
BIOL	Biological Habitats of Special Significance
BIP	Balanced Indigenous Population
BOD	biochemical oxygen demand
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CES	contaminants of emerging concern
CESA	California Endangered Species Act
CFGC	California Fish and Game Commission
CFU	Colony Forming Units
CMLMA	California Marine Life Management Act
CMLPA	California Marine Life Protection Act
CNFMP	California Nearshore Fishery Management Plan
COMM	Ocean Commercial and Non-freshwater Sport Fishing
CPFV	Commercial Passenger Fishing Vessel
CPS	Coastal Pelagic Species
CPS FMP	Coastal Pelagic Species Fishery Management Plan
CRFS	California Recreational Fisheries Survey
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DPS	Distinct Population Segment
EFH	essential fish habitat
EFHA	Essential Fish Habitat Assessment
ENSO	El Niño-Southern Oscillation
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FDA	United States Food and Drug Administration
FIB	fecal indicator bacteria
FMCs	fishery management councils
FMP	fishery management plan
HAPC	Habitat Areas of Particular Concern

HCB	hexachlorobenzene
IPHC	International Pacific Halibut Commission
km	kilometer
m	meter
MAR	Marine Habitat
mgd	million gallons per day
mi	mile
mi^2	square miles
MIGR	Migration of Aquatic Organisms
mL	milliliter
MMPA	Marine Mammal Protection Act
MMS	Marine Mammal Systems
MPAs	Marine Protected Areas
NAV	Navigation
NAVFAC	Naval Facilities Engineering Command
nm	nautical mile
NMFS	United States National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPGO	North Pacific Gyre Oscillation
NPS	National Park Service
OEHHA	Office of Environmental Health Hazard Assessment
PAHs	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council
PLOO	Point Loma Ocean Outfall
PLWTP	Point Loma Wastewater Treatment Plant
POSD	Port of San Diego
POTW	publicly owned treatment works
ppm	parts per million
PUD	City of San Diego’s Public Utilities Department
PWC	personal watercraft
RARE	Rare and Endangered Species
REC-1	Water Contact Recreation
REC-2	Non-Contact Water Recreation
RWQCB	Regional Water Quality Control Board, San Diego
SCCWRP	Southern California Coastal Water Research Project

SCUBA	self-contained underwater breathing apparatus
SHELL	Shellfish Harvesting
SIO	Scripps Institution of Oceanography
SMCA	State Marine Conservation Area
SMR	State Marine Reserve
SPWN	Spawning, Reproduction, and/or Early Development
STV	Statistical Threshold Value
SWQPA	State Water Quality Protection Area
SWRCB	State Water Resources Control Board
USDON	United States Department of the Navy
WILD	Wildlife Habitat
WSFMP	White Seabass Fishery Management Plan
ZID	zone of initial dilution

H.1 INTRODUCTION

This document is in support of the City of San Diego's (City's) application to the Regional Water Quality Control Board, San Diego (RWQCB) and the United States Environmental Protection Agency (EPA) requesting renewal of its' National Pollutant Discharge Elimination System (NPDES) permit for the discharge of treated wastewater to the Pacific Ocean from the 23,760-foot-long, 320-foot deep Point Loma Ocean Outfall (PLOO). The City's application requests renewal of modified secondary treatment requirements for the PLOO discharge in accordance with provisions of Section 301(h) and 301(j)(5) of the Clean Water Act (RWQCB and EPA 2017). The current 5-year discharge permit for the modified Point Loma discharge expires on September 30, 2022 (RWQCB and EPA 2017). The City's 301(h) renewal application will not request any increase in currently permitted discharge flows or mass emissions. Treatment operations at the Point Loma Wastewater Treatment Plant (PLWTP) will be conducted to ensure compliance with applicable water quality standards established in the California Ocean Plan State Water Resources Control Board (SWRCB) (SWRCB 2019).

During the upcoming renewed permit cycle, estimated to begin by 2024, changes to the city's wastewater system will result in a significant improvement to the discharge through the PLOO. By December 31, 2027 Phase 1 of the Pure Water San Diego Program (Pure Water) is expected to begin operation. On average, Pure Water will divert up to 52 million gallons per day (mgd) of wastewater away from the PLWTP to produce 30 mgd of water suitable for potable reuse, and up to 12 mgd of reclaimed water for non-potable reuse (e.g., irrigation, industrial and commercial uses). This diversion will not only augment San Diego's local water supply; but will also reduce the flow and pollutants discharged through the PLOO.

This Beneficial Use Assessment was prepared as part of the City of San Diego's 301(h) application for renewal of modified secondary treatment requirements. The term "beneficial uses" refers to the various ways water is beneficial to man and the environment. State and federal water quality standards are designed to protect existing and potential beneficial uses.

The *Water Quality Control Plan Ocean Waters of California* (Ocean Plan) identifies beneficial uses for California ocean waters and establishes standards to protect them (SWRCB 2019). Beneficial Uses specific to the San Diego Region are designated by the RWQCB in the *Water Quality Control Plan for the San Diego Basin* (Basin Plan). (RWQCB 2021). The RWQCB also identifies beneficial uses in individual waste discharge orders or NPDES permits.

These sources identify thirteen beneficial uses to be protected in the vicinity of the PLOO discharge. Accordingly, they are enumerated in the PLWTP NPDES permit.[1] No new or proposed beneficial uses have been added since that time. These designated beneficial uses are summarized below in Table H-1.

---

[1] See Tables F6 and F7 of RWQCB Order No R9-2017-0007 (NPDES No. CA0107409) (RWQCB and EPA, 2017).

Table H-1:
Point Loma Wastewater Treatment Plant NPDES Permit Beneficial Uses

Water Contact Recreation (REC-1)	Recreational uses involving body contact with water, such as swimming, wading, water skiing, skin diving, windsailing, surfing, fishing from paddle craft, or other uses where ingestion of water is reasonably possible.
Non-Contact Water Recreation (REC-2), including Aesthetic Enjoyment	Recreational uses involving the presence of water, but not necessarily requiring body contact, such as picnicking, sunbathing, hiking, beachcombing, sport fishing, pleasure boating, tide-pooling, marine life study and enjoyment of intangible assets associated with natural settings.
Ocean Commercial and Non-freshwater Sport Fishing (COMM)	Commercial collection of fish and shellfish, including those collected for bait, plus sport fishing in the ocean, bays, estuaries, and similar non-freshwater areas.
Wildlife Habitat (WILD)	Provides a water or food supply (and supports a vegetative habitat) for the maintenance of wildlife.
Preservation of Rare and Endangered Species (RARE)	Provides an aquatic habitat which is necessary, at least in part, for the survival of identified rare and endangered species.
Marine Habitat (MAR)	Provides for the preservation of the marine ecosystem, including the propagation and sustenance of fish, shellfish, marine mammals, waterfowl, and marine vegetation.
Shellfish Harvesting (SHELL)	Collection of filter-feeding shellfish such as clams, oysters, and mussels for sport or commercial purposes.
Preservation and Enhancement of Biological Habitats of Special Significance (BIOL)	Waters support designated areas or habitats, including, but not limited to established refuges, parks, sanctuaries, ecological reserves or preserves, and Areas of Special Biological Significance (ASBS), where the preservation and enhancement of natural resources requires special protection.
Mariculture (AQUA)	Promotes the culture of plants and animals in marine waters independent of any pollution source.
Migration of Aquatic Organisms (MIGR)	Supports and facilitates the migration of marine organisms.
Navigation (NAV)	Waters used for shipping, travel or other transportation by private, commercial or military vessels.
Spawning, Reproduction and/or Early Development (SPWN)	Waters supporting high quality habitats necessary for reproduction and early development of fish and wildlife.
Industrial Service Supply (IND)	Waters for industrial use that do not depend primarily on water quality including hydraulic conveyance and cooling water supply.

This Beneficial Use Assessment describes:

1) The existing environment at Point Loma
2) Beneficial Uses in the vicinity of the Point Loma
3) The effects of the existing PLWTP discharge on Beneficial Uses
4) The potential impacts of the proposed (future) operation of the PLWTP discharge

It also responds to the following specific questions in the PLOO NPDES renewal application:

1) Are commercial or recreational fisheries located in areas potentially affected by the discharge and have commercial or recreational fisheries been affected by the discharge?
2) Do recreational activities take place in areas potentially affected by the discharge and have recreational activities been affected by the discharge?
3) Are there any federal, state, or local restrictions on recreational activities in the vicinity of the discharge?
4) Are endangered species present in the vicinity of the discharge; and, have endangered species been negatively affected by the discharge?

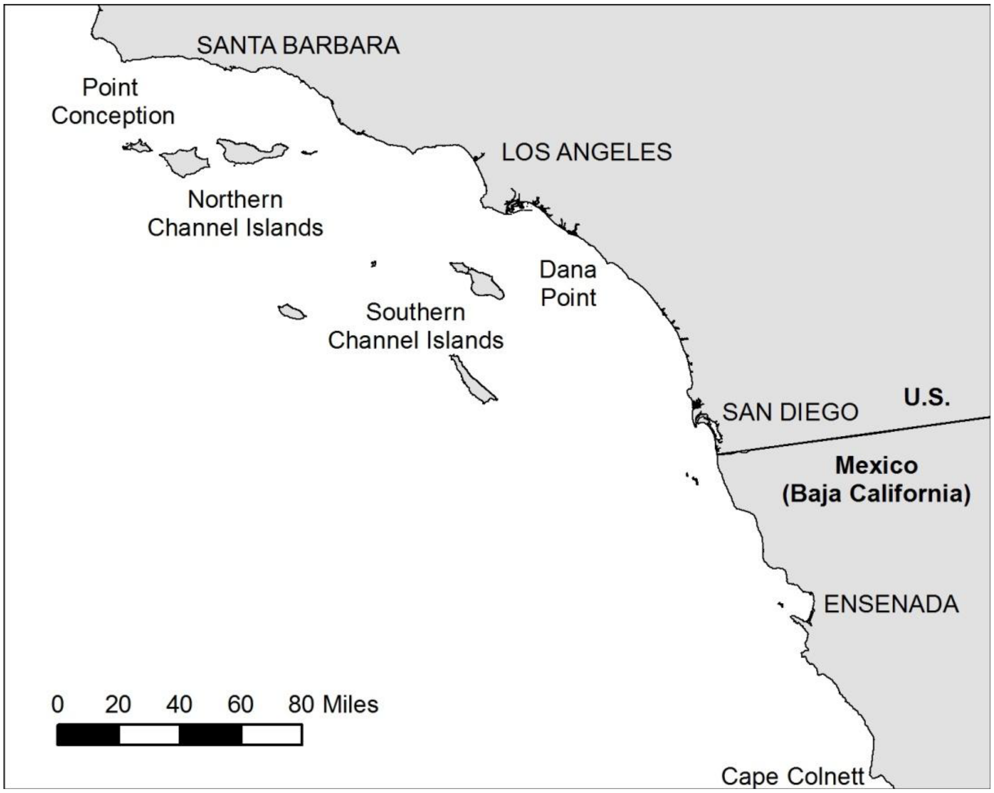
At the time of preparation of this NPDES application, consultations between EPA and NOAA Fisheries were ongoing regarding Endangered Species and Essential Fish Habitat effects associated with the PLOO discharge regulated under Order No. R9-2017-0007. Due to the timing of finalizing that review and the completion of this application, information from that review could not be included in this renewal application. If necessary, the information presented herein may be augmented in the future for use in any Endangered Species and Essential Fish Habitat assessment that may be necessary in conjunction with the renewal process for Order No. R9-2017-0007.

H.2 EXISTING ENVIRONMENT

H.2.1 Project Area

The marine waters off Point Loma are located in the Southern California Bight - a broad ocean embayment created by an indentation of California’s coastline south of Point Conception (Figure H-1). The Southern California Bight extends from Point Conception south to Cabo Colnett, Baja California, Mexico, and west to the Santa Rosa-Cortes Ridge. The continental shelf in this area has several submarine valleys and submerged mountains whose peaks form the offshore islands. Submarine ridges and troughs in the Southern California Bight generally run northwest to southeast, with the exception of the east-west trending Santa Barbara Channel.

Figure H-1:
Southern California Bight



The Southern California Bight's large urban population centers and busy harbors make it one of the most heavily utilized marine ecosystems on earth, yet the Southern California Bight supports a diverse assemblage of marine life including marine algae and plants, invertebrates, fish, sea turtles, marine mammals, sea birds, and a wide variety of habitats (Dailey et al. 1993, Schiff et al. 2000, Leet et al. 2001, Allen et al. 2005, 2006, 2011, Allen and Cross 2006, California Marine Life Protection Act (CMLPA) 2009, Howard et al. 2012, Ranasinghe et al. 2012, Setty et al. 2012, Southern California Coastal Water Research Project (SCCWRP) (SCCWRP 2012, 2021a), United States Department of the Navy (USDON) 2013.

Marine habitats in the Southern California Bight range from sandy beaches and rocky coasts to deep, soft- and hard-bottom areas. Intertidal zones include sandy beaches, rocky shores, tidal flats, coastal marsh, and manmade structures. There are nearly 40 tidally-influenced estuaries and lagoons with associated open water, soft bottom, tidal mud flats, and eelgrass beds.

Sandy and soft-bottom habitats dominate shorelines and subtidal habitats in the southern region. These substrates lack the relief or structural complexity of hard-bottom habitats, but support species adapted to low-relief, dynamic environments. Invertebrates and bottom-dwelling fish are the most common species in soft substrate areas.

Hard-bottom habitats like rocky reefs are less common but generally have greater productivity and species diversity than soft-bottom habitats. Kelp forests are associated with shallow rock bottoms while deep-sea corals and sponges are found in deep rock habitats. Kelp forest extending through the water column form dense surface canopies and promote high productivity and diversity of marine life.

The Southern California Bight's broad continental shelf includes channels, basins, and canyons, interspersed by shallower ridges. Underwater pinnacles and rocky outcrops are important aggregation sites for fish and other species. Marine canyons contain unique deep-water communities and provide foraging areas for seabirds and marine mammals. The marine environment surrounding the Channel Islands affords a distinctive ecological setting, with nutrient-rich waters and high-relief rocky habitats fostering substantial biodiversity.

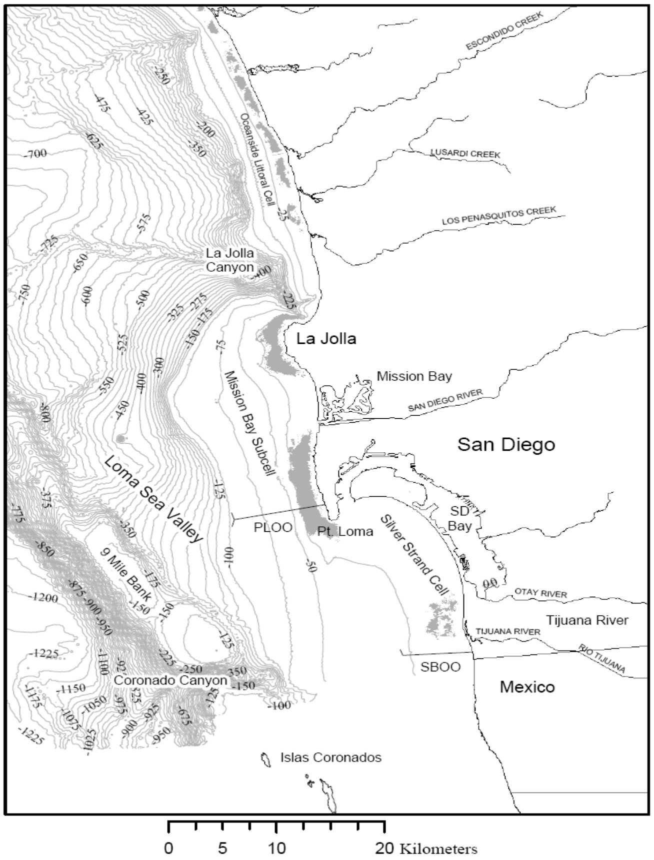
H.2.2 Point Loma Ocean Outfall

The PLOO discharges approximately 140 mgd of treated wastewater, generated by more than 2.3 million residents and industries (with source controls) in a 450-square-mile (mi^2) (1,165-square-kilometer (km^2)) area. [2] The PLWTP has a permitted capacity of 240 mgd. Treated wastewater is discharged through the PLOO 4.5 miles (mi) (7.2 kilometers (km)) offshore at a depth of approximately 310 feet (95 meters (m)) (Figure H-2; note the grey areas off Point Loma and La Jolla represent kelp beds).

---

[2] The average annual PLOO discharge flow during calendar year 2020 was 144.3 mgd.

**Figure H-2:
Location of the Point Loma Ocean Outfall**



The PLOO is one of the longest and deepest ocean outfalls in the world. It was extended to its present location in 1993 and is buried in a trench from shore through the surf zone out to a distance of about 2,600 feet (792 m) offshore. Over the next 400 feet (123 m) the pipeline gradually emerges from the rock trench. Beyond 3,000 feet (914 m) offshore, the remainder of the 4.5 mi (7.2 km) pipeline rests on a bed of ballast rock on the sea floor. The end of the pipeline connects to a perforated "Y" diffuser section of two legs, each 2,500 feet (762 m) long. Wastewater is discharged through diffuser ports ranging in depth from 306 feet (93 m) to 313 feet (95 m). Mathematical models of outfall operation indicate a median (50th percentile) initial dilution of 338:1 at a discharge flow of 240 mgd. The minimum month initial dilution (the initial dilution as determined assuming zero ocean currents and using the worst-case density conditions from over 13,000 density data profiles) is computed at 202:1.

The deep discharge and high initial dilution traps discharged diluted wastewater at a depth of more than 130 feet (40 m) below the ocean surface (Rogowski et al. 2012) (see Appendix D –Pt. Loma Plume Behavior and Tracking Studies, Appendix F – Coastal Remote Sensing 5-year Retrospective). This keeps the outfall plume in deep water areas and away from the near-shore environment (Rogowski et al., 2013; City of San Diego 2020). Another favorable feature of the PLOO is the location of the discharge near the break in the mainland shelf (Figure H-2). The shelf drops precipitously immediately offshore from the diffuser facilitating plume dispersal.

The pipeline and diffusers with their supporting bed of ballast rock form an artificial reef (see Appendix G – ROV Surveys of Discharge Area). The pipe and rock, covered with encrusted organisms (tube worms, anemones, barnacles) provide food and shelter to a variety of fish and invertebrates. This artificial habitat covers an area of about 22 acres (9 hectares) off Point Loma (assuming a 36 feet (11 m) width of pipe and ballast rock) (Wolfson and Glinski 1986).

Besides the PLOO, there are a number of other anthropogenic inputs to the continental shelf between La Jolla, California and the Mexico Border (Parnell and Riser 2012). These include tidal discharge, rainfall runoff, and storm drain flows from San Diego Bay and Mission Bay. The watershed management area of San Diego Bay covers about 450 mi^2 (1,165 km^2) and includes Otay and Sweetwater Rivers as well as Telegraph Canyon, Chollas, Switzer, and Paradise Creeks (City of San Diego 2008a). Mission Bay and the San Diego River also have an extensive watershed (440 mi^2 (1,140 km^2)) and contribute large flows to the ocean. Figure H-3 (from Ocean Imaging 2012) shows an example of the extensive turbidity plumes originating from Mission Bay, San Diego Bay, and other coastal sources following a major rainfall event.

Figure H-3:
Turbidity Plumes after Major Rainfall

San Diego Bay has been on the California state's list of impaired water bodies, with various sediments having high concentrations of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), copper and mercury (SWRCB 2018), EPA (EPA 2021). Some areas of the bay have been listed as impaired as a result of elevated indicator bacteria levels. A rough estimate of San Diego Bay's daily water exchange is 24,000 mgd, approximately 130 times the volume of flow from the PLOO (Bartlett et al. 2004).

Portions of Mission Bay have been identified by the SWRCB as water-quality limited because of elevated concentrations of indicator bacteria (SWRCB 2018). Other parts of the bay are also impaired as a result of elevated concentrations of toxics including PAHs, dichlorodiphenyltrichloroethane (DDT), heavy metals and toxic organic compounds (SDWCB 2018). A rough estimate of the Mission Bay water exchange rate (not including San Diego River output) is 3,600 mgd, or roughly 20 times the volume of flow from the PLOO (Bartlett et al. 2004).

Some beaches in San Diego County have been listed as bacteria-impaired water bodies (SWRCB 2018, EPA 2021) and none have been found to be impacted by the PLOO discharge (City of San Diego 2020). Ocean Beach is the closest of these beaches to the PLOO, at a distance of 7 mi away. San Diego River flows, dogs on the beach, and re-growth of indicator bacteria in wave-stranded kelp appear to be responsible for those impairments. Fecal material from dogs and birds has also been associated with bacterial exceedances that may impact nearshore water quality (Wright et al. 2009, Griffith et al. 2010, 2013, Araújo et al. 2014).

Further south, the Tijuana River and Estuary have historically been a source of significant contamination of the ocean in the San Diego area. The watershed that flows into them is about 1,731 mi^2 (4,483 km^2) in area; nearly three quarters of this watershed is in Mexico. The City of Tijuana has had limited sewage treatment facilities, with resulting overflows that have drained into the River and Estuary. The Tijuana River and Estuary have elevated water and sediment levels of metals such as lead, zinc, copper, chromium (Pb, Zn, Cu, and Cr, respectively), and PCBs (Bartlett et al. 2004). These concentrations increased significantly in the 1990s, coinciding with the introduction and expansion of the maquiladora (industrialization) program in Mexico.

Offshore, the EPA-designated LA-5 dredge disposal site is located 3.7 mi (6 km) south southwest of the PLOO. The LA-5 site ranges in depth from 328-410 feet (100-125 m) and was designed as a "non-dispersive" disposal site. Waste material is intended to remain stationary by virtue of being deep enough to limit resuspension by wave motion. The source of the material dumped at LA-5 is primarily sediments dredged from San Diego Bay. Because the material at LA-5 is from San Diego Bay, which has contaminated sediments, it is likely that sediments at the dredge disposal site are also contaminated (Parnell et al. 2008). The results of a multibeam sonar survey indicate that waste material is not all located within the designated disposal area (Bartlett et al. 2004). A total of 252 mounds were observed outside the disposal site, many of which were elliptical, indicating that material was dumped while vessels were underway. Dredged material dumped inshore of the disposal site may not remain stationary. The LA-5 site is just offshore of a 165 feet (50 m) scarp, therefore, mounds dumped inshore of the site are much shallower than intended. Resuspension from the shallower mounds constitutes another source of contamination that could influence water quality and biological conditions in the vicinity of

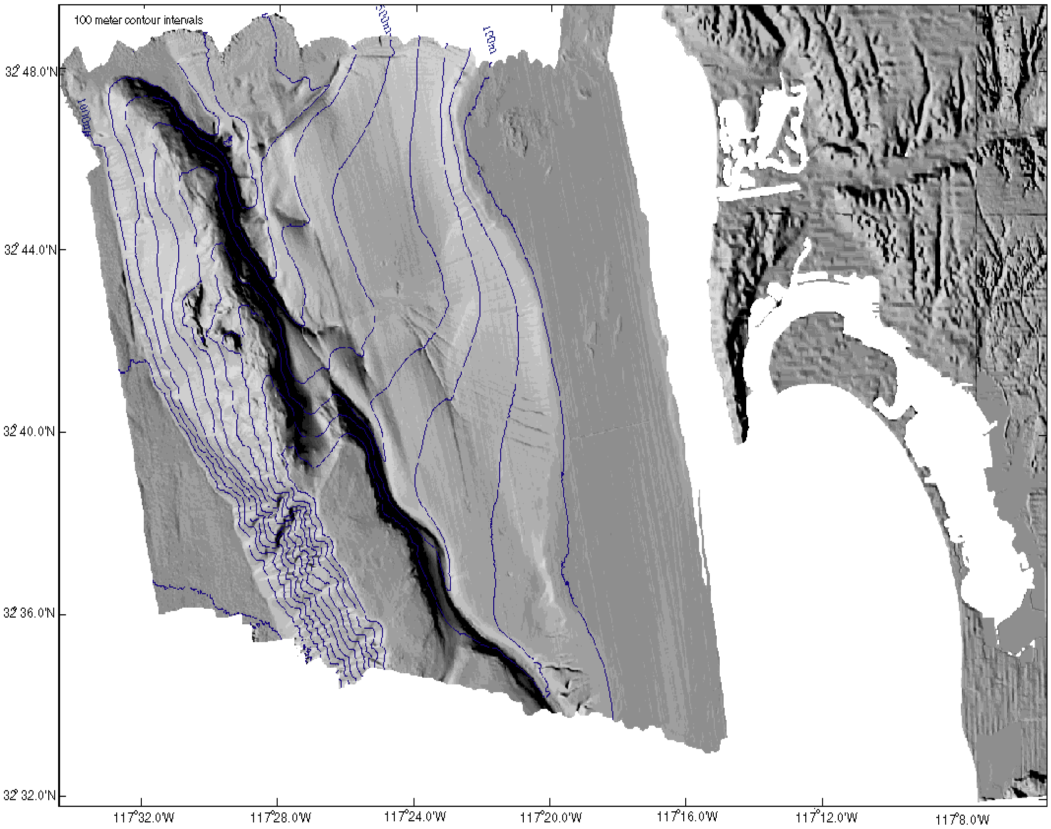
Point Loma. These unsanctioned dumps can elevate sample contamination in the area that is unrelated to the PLOO discharge (Parnell et al 2008).

H.2.3 Oceanographic Conditions

Bathymetry

Point Loma’s shoreline is primarily rocky reef with an occasional cobble or sand pocket beach. The principal feature of the nearshore marine environment is a large, 6 mile-long (10 km) kelp bed extending from the tip of Point Loma to the Mission Bay/San Diego River Jetty (Figure H-2). The kelp bed grows on a pavement-like mudstone/sandstone terrace from depths of about 25 feet (7.6 m) to about 90 feet (27 m) between 1/2 mi (0.8 km) from shore and 1 mi (1.6 km) from shore. The terrace is incised by shallow surge channels and covered in parts by cobbles and boulders. The terrace edge, the remnant of a now submerged seacliff, lies in 100 feet (30 m) depths. Here the bottom relief increases and pinnacles and large boulders rise above the fine gray bottom sands (California Department of Fish and Game (CDFG) 1968). In Figure H-4, the demarcation between the white nearer shore areas and the darker gray offshore waters corresponds roughly to this break (off Point Loma only). This also corresponds with the outer limit of the kelp bed, or about 90 feet (27 m) depth.

**Figure H-4:
Seafloor Bathymetry off San Diego, California**



Map from: USGS 1998. Note: Each minute of latitude on the vertical axis represents 1 nautical mile.

Beyond the outer edge of the kelp bed, about 1 nautical mile (nm) from shore, the seafloor gradually slopes downward (at an angle of about 1.5%) out to a shelf break at 350 feet, just outside of the 100 m contour line. Beyond the 100 m contour, the seafloor declines at an angle of 4% across the shelf break, then continues its gradual slope for another 5 mi out to a depth of 1,000 feet (305 m). This shelf area consists largely of unconsolidated bottom sediments.

Thermocline

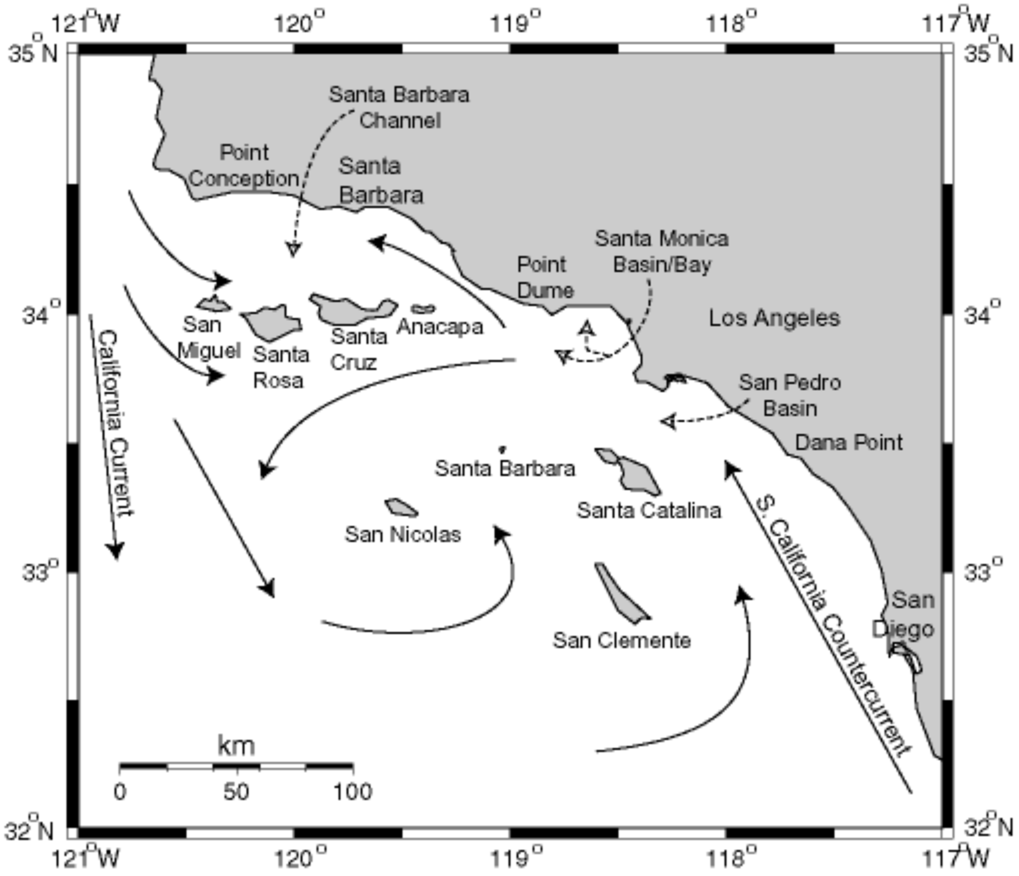
In the ocean, the thermocline, a vertical transition zone of rapidly changing temperature divides the upper layer of warmer water from the colder, deeper water (Noble 2009, California State University Long Beach (CSULB) 2014). Because density is controlled largely by temperature, the thermocline coincides with the pycnocline, a vertical zone of rapidly changing density. The density gradient across the pycnocline causes resistance to vertical mixing, restricting exchange between the surface waters and the deeper, colder waters. This phenomenon is referred to as water column stratification.

Seasonality is responsible for the main stratification patterns observed in the coastal waters off San Diego and the rest of southern California (Rogowski et al. 2012, 2013). Relatively warm waters and a more stratified water column are typically present during the dry season from May to September while cooler waters and weaker stratification characterize ocean conditions during the wet season from October to April. Winter storms bring higher winds, rain, and waves that result in a well-mixed, non-stratified water column (Hickey 1993). Surface waters begin to warm by late spring and are then subjected to increased surface evaporation. Once the water column becomes stratified, minimal mixing conditions typically remain throughout the summer and into early fall. Toward the end of the year, surface water cooling along with increased storm frequency returns the water column to well-mixed conditions. Interannual variations in the depth of the thermocline appear to be correlated with long-term climatic changes, El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Pacific Gyre Oscillation (NPGO) (Benjamin and Carton 1999, Schwing et al. 2002, Bjorkstedt et al. 2013, Miller et al. 2013).

Water Circulation

The cold California Current is the major surface current in the Southern California Bight (Figure H-5). This broad, slowly meandering, south-moving current extends from Vancouver, Canada to the southern tip of Baja California, Mexico from shore to several hundred miles offshore (Perry et al. 2007, Noble 2009). In deep waters offshore of the continental shelf, flows are southward all year round; however, over the continental shelf, southward flows occur only in spring, summer, and fall. During winter months, flow over the shelf reverses, and water moves northward as the Southern California Countercurrent. The transitions between northward and southward flows on the shelf occur seasonally, in March/April and October/November, thus are termed the "spring transition and fall transition”.

Figure H-5:
Circulation Patterns in the Southern California Bight



(After Hickey, B. M., 1992, Progress in Oceanography, V30: 37-115)

Below the thermocline, the California Undercurrent flows northward with speeds ranging from 3 to 25 centimeters per second (cm/sec); the maximum water velocity occurs at a depth of 60 m (NRC 1990). This northward flow opposes the California Current at the surface and spans the entire mid-latitude eastern boundary of the North Pacific (Pierce et al. 2000). The California Undercurrent is typically found inshore of the California Current and is composed of water originating in the Equatorial Pacific (Noble 2009). The flow of the California Undercurrent is relatively weak; its maximum strength occurs during the summer months and a secondary maximum occurs in the winter (Hickey 1993, Perry et al. 2007). This water mass can be delineated from deep water contained farther offshore in the California Current because the water of the California Undercurrent contains higher nutrient concentrations and lower dissolved oxygen concentrations.

Deepwater circulation can be divided into three seasonal patterns (CSULB 2013). From December to February, flow is strengthened and partially displaces the California Current to the west. From March to June, along-shore winds strengthen and drive the surface waters to create upwelling of deep cold water to the surface along the coast. The shift offshore creates a condition in which the California Current intensifies in localized areas due to bottom topography and current strength. July to November the California Current dominates, weakening the California Undercurrent (Perry et al. 2007). In general, the water contained in the California Undercurrent does not reach the surface. However, during periods of weak California Current flow (winter months or during an El Niño event), the California Undercurrent may reach the surface offshore of Los Angeles, join the California Countercurrent and flow as far north as Vancouver Island, Canada.

Upwelling

Upwelling is a wind driven, dynamic process that brings nutrient-rich deep water to the surface and nutrient-poor surface waters offshore through the interaction of currents, density, or bathymetry (Noble 2009). In wind driven upwelling, warmer surface waters are transported perpendicular to the direction of the wind. Deep, cold water moves vertically into the euphotic zone to replace the nutrient-poor surface water that was transported offshore.

Winds that promote upwelling are generally strong along the California coastline; upwelling in this region occurs throughout the year with the strongest upwelling in the spring and summer months (Schwing et al. 2000, Perry et al. 2007). In the Southern California Bight, upwelling tends to be limited to late winter and early spring due to a reduction in wind stress. Coastal upwelling appears to be the dominant process affecting the physical and ecological structure of eastern boundary current systems, including the California Current System. Coastal upwelling substantially affects regional and local oceanic circulation, thermohaline structure and stability, and water mass exchange between the coastal and deep ocean waters. Intense upwelling has been correlated to recruitment success for commercially important fish stocks in coastal California waters.

H.2.4 Biological Conditions

Marine life can be conveniently grouped into categories that reflect their spatial position in the ocean. Pelagic species occupy the water column. Epibenthic species live above the bottom, and benthic species live on the bottom or in the sediments. A general description of the food chain follows, beginning with the smallest organisms and ending with the largest.

Plankton

Plankton float or drift passively with currents and form the base of the oceanic food web. Plankton include a wide variety of bacteria (bacterioplankton), plant-like organisms and algae (phytoplankton), and animals (zooplankton) including fish larvae (ichthyoplankton). Although most planktonic species are microscopic, the term plankton is not synonymous with small size; some jellyfish can be as large as 10 feet (3 m) in diameter. Phytoplankton aggregate near the surface. They are grazed on by zooplankton, ichthyoplankton, and small fishes which in turn are consumed by larger fishes, birds, mammals, and man.

Phytoplankton

Marine phytoplankton are microscopic, single celled plants that use sunlight and chlorophyll to photosynthesize organic matter. Phytoplankton in the ocean's surface layers produce most of the organic matter in the sea and are crucial to overall ocean productivity. The distribution of most marine organisms is linked to phytoplankton productivity.

In general, phytoplankton are patchily distributed, occurring in regions with optimal conditions for growth. Nearshore ocean waters typically have a higher nutrient content and foster greater primary productivity and plankton biomass than open ocean waters.

In the Southern California Bight, waters from both the north and the south mix and promote increased phytoplankton abundance and diversity (Hardy 1993, Schiff et al. 2000, Kim et al. 2009). Over 280 species of phytoplankton have been reported there (Eppley 1986). The diversity of phytoplankton species in the region reflects the transition from subarctic waters in the north to more subtropical waters in the south. Highest levels of productivity occur in the spring/summer months with the lowest levels of production occurring during the winter months.

Along the California coast, there is a decrease in phytoplankton production in the surface waters during El Niño conditions due in part to a decrease of upwelling strength (Kahru and Mitchell 2000, Hernández de la Torre et al. 2004). This causes the chlorophyll maximum to occur deeper in the water column (McGowan 1984, Bjorkstedt et al. 2013, Chenillat et al. 2013). In addition, El Niño conditions weaken the California Current and tend to favor an increase in subtropical species (Leet et al. 2001). Following an El Niño, coastal phytoplankton abundance increases to long-term average levels (Lavaniegos et al. 2003, Hernández de la Torre et al. 2004). Conversely, La Niña conditions cause a shift towards more subarctic phytoplankton species (Goes et al. 2001).

Marine phytoplankton populations can undergo periods of explosive growth in response to favorable environmental conditions. These events are called algal blooms. Like other coastal regions, southern California can experience rapid population growths of phytoplankton. Some species of phytoplankton can produce potentially harmful toxins that can affect wildlife including birds, fish, shellfish, and mammals (Scholin et al. 2000, Gulland et al. 2002, Kudela et al. 2003, Brodie et al. 2006, Kim et al. 2009, Carter et al. 2013, Schnetzer et al. 2013).

The first recognized toxic algal bloom occurred in Monterey Bay in 1991 resulting in the deaths of pelicans and cormorants that had consumed sardines containing high levels of domoic acid from the phytoplankton species *Pseudo-nitzschia* (SCCWRP 2013). Domoic acid is a water-soluble neurotoxin that accumulates in filter-feeding organisms including shellfish and planktivorous fish such as anchovy and sardine. Humans consuming domoic acid-contaminated seafood experience Amnesic Shellfish Poisoning whose symptoms can include vomiting, confusion, memory loss, coma and even death. Although fatal Amnesic Shellfish Poisoning cases in humans are rare, domoic acid poisoning has caused large-scale mortality in marine animal populations including sea lions and seabirds, and domoic acid-related shellfish closures along U. S. coasts have caused significant economic loss (National Oceanic and Atmospheric Administration (NOAA 2014a).

In 1998, a *Pseudo-nitzschia* bloom in Monterey was followed by over 400 sea lion carcasses appearing on shore exhibiting signs of neurological damage from eating infected sardines. A harmful red tide event in 2007 caused by *Cochlodinium* killed abalone at the Monterey Abalone Company, costing almost $60,000 in damage. Algal blooms may also be detrimental because the size of the bloom along with other environmental conditions may lead to depletion of oxygen levels in the water.

Harmful Algal Blooms (HABs) are defined as algal blooms that are harmful to humans or biological resources. Harmful algae are generally present year-round in the water column in very small amounts, but only become a problem for humans and animals when the phytoplankton populations reach particularly high levels. Algal blooms and HABs are often visible due to pigments produced by the phytoplankton and may also be referred to as "red tides". In April 2020, during a period of seasonal upwelling providing nutrients to the surface and the area experiencing above normal precipitation Southern California became subjected to an unusually long bloom that resulted fish mortality appearing on beaches from Orange County to San Diego (SCCOOS 2020).

Several researchers have determined that the extent of algal blooms in the Southern California Bight region have increased over the last two decades (Kahru et al., 2012; Nezlin et al., 2012). However, according to reports from Ocean Imaging Inc., there were no red tide events directly associated with the PLOO. Blooms tend to originate in shallower waters off northern San Diego County and move south, or off southern San Diego and move north (Svejkovsky, 2015-2017, Hess 2018-2021, Appendix F). Nevertheless, red tides have been recorded in the Southern California Bight region for over a century (Allen, 1933; Horner et al., 1997; Kim et al., 2009; McGowan et al., 2017; Svejkovsky J. 2003-2018; Torrey, 1902). The depth of the PLOO discharge inhibits the effluent from reaching the surface waters due to thermal stratification, which typically results in the plume being trapped offshore at depths of 40m to 60m below the surface (City of San Diego 2018, Rogowski et al 2012, 2013). During the spring and summer months, when algal blooms are most prevalent in the Southern California Bight region (Smith et al 2018), thermal stratification is the strongest and plume trapping depths are greatest (Bartlett et al 2004). Even in the winter months, when vertical stratification of the water column is weakest, the PLOO plume does not typically rise to the surface (Svejkovsky 2015 -2017, Hess 2018-2021).

Blooms of harmful algal species can pose threats to the marine environment and have substantial economic impact. (NOAA 2021a). They occur in coastal waters in response to a variety of environmental conditions including temperature, nutrients, light intensity, and currents. The Southern California Bight receives large amounts of natural nutrients via upwelling; but is also subject to anthropogenic input from atmospheric deposition, urban runoff, outflow from rivers, estuaries, harbors and wastewater effluents. Considerable work is currently underway to investigate the possible factors contributing to HABs in the Southern California Bight, the result of which can guide future regulatory and management decisions (SCCWRP 20201a, 2021b). Through its participation in the SCCWRP San Diego will be participating in these studies and can modify its monitoring program as necessary to support these efforts.

Zooplankton

Zooplankton do not photosynthesize, but instead, rely upon phytoplankton as a source of food. They are taxonomically and structurally diverse, ranging in size from microscopic unicellular organisms to large multicellular organisms. Zooplankton may be herbivorous (consuming plants), carnivorous (consuming animals), detrivorous (consuming dead organic material), or omnivorous (consuming a mixed diet). Examples of zooplankton include foraminifera, pteropods, copepods, and myctophid fish.

Along the California coast the abundance of zooplankton is correlated with the strength of the California Current such that high levels of flow result in high zooplankton biomass (Dawson and Pieper 1993). Zooplankton biomass tends to reach its maximum in the summer months, coinciding with peak krill (*Euphausia*) biomass. The high abundance of euphasiids attracts whales to congregate and feed off the California and Mexico coastlines (Burtenshaw et al. 2004).

In the Southern California Bight, El Niño and La Niña conditions affect the distribution of zooplankton (Suntsov et al. 2012). During strong El Niño events, macrozooplankton biomass declines substantially (Roemmich and McGowan 1995, McGowan et al. 1998). During the 1998 El Niño event, the macrozooplankton biomass was lower than ever documented in the 1951 to 1998 record (Hayward 2000). Southern, warm-water species become more abundant during El Niño events and northern, cool-water species decline.

During La Niña conditions, macrozooplankton biomass is anomalously high and subarctic species are more abundant (Schwing et al. 2000). Increased upwelling during a La Niña event can negatively impact the recruitment of benthic nearshore organisms (urchins, barnacles, and crabs); these organisms are dependent on relaxed upwelling conditions to transport planktonic larvae onshore for settlement (Schwing et al. 2000).

Nekton

Nekton are organisms that swim freely, are generally independent of currents, and, range in size from microscopic to gigantic, such as whales. Nekton include invertebrates (e.g., squid) and vertebrates (marine mammals, sea turtles and fish). Nekton are discussed in the following sections on essential fish habitat (EFH), commercial and recreational fisheries, and endangered species.

Marine Habitats and Ecology

The Southern California Bight is influenced by two major oceanic currents: the southward-flowing, cold-water California Current and the northward-flowing, warm-water California Countercurrent (Perry et al. 2007, CSULB 2013). These currents mix in the Southern California Bight and strongly influence patterns of ocean water circulation, sea temperatures, and distributional trends of marine flora and fauna along the southern California coast and Channel Islands (Dailey et al. 1993, Schiff et al. 2000, Horn and Allen 1978, Leet et al. 2001, Horn et al. 2006, Miller and Schiff 2012, Ranasinghe et al. 2012, Setty et al. 2012, Koslow et al. 2013).

High species richness is a product of the region's complex oceanographic topography and the convergence of multiple, influential water masses (Noble 2009). These include (1) large scale climate processes such as the ENSO, PDO, and NPGO that can affect long-term trends (Bjorkstedt et al. 2013, NOAA 2021), (2) the California Current System coupled with local gyres that transport distinct water masses into and out of the Southern California Bight throughout the year, and (3) seasonal changes in local weather patterns. Relatively warm waters and a more stratified water column are typically present during the dry season from May to September while cooler waters and weaker stratification characterize ocean conditions during the wet season from October to April. Winter storms bring higher winds, rain, and waves creating a well-mixed, non-stratified water column. Surface waters begin to warm by late spring and are then subjected to increased surface evaporation. Once the water column becomes stratified, minimal mixing conditions typically remain throughout the summer and into early fall. Toward the end of the year, surface water cooling along with increased storm frequency returns the water column to well-mixed conditions.

The Southern California Bight is home to more than 5,000 species of marine invertebrates, over 480 species of marine fish, five species of sea turtles, 39 species of marine mammals, and 195 species of coastal and offshore birds (Dailey et al. 1993, Schiff et al. 2000, Leet et al. 2001, Allen et al. 2005, 2006, 2011, Allen and Cross 2006, CMLPA 2009, Ranasinghe et al. 2012, Setty et al. 2012, SCCWRP 2012, 2014, 2020). The diversity of marine life is greatest in southern California and declines to the north through the region (Horn and Allen 1978, Horn et al. 2006). The Point Loma area is located within a transitional zone between subarctic and subtropical water masses. Point Conception, California (34.5 °North) is the distinguished biogeographical boundary between subtropical species (i.e., species with preferences of temperatures above 50-68 degrees Fahrenheit °F (10 to 20 degrees Celsius (°C)) of the San Diego Province and temperate species (i.e., species with temperature preferences below 59 °F (15 °C)) of the Oregon Province (Horn et al. 2006, Suntsov 2012).

The California Current system is rich in microscopic organisms (i.e., diatoms, tintinnids, and dinoflagellates) which form the base of the food chain in the area (Hardy 1993). Small coastal pelagic fish and squid depend on this planktonic food supply and in turn are fed upon by larger species. Groundfish (e.g., flatfish, roundfish, skates/sharks/chimeras, rockfish, etc.) are important recreational and commercial species (Love 2006). The shelf and slope demersal rockfish are the most specious genus of fish off the western coast of North America (Love et al. 2002). These fish are typically the dominant species in many ichthyological surveys, in terms of abundance and diversity, especially between the 20 to 200 m isobaths. Highly migratory species (e.g., tuna, billfish, sharks, dolphinfish, and swordfish) and coastal pelagic species (e.g., anchovies, mackerels, sardines, and squids) support extensive fisheries in the area (Hackett et al. 2009).

The diverse habitats of the Southern California Bight greatly influence the distribution of marine fauna and flora in the area (Horn et al. 2006, Miller and Schiff 2012, McClatchie 2014). Cross and Allen (1993) defined fish habitats in three broad categories: the pelagic zone, soft substrate habitats (i.e., bays, estuaries, open coast), and hard substrate and kelp bed habitats (i.e., rocky habitats, reefs). The pelagic zone, relating to open water, is the largest habitat in the area with 40% of the fish species inhabiting this area. This zone is subdivided into three distinct regions: epipelagic (up to 50 m deep), mesopelagic (50 to 500 m deep), and bathypelagic regions (greater than 500 m deep). The epipelagic region is inhabited by small, planktivorous schooling fish (e.g., northern anchovy), predatory schooling fish (e.g., Pacific mackerel), and large solitary predators (e.g., blue shark). Abundance of all epipelagic species changes seasonally with fish moving offshore to spawn. The mesopelagic region is characterized by steep environmental gradients and fish that are small, slow growing, long-lived, and reproduce early and repeatedly (e.g., bigeye lightfish). The bathypelagic zone is a rather uniform region containing large, sluggish, fast growing, short-lived fish, that reproduce late and typically only once (e.g., bigscale and hatchetfish) (Cross and Allen 1993, Love et al. 2009).

Typical fish utilizing soft substrates (sand, silt, and mud) include sharks, skates, rays, smelts, flatfish (flounders), gobies and northern anchovies. Regions with hard substrates and kelp beds (*Macrocystis*) are not as abundant as other benthic habitats in the Southern California Bight, but provide productive habitats for many species.

Shallow reefs (i.e., <30 m depth) are the most common type of hard substrate (i.e., coarse sand, calcareous organic debris, rocks) found in the area. These reefs also support kelp beds, which serve as nursery areas for various fish species. Rocky intertidal regions are often turbulent, dynamic environments, where organisms must cope with stresses associated with tides (e.g., changes in temperature, salinity, oxygen, and pH) and wave impact. Deep reef fish, found along deep banks and seamounts, are typically large, mobile species (e.g., rockfish and spiny dogfish).

Kelp beds promote a high diversity of associated marine organisms (Foster and Schiel 1985, Reed et al. 2011, Foster et al. 2013). Smaller fish feed on high plankton densities in the area, while larger fish congregate to feed on smaller species. Kelp beds are especially important habitats for young-of-the-year rockfish species, such as the kelp rockfish, whose densities positively correlate to the size of the kelp bed.

Inshore areas (bays and estuaries) provide nursery habitats and feeding grounds to a variety of species, some of commercial importance (e.g., California halibut) (Allen et al. 2006). San Diego Bay's seagrass beds are used by schooling species, such as anchovies and topsmelt (Allen et al. 2002) with the highest abundance and biomass of fish occurring in the spring (i.e., April) and summer (i.e., July). Juvenile northern anchovy, topsmelt, and slough anchovy comprise up to 79% of the fish in the Bay.

The influence of the California Current on the physical and biological environment of the Southern California Bight fluctuates significantly on a year-to-year basis (Noble 2009, Bjorkstedt et al. 2013, Koslow et al. 2013, Miller and McGowan 2013). It is also affected by larger-scale climate variations, such as ENSO, PDO, and NPGO (Dayton and Tegner 1984, 1990, Tegner and Dayton 1987, 1991, Dayton et al. 1992, Hickey 1993, Tegner et al. 1996, 1997, Horn and Stephens 2006, Parnell et al. 2010, Miller and Schiff 2012, Miller et al. 2013, NOAA 2021). The El Niño-La Niña n Oscillation is the result of interannual changes in sea level pressures between the eastern and western hemispheres of the tropical Pacific; these events can initiate large shifts in the global climate, atmospheric circulation, and oceanographic processes (Doney et al. 2012, Chenillat et al. 2013, NMFS 2013a, NOAA 2021, Sydeman et al. 2013).

El Niño conditions typically last 6 to 18 months although they can persist for longer periods of time. Under normal conditions, rainfall is low in the eastern Pacific and is high over the warm waters of the western Pacific. El Niño conditions occur when unusually high atmospheric pressure develops over the western tropical Pacific and Indian Oceans and low sea level pressure develops in the southeastern Pacific. During El Niño conditions, the trade winds weaken in the central and west Pacific; thus, the normal east to west surface water transport and upwelling along South America decreases. This results in increased (sometimes extreme) rainfall across the southern U.S. and Peru and drought conditions in the western Pacific (Field et al. 2003). La Niña is the opposite phase of El Niño in the Southern Oscillation cycle. La Niña is characterized by strong trade winds that push the warm surface waters back across to the western Pacific increasing upwelling along the eastern Pacific coastline, causing unusually cold sea surface temperatures.

The PDO is a longer-term climatic pattern than El Niño with similar warm and cool phases that may persist for 20 to 30 years (Miller 1996, Benjamin and Carton 1999). PDO warm regimes increases water temperature, giving temporary advantage to warm-water species, allowing them to become more abundant and widespread (CMLPA 2009). PDO cold regimes have the opposite effect, causing cold-water species to grow more abundant and widespread, while warm-water species become less so.

During years experiencing an El Niño event, tropical species (i.e., species with temperature preferences above 68° F (20° C)) begin to migrate into the project area, while temperate species, which normally inhabit the area, move north and out of the region (Allen et al. 2005). For example, two tropical species, the Mexican barracuda and scalloped hammerhead shark, were recorded off southern California for the first time during the 1997/1998 El Niño event. Rockfish are particularly sensitive to El Niño, with these events resulting in recruitment failure and adults exhibiting reduced growth. Ultimately, a decline in biomass results and a poor overall condition in the region becomes evident, such as landings of market squid being dramatically decreased during the 1997/1998 El Niño event (Hayward 2000). A particularly significant marine warming event occurred in the Southern California region during 2014-2015, shifting the distribution of marine species during that period and resulting in a variety of marine animals including fish, sea turtles, and red crabs being found in waters farther north than their usual distribution. Mass strandings of some marine mammals and sea birds also occurred (OEHHA 2020).

During El Niño years, San Diego Bay often becomes a refuge for subtropical/tropical species that have a normal distribution further south than the study area (Allen et al. 2002). For example, from April 1997 through July 1998, three new fish (bonefish, yellowfin goby, and longtail goby) and three new invertebrate species (arched swimming crab, Mexican brown shrimp, and a bivalve species (*Petricola hertzana*)) were recorded in the southern California estuaries of the San Diego coastal region (i.e., Tijuana Estuary and Los Peñasquitos Lagoon), while northern anchovy, the dominant species in San Diego Bay, was virtually absent during the El Niño event. Southern species moving into these areas are typically incapable of reproducing or establishing permanent populations due to the short-term nature of these events.

Past La Niña events have not had such a dramatic impact on ichthyofauna and marine invertebrate populations as El Niño events. Nevertheless, La Niña years can result in below normal recruitment for many invertebrate species (e.g., rock crabs), and larval rockfish abundance has been reportedly low during years experiencing La Niña events (Lundquist et al. 2000). Cooling trend years have increased abundance and commercial landings of herring, anchovies, and squid populations (Hayward 2000; Lluch-Belda et al. 2003, Zeidberg et al. 2006).

H.3 COMMERCIAL AND RECREATIONAL FISHERIES

H.3.1 Introduction

The marine environment in the vicinity of Point Loma supports a wide variety of commercial and recreational fisheries. This section begins with a discussion of EFH, followed by a description of commercial and recreational fishing in the Point Loma area with fisheries catch tallied for the period 2015-2019.

This assessment uses the term "fish" to include both cartilaginous species - sharks, skates, and rays - and bony species. Cartilaginous fish, as the name implies, have a skeleton of cartilage, which is partially calcified, but is not true bone. Bony fish also have cartilage, but their skeletons consist of calcified bone. Fish are generally categorized as pelagic (living in the water column), benthic (living on or near the ocean bottom), or demersal (associated with the ocean bottom, but also feeding in the water column).

H.3.2 Essential Fish Habitat

The Sustainable Fisheries Act of 1996 (an amendment to the Magnuson-Stevens Fishery Conservation and Management Act) provided a new habitat conservation tool: the EFH mandate (NOAA 2021b). Regional fishery management councils (FMCs) are required to identify EFH for federally managed species (i.e., species covered under fishery management plans (FMPs)). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 United States Code [U.S.C.] 1802[10]). The term "fish" is defined as "finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds." The United States National Marine Fisheries Service (NMFS) in 2002 further clarified EFH with the following definitions (50 Code of Federal Regulations (CFR) 600.05–600.930): "Waters" include all aquatic areas and their associated biological, chemical, and physical properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "Substrate" includes 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 a species' "full life cycle" (NMFS 2002a).

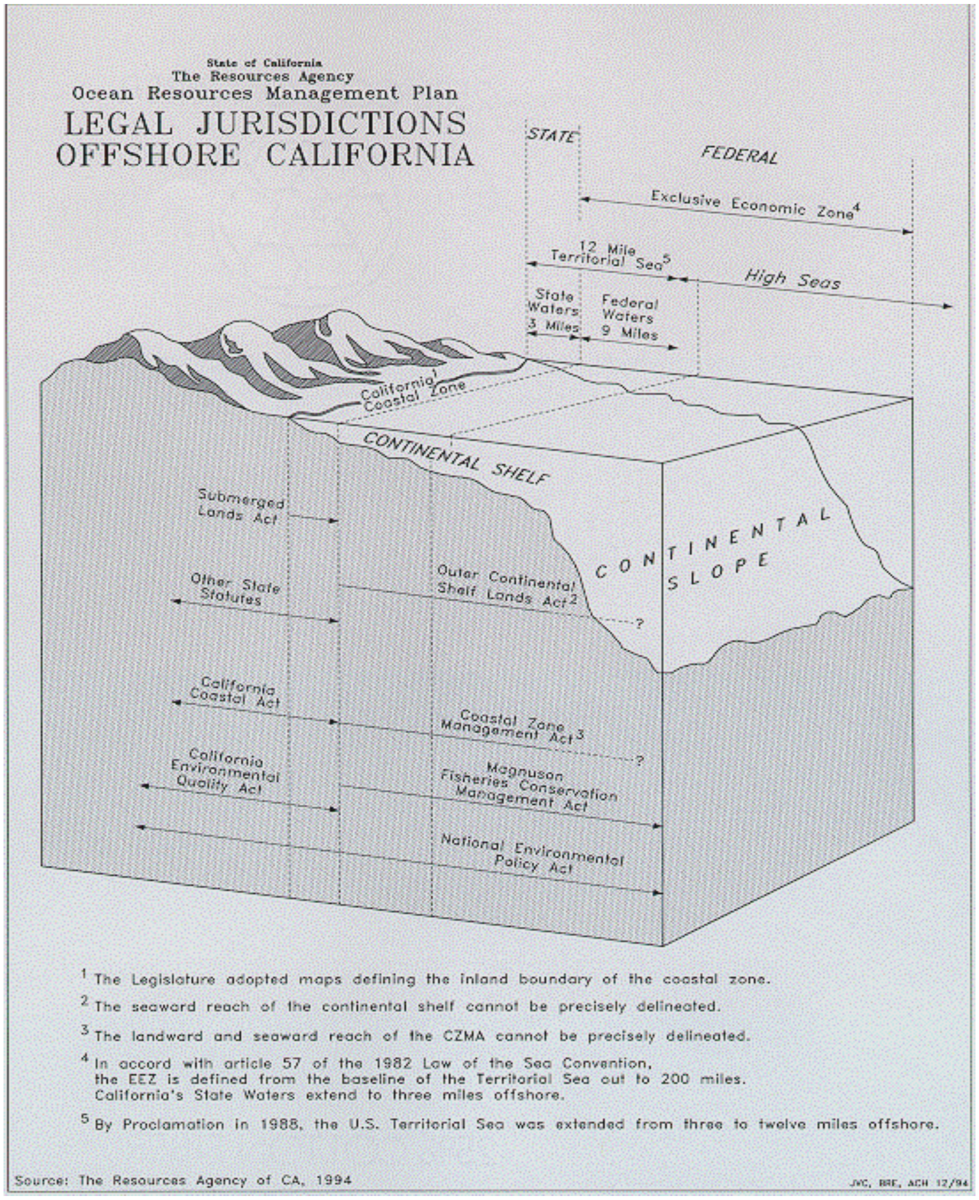
The Sustainable Fisheries Act requires that EFH be identified and mapped for each federally managed species. The NMFS and regional FMCs determine the species' distributions by life stage and characterize associated habitats, including Habitat Areas of Particular Concern (HAPC). HAPC are discrete areas within EFH that either play especially important ecological roles in the life cycles of managed species or are especially vulnerable to degradation from human-induced activities (50 CFR 600.815[a][8]). The Sustainable Fisheries Act requires federal agencies to consult with the NMFS on activities that may adversely affect EFH. For actions that affect a threatened or endangered species, or its critical habitat, and its EFH, federal agencies must integrate Endangered Species Act (ESA) and EFH consultations.

An Essential Fish Habitat Assessment (EFHA) is a critical review of a proposed project and its' potential impacts to EFH. As set forth in the rules (50 CFR 600.920[e][3]), EFHAs must include (1) a description of the proposed action; (2) an analysis of the effects, including cumulative effects, of the action on EFH, the managed species and associated species; (3) the effects of the action on EFH; and (4) proposed mitigation, if applicable. Once the NMFS learns of a federal or state activity that may have adverse effects on designated EFH, the NMFS is required to develop EFH consultation recommendations for the activity. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NOAA 2007).

H.3.3 Regulatory Background

Commercial fisheries are protected and managed by the Magnuson-Stevens Fishery Conservation and Management Act (NOAA 2021b), by State and Inter-State Fisheries Management Plans (e.g., Pacific Fishery Management Council (PFMC)), and by the California Department of Fish and Wildlife (CDFW), prior to 2013 called the CDFG. The Magnuson-Stevens Fishery Conservation and Management Act of 1976 established jurisdiction over marine fishery resources in the 200-nm (370-km) U. S. Exclusive Economic Zone (Figure H-6). The Magnuson-Stevens Fishery Conservation and Management Act was reauthorized and amended by the Sustainable Fisheries Act of 1996 (NOAA 2021b). The Sustainable Fisheries Act requires that regional FMCs develop and implement FMPs to protect managed species included in the plans. FMPs are developed to achieve the goal of no net loss of the productive capacity of habitats that sustain commercial, recreational, and native fisheries. Magnuson-Stevens Fishery Conservation and Management Act was reauthorized in 2007 and is periodically updated and amended most recently in 2018 (NOAA 2021b)

Figure H-6:
Legal Jurisdictions Offshore California (COPC 2021)



[1] The Legislature adopted maps defining the inland boundary of the coastal zone.

[2] The seaward reach of the continental shelf cannot be precisely delineated.

[3] The landward and seaward reach of the CZMA cannot be precisely delineated.

[4] In accord with article 57 of the 1982 Law of the Sea Convention, the EEZ is defined from the baseline of the Territorial Sea out to 200 miles. California's State Waters extend to three miles offshore.

[5] By Proclamation in 1988, the U.S. Territorial Sea was extended from three to twelve miles offshore.

Source: The Resources Agency of CA, 1994

H.3.4 Fishery Management Plans

The U. S. Exclusive Economic Zone extends from the outer boundary of state waters (3 nm (5.6 km) from shore) to a distance of 200 nm (370 km) from shore. Offshore fisheries in the Southern California Bight are managed by the NMFS (NOAA 2021c) with assistance from the PFMC (PFMC 2020a), and the Southwest Fisheries Science Center (NOAA 2021d). Inshore fisheries (less than 3 nm (5.6 km)) from shore are managed by the CDFW (CDFW 2021a). In practice, state and federal fisheries agencies manage fisheries cooperatively with FMPs generally covering the area from coastal estuaries out to 200 nm (370 km) offshore.

FMPs are extensive documents that are constantly revised and updated. The Pacific Coast Groundfish Fishery Management Plan, for example, originally produced in 1977, has been amended 33 times (PFMC 2021a). FMPs describe the nature, status, and history of the fishery, and, specify management recommendations, yields, quotas, regulations, and harvest guidelines. Associated Environmental Impact Statements (EISs) address the biological and socioeconomic consequences of management policies. FMCs have web sites that present the various elements of their FMPs, current standards and regulations, committee hearings and decisions, research reports, source documents, and links to related sites (e.g., PFMC 2021a). Coverage of the ecology of marine fish, fisheries, and environmental issues in California is presented in reviews by Horn and Allen 1978, Allen et al. 2006, Horn and Stephens 2006, Horn et al. 2006, Love 2006, 2011, Butler et al. 2012, Miller and Schiff 2012, Suntsov et al. 2012, Koslow et al. 2013, Miller and McGowan 2013, and Naval Facilities Engineering Command (NAVFAC) 2013.

Fisheries Management Plans with managed species that could occur in the vicinity of Point Loma are the Pacific Groundfish FMP (NMFS 2013b, PFMC 2020b), the Coastal Pelagic Species (CPS) FMP (PFMC 2020c), and the United States West Coast Fisheries for Highly Migratory Species (HMS) (PFMC 2020d) (Table H-2).

Table H-2:
Federal Fishery Management Species, actively managed under the Pacific Coast Groundfish Management Plan August 2020

Groundfish Management Plan Species
http://www.pcouncil.org/groundfish/fishery-management-plan/

COMMON NAME	SCIENTIFIC NAME
Sharks	
Big skate	*Raja binoculata*
California skate	*Raja inornata*
Leopard shark	*Triakis semifasciata*
Longnose skate	*Raja rhina*
Ratfish	
Ratfish	*Hydrolagus colliei*
Morids	
Finescale codling (Pacific flatnose)	*Antimora microlepis*
Grenadiers	
Pacific rattail (Pacific grenadier)	*Coryphaenoides acrolepis*
Roundfish	
Cabezon	*Scorpaenichthys marmoratus*

Kelp greenling	*Hexagrammos decagrammus*
Lingcod	*Ophiodon elongatus*
Pacific cod	*Gadus macrocephalus*
Pacific whiting (hake)	*Merluccius productus*
Sablefish	*Anoplopoma fimbria*
Rockfish	
Aurora rockfish	*Sebastes aurora*
Bank rockfish	*S. rufus*
Black rockfish	*S. melanops*
Black and yellow rockfish	*S. chrysomelas*
Blackgill rockfish	*S. melanostomus*
Blackspotted rockfish	*S. melanostictus*
Blue rockfish	*S. mystinus*
Bocaccio	*S. paucispinis*
Bronzespotted rockfish	*S. gilli*
Brown rockfish	*S. auriculatus*
Calico rockfish	*S. dallii*
California scorpionfish	*Scorpaena gutatta*
Canary rockfish	*Sebastes pinniger*
Chameleon rockfish	*S. phillipsi*
Chilipepper	*S. goodei*
China rockfish	*S. nebulosus*
Copper rockfish	*S. caurinus*
Cowcod	*S. levis*
Darkblotched rockfish	*S. crameri*
Deacon rockfish	*S. diaconus*
Dusky rockfish	*S. ciliatus*
Dwarf-red rockfish	*S. rufinanus*
Flag rockfish	*S. rubrivinctus*
Freckled rockfish	*S lentiginosus*
Gopher rockfish	*S. carnatus*
Grass rockfish	*S. rastrelliger*
Greenblotched rockfish	*S. rosenblatti*
Greenspotted rockfish	*S. chlorostictus*
Greenstriped rockfish	*S. elongatus*
Halfbanded rockfish	*S. semicinctus*
Harlequin rockfish	*S. variegatus*
Honeycomb rockfish	*S. umbrosus*
Kelp rockfish	*S. atrovirens*
Longspine thornyhead	*Sebastolobus altivelis*
Mexican rockfish	*Sebastes macdonaldi*
Olive rockfish	*S. serranoides*
Pink rockfish	*S. eos*

Pinkrose rockfish	*S. simulator*
Pygmy rockfish	*S. wilsoni*
Pacific ocean perch	*S. alutus*
Quillback rockfish	*S. maliger*
Redbanded rockfish	*S. babcocki*
Redstripe rockfish	*S. proriger*
Rosethorn rockfish	*S. helvomaculatus*
Rosy rockfish	*S. rosaceus*
Rougheye rockfish	*S. aleutianus*
Sharpchin rockfish	*S. zacentrus*
Shortbelly rockfish	*S. jordani*
Shortraker rockfish	*S. borealis*
Shortspine thornyhead	*Sebastolobus alascanus*
Silvergray rockfish	*Sebastes brevispinis*
Speckled rockfish	*S. ovalis*
Splitnose rockfish	*S. diploproa*
Squarespot rockfish	*S. hopkinsi*
Starry rockfish	*S. constellatus*
Stripetail rockfish	*S. Saxicola*
Sunset rockfish	*S. crocotulus*
Swordspine rockfish	*S. ensifer*
Tiger rockfish	*S. nigrocinctus*
Treefish	*S. serriceps*
Vermilion rockfish	*S. miniatus*
Widow rockfish	*S. entomelas*
Yelloweye rockfish	*S. ruberrimus*
Yellowmouth rockfish	*S. reedi*
Yellowtail rockfish	*S. flavidus*
Flatfish	
Arrowtooth flounder (turbot)	*Atheresthes stomias*
Butter sole	*Isopsetta isolepis*
Curlfin sole	*Pleuronichthys decurrens*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
Flathead sole	*Hippoglossoides elassodon*
Pacific sanddab	*Citharichthys sordidus*
Petrale sole	*Eopsetta jordani*
Rex sole	*Glyptocephalus zachirus*
Rock sole	*Lepidopsetta bilineata*
Sand sole	*Psettichthys melanostictus*
Starry flounder	*Platichthys stellatus*

Coastal Pelagic Management Plan Species through amendment 17, June 2019.

http://www.pcouncil.org/coastal-pelagic-species/fishery-management-plan-and-amendments/

COMMON NAME	SCIENTIFIC NAME
Jack mackerel	*Traxchurus symmetricus*
Krill	*euphausiids*
Pacific mackerel	*Scomber japonicus*
Pacific sardine	*Sardinops sagax*
Market squid	*Loligo opalescens*
Northern anchovy	*Engraulis mordax*

Highly Migratory Management Plan Species through amendment 5, April 2018.

http://www.pcouncil.org/highly-migratory-species/fishery-management-plan-and-amendments/

COMMON NAME	SCIENTIFIC NAME
Sharks	
Bigeye thresher shark	*Alopias superciliosus*
Blue shark	*Prionace glauca*
Common thresher shark	*Alopias vulpinus*
Pelagic thresher shark	*Alopias pelagicus*
Shortfin mako shark	*Isurus oxyrinchus*
Tunas	
Albacore tuna	*Thunnus alalunga*
Bigeye tuna	*Thunnus obesus*
Northern bluefin tuna	*Thunnus orientalis*
Skipjack tuna	*Katsuwonus pelamis*
Yellowfin tuna	*Thunnus albacares*
Billfish	
Striped marlin	*Tetrapturus audax*
Swordfish	*Xiphias gladius*
Dolphin-fish	
Dorado (mahi mahi)	*Coryphaena hippurus*

Sources: PFMC 2020b, 2020c, 2020d.

The Pacific coast groundfish fishery is the largest, most important fishery managed by the PFMC in terms of landings and value (PFMC2020a). Groundfish managed species are found throughout the Southern California Bight. More than 90 species of bottom-dwelling marine finfish are included in the federally-managed groundfish fishery. Groundfish species include all rockfishes in the Scorpaenidae family, flatfishes such as Dover sole (*Microstomus pacificus*) and petrale sole (*Eopsetta jordani*), roundfishes such as sablefish (*Anoplopoma fimbria*) and lingcod (*Ophiodon elongatus*), and various sharks and skates. The species managed under the Pacific Groundfish Management Plan are usually found on or near the bottom; rockfish - including widow, yellowtail, canary, shortbelly, and vermilion rockfish; bocaccio, chilipepper, cowcod, yelloweye, thornyheads, and Pacific Ocean perch; roundfish - lingcod, cabezon, kelp greenling, Pacific cod, Pacific whiting (hake), and sablefish; flatfish - including various soles, starry flounder, and sanddab; sharks and skates - leopard shark, soupfin shark, spiny dogfish, big skate, California skate, and longnose skate; and three other species: ratfish, finescale codling, and Pacific rattail grenadier (Table H-2).

The groundfish species managed by the Pacific Groundfish FMP range throughout the Exclusive Economic Zone and occupy diverse habitats at all stages in their life histories. Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish that show strong affinities to a particular location or substrate type.

Rockfish are found from the intertidal zone out to the deepest waters of the Exclusive Economic Zone (Love et al. 2002, 2009, Butler et al. 2012,). For management purposes, these species are often placed in three groups defined by depth range and distance offshore: nearshore rockfish, shelf rockfish, and slope rockfish (CDFW 2021a).

Table H-3:
Rockfish Distribution in the Southern California Bight

Shallow Nearshore Rockfish

black-and-yellow (*S. chrysomelas*)
China (*S. nebulosus*)
gopher (*S. carnatus*)
grass (*S. rastrelliger*)
kelp (*S. atrovirens*)

Deeper Nearshore Rockfish

black (*Sebastes melanops*)
blue (*S. mystinus*)
brown (*S. auriculatus*)
calico (*S. dalli*)
copper (*S. caurinus*)
olive (*S. serranoides*)
quillback (*S. maliger*)
treefish (*S. serriceps*)

Shelf Rockfish

bocaccio (*Sebastes paucispinis*)
bronzespotted (*S. gilli*)
canary (*S. pinniger*)
chameleon (*S. phillipsi*)
chilipepper (*S. goodei*)
cowcod (*S. levis*)
dwarf-red (*S. rufinanus*)
flag (*S. rubrivinctus*)
freckled (*S. lentiginosus*)
greenblotched (*S. rosenblatti*)
greenspotted (*S. chlorostictus*)
pinkrose (*S. simulator*)
pygmy (*S. wilsoni*)
redstriped (*S. proriger*)
rosethorn (*S. helvomaculatus*)
rosy (*S. rosaceus*)
silvergrey (*S. brevispinis*)
speckled (*S. ovalis*)
squarespot (*S. hopkinsi*)
starry (*S. constellatus*)
stripetail (*S. saxicola*)
swordspine (*S. ensifer*)

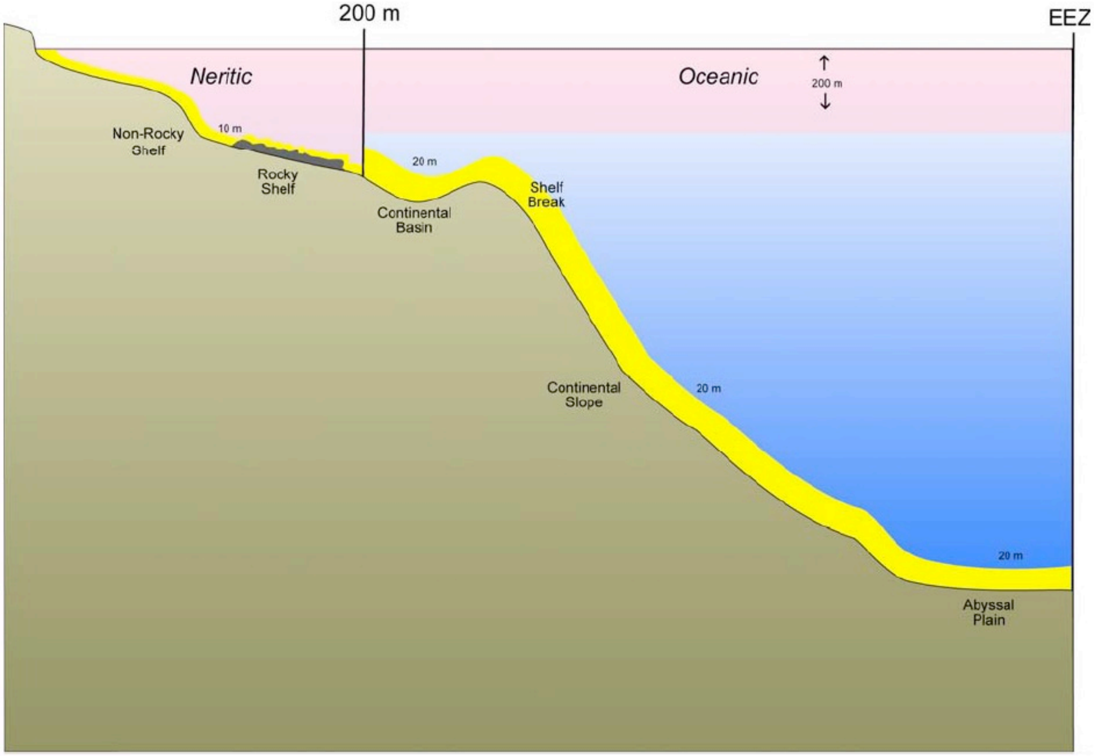
greenstriped (*S. elongatus*)
halfbanded (*S. semicinctus*)
honeycomb (*S. umbrosus*)
Mexican (*S. macdonaldi*)
pink (*S. eos*)
tiger (*S. nigrocinctus*)
vermilion (*S. miniatus*)
widow (*S. entolemas*)
yelloweye (*S. ruberrimus*)
yellowtail (*S. flavidus*)

Slope Rockfish

aurora (*S. aurora*)
bank (*S. rufus*)
blackgill (*S. melanostomus*)
darkblotched (*S. crameri*)
Pacific ocean perch (*S. alutus*)
redbanded (*S. babcocki*)
rougheye (*S. aleutianus*)
sharpchin (*S. zacentrus*)
shortraker (*S. borealis*)
splitnose (*S. diploproa*)
yellowmouth (*S. reedi*)

The nearshore rockfish spend most of their lives in relatively shallow water. This group is often subdivided into a shallow component and a deeper component. Shelf rockfish are found along the continental shelf (Figure H-7, from USDON 2013). Slope rockfish occur in the deeper waters of the shelf and down the continental slope. The roundfish, flatfish, sharks, and skates covered under the Groundfish FMP are generally concentrated in shallow water while the ratfish, finescale codling, and Pacific rattail are deepsea fish (Eschmeyer et al. 1985, Leet et. al. 2001, Butler et al. 2012, CDFW 2021a).

Figure H-7:
Pacific Coast Groundfish Ranges



The Pacific halibut (*Hippoglossus stenolepis*), a flat groundfish, is regulated by the United States and Canada through a bilateral commission, the International Pacific Halibut Commission (IPHC) (IPHC 2014) and is therefore not in a federal FMP. The normal range of Pacific halibut is from Santa Barbara, California to Nome, Alaska. It would not usually be found in the Point Loma area.

A variety of different fishing gear is used to target groundfish including troll, longline, hook and line, pots, gillnets, and other types of gear (bottom trawls were banned in March 2006 out to a depth of 3,500 m) (Table H-4 (from NMFS 2005b)). The West Coast groundfish fishery has four access components: limited entry - which limits the number of vessels allowed to participate; open access - which allocates a portion of the harvest to fishers without limited entry permits; recreational; and tribal - fishers who have federally recognized treaty rights (PFMC 2021a).

**Table H-4:
Gear Types Used in the West Coast Groundfish Fishery**

Fishery	Trawl and Other Net	Longline, Pot, Hook and Line	Other
Limited Entry Fishery (commercial)	Mid-water Trawl, Whiting trawl, Scottish Seine	Pot, Longline	
Open Access Fishery Directed Fishery (commercial)	Set Gillnet Sculpin Trawl	Pot, Longline, Vertical hook/line, Rod/Reel, Troll/dinglebar, Jig, Drifted (fly gear), Stick	
Open Access Fishery Incidental Fishery (commercial)	Exempted Trawl (pink shrimp, spot and ridgeback prawn, CA halibut, sea cucumber), Setnet, Driftnet, Purse Seine (Round Haul Net)	Pot (Dungeness crab, CA sheephead, spot prawn) Longline, Rod/Reel Troll	Dive (spear) Dive (with hook and line) Poke Pole
Tribal	as above	as above	as above
Recreational	Dip Net, Throw net (within 3 miles)	Hook and Line methods Pots (within 3 miles) from shore, private boat, commercial passenger vessel	Dive (spear)

Managed jointly by the PFMC and the NMFS under the Coastal Pelagic Species Fisheries Management Plan (CPS FMP), Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*) are included in complex known as the CPS. The Coastal Pelagics FMP also includes two invertebrates, market squid and krill (PFMC 2020c). The CPS inhabit the pelagic realm, i.e., live in the water column, not near the sea floor. They are usually found from the surface to 3,281 feet (1,000 m) deep.

Northern anchovy (*Engraulis mordax*) are small, short-lived fish that typically school near the surface (PFMC 2020c). They occur from British Columbia to Baja California. Northern anchovies are divided into northern, central, and southern sub-populations. The central sub-population has been the focus of large commercial fisheries in the U.S. and Mexico. Most of this sub-population is located in the Southern California Bight between Point Conception, California and Point Descanso, Mexico. Northern anchovy are an important part of the food chain for other species, including other fish, birds, and marine mammals.

Pacific sardine (*Sardinops sagax*), also a small schooling fish, have been the most abundant fish species managed under the Pacific Groundfish FMP. They range from the tip of Baja California to southeastern Alaska. Sardines live up to 13 years, but are usually captured by their 5th year.

Pacific (chub) mackerel (*Scomber japonicus*) are found from southeastern Alaska to Mexico, and are most abundant south of Point Conception, California within 20 mi (32 km) from shore. The "northeastern Pacific" stock of Pacific mackerel is harvested by fishers in the U. S. and Mexico. Like sardines and anchovies, mackerel are schooling fish, often co-occurring with other pelagic species like jack mackerel and sardines. As with other CPS, they are preyed upon by a variety of fish, mammals, and sea birds.

Jack mackerel (*Trachurus symmetricus*) grow to about 2 feet and can live up to 35 years. They are found throughout the northeastern Pacific, often well outside the Exclusive Economic Zone. Small jack mackerel are most abundant in the Southern California Bight, near the mainland coast, around islands, and over shallow rocky banks. Older, larger fish range from Cabo San Lucas, Baja California, to the Gulf of Alaska, offshore into deep water and along the coast to the north of Point Conception. Jack mackerel in southern California usually school over rocky banks, artificial reefs, and shallow rocky reefs.

Market squid (*Loligo opalescens)* range from the southern tip of Baja California to southeastern Alaska (Leet et al. 2001). They are most abundant between Punta Eugenio, Baja California, and Monterey Bay, California. Usually found near the surface, market squid can occur to depths of 2,625 feet (800 m) or more. Squid live less than a year and prefer full-salinity ocean waters. They are important forage foods for fish, birds and marine mammals.

In 2006, the PFMC included krill in the CPS and adopted a complete ban on commercial fishing for all species of krill in West Coast federal waters (PFMC 2006). Krill are small shrimp-like crustaceans that are an important basis of the marine food chain. They are eaten by many managed species, as well as by whales and seabirds.

Coastal pelagic species are harvested directly and incidentally (as bycatch) in other fisheries. Usually targeted with "round-haul" gear including purse seines, drum seines, lampara nets, and dip nets, they are also taken as bycatch in midwater trawls, pelagic trawls, gillnets, trammel nets, trolls, pots, hook-and-line, and jigs. Market squid are fished nocturnally using bright lights to attract the squid to the surface. They are pumped directly from the sea into the hold of the boat, or taken with an encircling net (PFMC 2005). Market squid are harvested for human consumption and as bait in recreational fisheries.

Most of the CPS commercial fleet is located in California, mainly in Los Angeles, Santa Barbara-Ventura, and Monterey. About 75% of the market squid and Pacific sardine catch are exported, mainly to China, Australia (where they are used to feed farmed tuna), and Japan (where they are used as bait for longline fisheries).

The U.S. West Coast Fisheries for HMS covers 13 free-ranging species; 5 tuna - Pacific albacore, yellowfin, bigeye, skipjack, and northern bluefin; 5 sharks - common thresher, pelagic thresher, bigeye thresher, shortfin mako, and blue shark; 2 billfish - striped marlin and Pacific swordfish; and dorado (also known as dolphinfish or mahi-mahi) (Table H-2). HMS have a wide geographic distribution, both inside and outside the Exclusive Economic Zone. They are open-ocean, pelagic species, that may spend part of their life cycle in nearshore waters. HMS are harvested by U. S. commercial fishers and by foreign fishing fleets, with only a fraction of the total harvest taken within U.S. waters (PFMC 2020d). HMS are also an important component of the recreational sport fishery, especially in southern California.

Under the HMS FMP, the PFMC monitors other species for informational purposes. In addition, some species-including great white sharks, megamouth sharks, basking sharks, Pacific halibut, and Pacific salmon - are designated as prohibited catch. If fishers targeting highly migratory species catch these species, they are required to immediately release them.

The federal Shark Conservation Act of 2010 was signed into law January 4, 2011, specifying that no shark is to be landed without fins being naturally attached (CalCOFI 2013). In addition, the State of California passed AB 376 - a bill banning the possession and sale of shark fins, beginning January 1, 2012. While shark fisheries in California are still legal, and those possessing the proper license or permit are allowed to retain shark fins under California law, sales and distribution are prohibited. Restaurants and retailers were allowed to sell stock on hand as of the implementation until July 1, 2013. There is also an exception for taxidermy.

The HMS fishery, with the exception of the swordfish drift gillnet fishery off California, is one of the only remaining open access fisheries on the West Coast. However, the PFMC is currently considering a limited entry program to control excess capacity. The use of entangling nets (set and drift gill nets, and trammel nets) in California state waters (<3 nm (5.6 km) from shore) was banned in 1994 by Proposition 132, the Marine Resources Protection Act of 1990 (FGC §8610 et seq.).

Many different gear types are used to catch HMS in California. These include; (1) trolling lines - fishing lines with jigs or live bait deployed from a moving boat, (2) drift gillnets - panels of netting weighted along the bottom and suspended vertically in the water by floats that are attached to a vessel drifting along with the current, (3) harpoon - a small and diminishing fishery mainly targeting swordfish, (4) pelagic longlines - baited hooks on short lines attached to a horizontal line (the HMS FMP now prohibits West Coast longliners from fishing in the Exclusive Economic Zone due to concerns about the take of endangered sea turtles), (5) coastal purse seines - encircling nets closed by synching line threaded through rings on the bottom of the net (usually targeting sardines, anchovies, and, mackerel but also target tuna where available), (6) large purse seines - used in major fisheries in the eastern tropical Pacific and the central and western Pacific (this fishery is monitored by the Inter-American Tropical Tuna

Commission, and, in the Exclusive Economic Zone by NMFS); and, (7) recreational fisheries - HMS recreational fishers in California include private vessels and charter vessels using hook-and-line to target tunas, sharks, billfish, and dorado.

As mentioned previously, Pacific halibut (*Hippoglossus stenolepis*) is managed by the IPHC (IPHC 2014). This large species of halibut is mainly encountered well north of the Point Loma area, and, its harvest is prohibited in the area. A smaller relative, the California halibut (*Paralichthys californicus*), is found along the coast of southern California, but is not included in a FMP.

Although FMPs are mandated for federal waters, managed species also occur in state waters. These areas in California (i.e., inshore of 3 nm) are managed under the California Marine Life Management Act (CMLMA) (CDFW 2014b). California FMPs have been produced for nearshore finfish (CDFW 2014c), white seabass (CDFWd), market squid (CDFWe), and, a spiny lobster FMP is being developed (CDFWf).

The California Nearshore Fishery Management Plan (CNFMP) (CDFW 2014c) covers both commercial nearshore fisheries and recreational fishers. The five goals of the CNFMP are to 1) ensure long-term resource conservation and sustainability 2) employ science-based decision-making 3) increase constituent involvement in management 4) balance and enhance socio-economic benefits 5) identify implementation costs and sources of funding. Five management approaches form the basis for integrated management strategies to meet the goals and objectives of the CNFMP and CMLMA. They are: the Fishery Control Rule, Management Measures, Restricted Access, Regional Management, Marine Protected Areas (MPAs), and Allocation (CDFW 2014c).

Table H-5:
Key CNFMP Management Goals and Objectives

NFMP Goal or Objective	Fishery Control Rule	Management Measures	Restricted Access	Regional Management	MPAs	Allocation
Conserve ecosystems	Stock assessments completed					
Allow only sustainable uses	Setting TACs based on NFMP fishery control rule; inseason monitoring	Size limits on species that survive release; trip limits match capacity; limit gear				
Adjust catch allowance to reflect uncertainty	TACs based on stock assessments (black & gopher rockfish, cabezon, CA scorpionfish)	Trip limits				
Match fish harvest capacity to sustainable catch levels			RA program for NFP species; DNSFP program			
Allocate restrictions and benefits fairly and equitably		FGC guidance to Council for regulation development		Regional discussions with constituents on proposed regulation changes		Revised as updated information is available
Minimize/limit bycatch and mortality		Match seasons and depths for cooccurring species	Bycatch permit with trip quota; bimonthly trip limits			
Maintain, restore and preserve habitat			Allowable gear limited to hook & line, traps and dip nets	Identify appropriate habitat for 19 species; NFMP MPA		

NFMP Goal or Objective	Fishery Control Rule	Management Measures	Restricted Access	Regional Management	MPAs	Allocation
				criteria in MLPA Master plan design criteria		
Identify, assess, and enhance habitats					Identify appropriate habitat for 19 species	
Identify and minimize fishing that destroys habitat		CA input into Council EFH designations	NFP program gear endorsements			
Employ Science based Decision making	OYs/TACs based on stock assessments					
Conduct collaborative research	CRANE					
Collect data on spatial distribution of habitats and organisms	CRANE EFI collection			Initial focus on southern California and south central regions		CRANE & Channel Islands MPA monitoring

Table H-5 Note: Blank cells not applicable for the indicated goal or objective.

The CNFMP covers 19 species that frequent kelp beds and reefs generally less than 120 feet (36 m) deep off the coast of California and the near offshore islands (CDFW 2014c).

Table H-6:
Managed Species - California Nearshore Fishery Management Plan

Black rockfish - *Sebastes melanops*
Gopher rockfish - *Sebastes carnatus*
Black & yellow rockfish - *Sebastes chrysomelas*
Grass rockfish - *Sebastes rastrelliger*
Blue rockfish - *Sebastes mystinus*
Kelp greenling – *Hexagrammos decagrammus*
Brown rockfish - *Sebastes auriculatus*
Kelp rockfish – *Sebastes atrovirens*
Cabezon - *Scorpaenichthys marmoratus*
Monkeyface prickleback – *Cebidichthys violaceus*
Calico rockfish - *Sebastes dallii*
Olive rockfish - *Sebastes serranoides*
California scorpionfish - *Scorpena guttata*
Quillback rockfish - *Sebastes maliger*
California sheephead – *Semicossyphus pulcher*
Rock greenling - *Hexagrammos lagocephalus*
China rockfish - *Sebastes nebulosus*
Treefish - *Sebastes serriceps*
Copper rockfish - *Sebastes caurinus*

Thirteen of these species are rockfish - all of which are included in the federal Pacific Groundfish FMP. Three of the remaining six species are also covered under the Pacific Groundfish FMP. The three species not covered by the Pacific Groundfish FMP are the California sheephead (*Semicossyphus pulcher*), the rock greenling (*Hexagrammos lagocephalus*), and the monkeyface prickleback (*Cebidichthys violaceus*). These species are actively managed by the CDFW (CDFW 2014c) through catch limits, gear restrictions and monitoring.

The California sheephead is a large, colorful member of the wrasse family (Leet et al. 2001, CDFW 2013a). Male sheephead reach a length of 3 feet, a weight of 36 pounds (lbs), and have a white chin, black head, and, a pink to red body. Females are smaller, with a brown-colored body (Eschmeyer et al. 1985). Sheephead populations off southern California have declined because of fishing pressure. Large males are now rare because they are sought by recreational spear fishermen. Sheephead are taken commercially by traps and kept alive for display in restaurant aquaria where patrons select a specific fish for preparation. The rock greenling is a smaller member of the lingcod family. The monkeyface prickleback, also called the monkeyface eel, is more closely related to rockfish than eels. Its elongate shape is an adaptation to living in cracks, crevices, and under boulders.

White seabass (*Atractoscion nobilis*), large members of the croaker family, occur in ocean waters off the west coasts of California and Mexico. This highly-prized species is recovering from reduced population levels in the late 1900s. The current California management strategy of the

White Seabass Fishery Management Plan (WSFMP) provides for moderate commercial harvests while protecting young white seabass and spawning adults through seasonal closures, gear provisions, and size and bag limits (CDFW 2014d). The WSFMP also has a recreational fishery component with size and bag limits, and season closures. There is an ongoing white seabass hatchery program at Carlsbad, California operated by the Hubbs-Sea World Research Institute. The hatchery provides juvenile white seabass to other field-rearing systems operated by volunteer fishermen throughout southern California.

Market squid (*Loligo opalescens*), discussed previously under the Coastal Pelagics FMP, has historically been the state's largest fishery by tonnage and economic value (CDFW 2014g). Market squid are also important to the recreational fishery as bait and as forage for fish, marine mammals, birds, and other marine life. Squid belong to the class Cephalopoda of the phylum Mollusca. They have large eyes and strong parrot-like beaks. Using their fins for swimming and jets of water from their funnel they are capable of rapid propulsion forward or backward. The squid's capacity for sustained swimming allows it to migrate long distances.

The Abalone Recovery and Management Plan (CDFW 2014h) establishes a cohesive framework for the recovery of depleted abalone populations in southern California. All of California’s abalone species are included in the plan: red abalone, *Haliotis rufescens*; green abalone, *H. fulgens*; pink abalone, *H. corrugata*; white abalone, *H. sorenseni*; pinto abalone, *H. kamtschatkana* (including *H. assimilis*); black abalone, *H. cracherodii*; and flat abalone, *H. walallensis*. The recovery and management plan for these species implements measures to prevent further population declines throughout California, and to ensure that current and future populations will be sustainable.

The decline of abalone is due to a variety of factors, primarily commercial and recreational fishing, disease, and natural predation. The recovery of a near-extinct abalone predator, the sea otter, has further reduced the possibility for an abalone fishery in most of central California. Withering syndrome, a lethal bacterial infection, has caused widespread decline among black abalone in the Channel Islands and along the central California coast. As nearshore abalone populations became depleted, fishermen traveled to more distant locations, until stocks in most areas collapsed. Advances in diving technology also played a part in stock depletion. The advent of self-contained underwater breathing apparatus (SCUBA) in the mid-1900s gave birth to the recreational fishery in southern California, which placed even more pressure on a limited number of fishing areas.

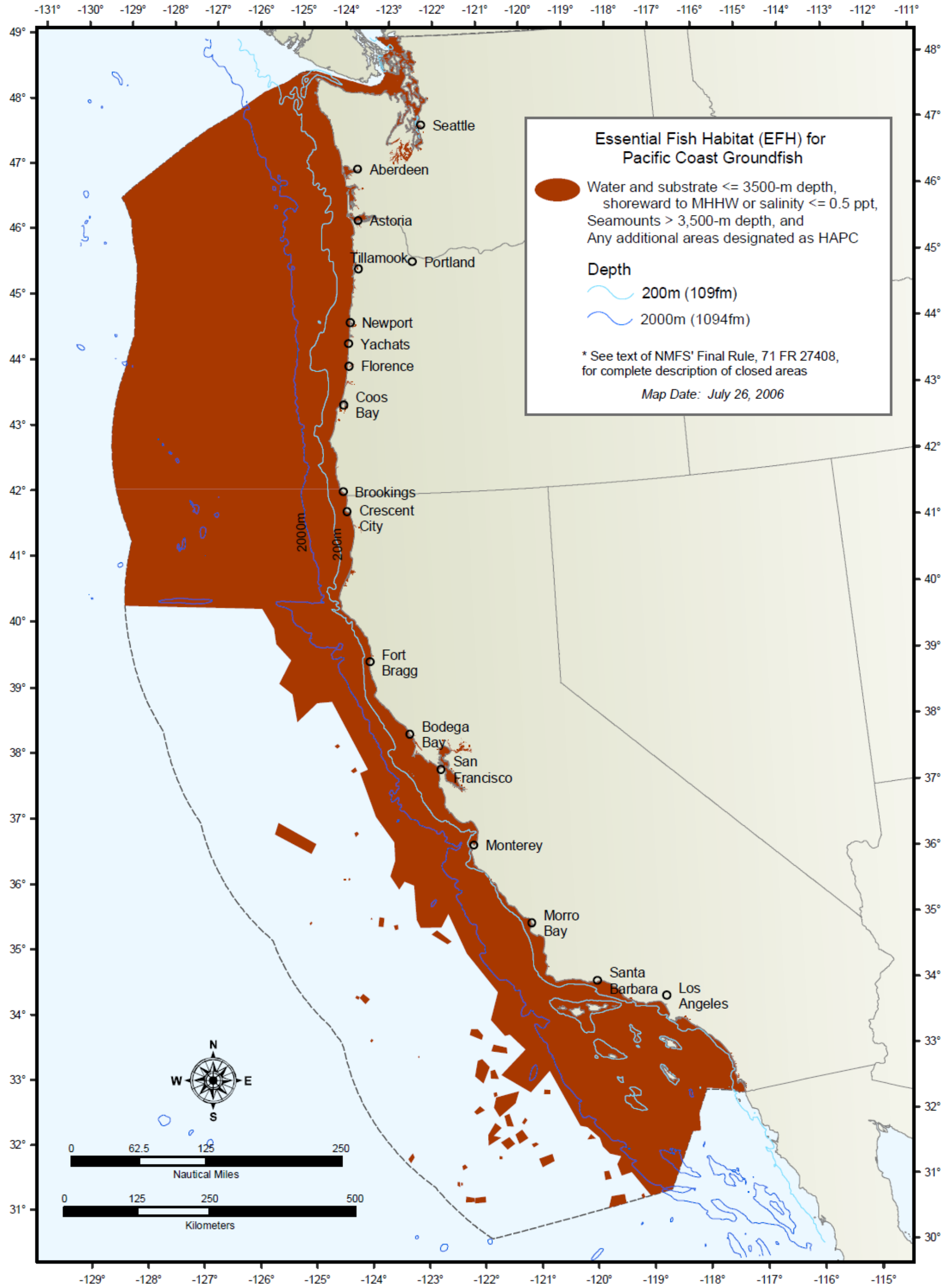
Following stock collapse, the California Fish and Game Commission (CFGC) closed the southern California pink, green, and white abalone fisheries in 1996 and all abalone fishing south of San Francisco in early 1997. The southern abalone fishery was closed indefinitely with the passage of the Thompson bill (AB 663) in 1997. This bill created a moratorium on taking, possessing, or landing abalone for commercial or recreational purposes in ocean waters south of San Francisco, including all offshore islands.

H.3.5 Designated Essential Fish Habitat

The NMFS and the PFMC designate EFH and develop FMPs for all fisheries occurring within the Southern California Bight from Point Conception to the U.S./Mexico border. The Sustainable Fisheries Act contains provisions for identifying and protecting habitat essential to federally Managed Species (NOAA 2014e). The FMPs identify EFH, describe EFH impacts (fishing and non-fishing), and suggest measures to conserve and enhance EFH. The FMPs also designate HAPC where one or more of the following criteria are demonstrated: (a) important ecological function; (b) sensitivity to human-induced environmental degradation; (c) development activities stressing the habitat type; or (d) rarity of habitat.

EFH for groundfish managed species includes all waters and substrate from the high tide line or the upriver extent of saltwater intrusion to: 1) depths of 11,483 feet (3,500 m), 2) seamounts in depths greater than 11,483 feet (3,500 m), and 3) areas designated as HAPC not already identified by the above criteria (NMFS 2013b, Figure H-8, from PFMC 2012). With respect to EFH, nearshore areas are considered to be shallower than 120 feet (36 m) with offshore areas beyond that depth. The continental shelf is considered to begin at the 656 feet (200 m) contour.

Figure H-8:
Groundfish Essential Fish Habitat



The Pacific Groundfish FMP divides EFH into seven composite habitats including their waters, substrates, and biological communities: 1) estuaries - coastal bays and lagoons, 2) rocky shelf - on or within 33 feet (10 m) of rocky bottom (excluding canyons) from the high tide line to the continental shelf break, 3) nonrocky shelf - on or within 33 feet (10 m) of unconsolidated bottom (excluding the rocky shelf and canyons) from the high tide line to the continental shelf break, 4) canyon - submarine canyons, 5) continental slope/basin **-** on or within 66 feet (20 m) of the bottom of the continental slope and basin below the shelf break extending to the westward boundary of the Exclusive Economic Zone, 6) neritic zone **-** the water column more than 33 feet (10 m) (narrow yellow band above) above the continental shelf, and 7) oceanic zone - the water column more than 66 feet (20 m) (wide yellow band above) above the continental slope and abyssal plain, extending to the westward boundary of the Exclusive Economic Zone (PFMC 2011a, PFMC 2014b).

Table H-7:
Groundfish Species Essential Fish Habitat

Blank cells not applicable for the species/group listed. Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2011a). * = Associated with macrophytes, algae, or seagrass. (PFMC 2014b).

Group/Species	Estuarine	Rocky Shelf	Non-Rocky Shelf	Neritic	Canyon	Continental Slope and Basin	Ocean
Flatfish							
Curlfin Sole			A, SA	E		A, SA	E
Dover Sole			A, SA, J	L, E		A, SA, J	L, E
English Sole	A*, SA, J*, L*, E	A*, SA, J*	A*, SA, J*	L*, E		A*	
Petrale Sole			A, J	L, E		A, SA	L, E
Rex Sole	A		A, SA	E		A, SA	L, E
Rock Sole		A*, SA*, J*, E*	A*, SA*, J*, E*	L		A*, SA*, J*, E*	
Sand Sole			A, SA, J	L, E			
Pacific Sanddab	J, L, E		A*, SA, J	L, E			L, E
Rockfish							
Aurora Rockfish			A, MA, LJ			A, MA, LJ	L
Bank Rockfish		A, J	A, J		A, J	A, J	
Black Rockfish	A*, SJ*	LJ*	LJ*	A*, SJ*			A*
Black-and-yellow Rockfish		A*, MA, LJ*, SJ*, P		L*			
Blackgill Rockfish		LJ		SJ, L		A, LJ	S, LJ
Blue Rockfish		A*, MA, LJ*	LJ*	SJ*,L			

Blank cells not applicable for the species/group listed. Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2011a). * = Associated with macrophytes, algae, or seagrass. (PFMC 2014b).

Group/Species	Estuarine	Rocky Shelf	Non-Rocky Shelf	Neritic	Canyon	Continental Slope and Basin	Ocean
Bocaccio	SJ*, L	A*, LJ*	A*, LJ*	SJ*, L	LJ*	A*, LJ*	
Bronzespotted Rockfish						A	
Brown Rockfish	A*, MA, J*, P	A*, MA, J*, P					
Calico Rockfish	A, J	A, J	A, J				
Canary Rockfish		A, P		SJ*, L		A, P	SJ*, L
Chilipepper		A, LJ, P	A, LJ, P	SJ*, L		A, LJ, P	
China Rockfish		A, J, P		L			
Copper Rockfish	A*, LJ*, SJ*, P	A*, LJ*		SJ*, P			
Cowcod		A, J	J	L			
Darkblotched Rockfish		A, MA, LJ, P	A, MA, LJ, P			A, MA, P	SJ, L
Flag Rockfish		A, P					
Gopher Rockfish		A*, MA, J*, P	A*, A, J*, P				
Grass Rockfish		A*, J*, P					
Greenblotched Rockfish		A, J, P	A, J, P		A, J, P	A, P	
Greenspotted Rockfish		A, J, P	A, J, P				
Greenstriped Rockfish		A, P	A, P				
Honeycomb Rockfish		A, J, P			J		
Kelp Rockfish	SJ*	A*, LJ*, P		SJ*			
Mexican Rockfish		A	A	L			L
Olive Rockfish		A*, J*, P			A*, P		
Pacific Ocean Perch		A, LJ	A, LJ	SJ	A	A, P	SJ, L
Pink Rockfish		A	A			A	
Redbanded Rockfish			A			A	
Redstripe Rockfish		A, P				A, P	
Rosethorn Rockfish		A, P	A, P			A, P	
Rosy Rockfish		A, J, P					
Rougheye Rockfish		A	A			A	
Sharpchin Rockfish		A, P	A, P			A, P	L
Shortbelly Rockfish		A*, P	A*, P		A*, P	A*, P	

Blank cells not applicable for the species/group listed. Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2011a). * = Associated with macrophytes, algae, or seagrass. (PFMC 2014b).

Group/Species	Estuarine	Rocky Shelf	Non-Rocky Shelf	Neritic	Canyon	Continental Slope and Basin	Ocean
Silverygray Rockfish		A*	A*			A*	
Speckled Rockfish		A, J, P			A, P	A, P	
Splitnose Rockfish			A, J*, P			A, P	
Squarespot Rockfish		A, P			A, P		
Starry Rockfish		A, P				A, P	
Stripetail Rockfish			A, P			A, P	
Tiger Rockfish		A				A	
Treefish		A					
Vermilion Rockfish		A, J*	J*		A	A	
Widow Rockfish		A, MA, LJ,P	A, MA, LJ, P	SJ*, L	A, MA, LJ, P	A, MA, P	SJ*, L
Yelloweye Rockfish		A, P				A, P	
Yellowtail Rockfish		A, MA, LJ, P	A, MA, LJ, P	SJ*		A, MA, P	SJ*
<u>Scorpionfish</u>							
California Scorpionfish	E	A, SA, J	A, SA, J	E			
<u>Thornyhead</u>							
Longspine Thornyhead						A, SA, J	L, E
Shortspine Thornyhead			A			A, SA	L, E
<u>Roundfish</u>							
Cabezon	A, SA, LJ, SJ*, L, E	A, SA, LJ, E		SJ*, L			SJ*, L
Kelp Greenling	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E		SJ*, L			SJ*, L
Lingcod	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E	A*, LJ*	SJ*, L		A*	
Pacific Cod	A, SA, J, L, E		A, SA, J, E	A, SA, J, L		A, SA, E	A, SA, J, L
Pacific Hake (Whiting)	A, SA, J, L, E			A, SA, J, L, E			A, SA, L, E
Pacific Flatnose					A	A	
Pacific Grenadier			A, SA, J			A, SA, J	L

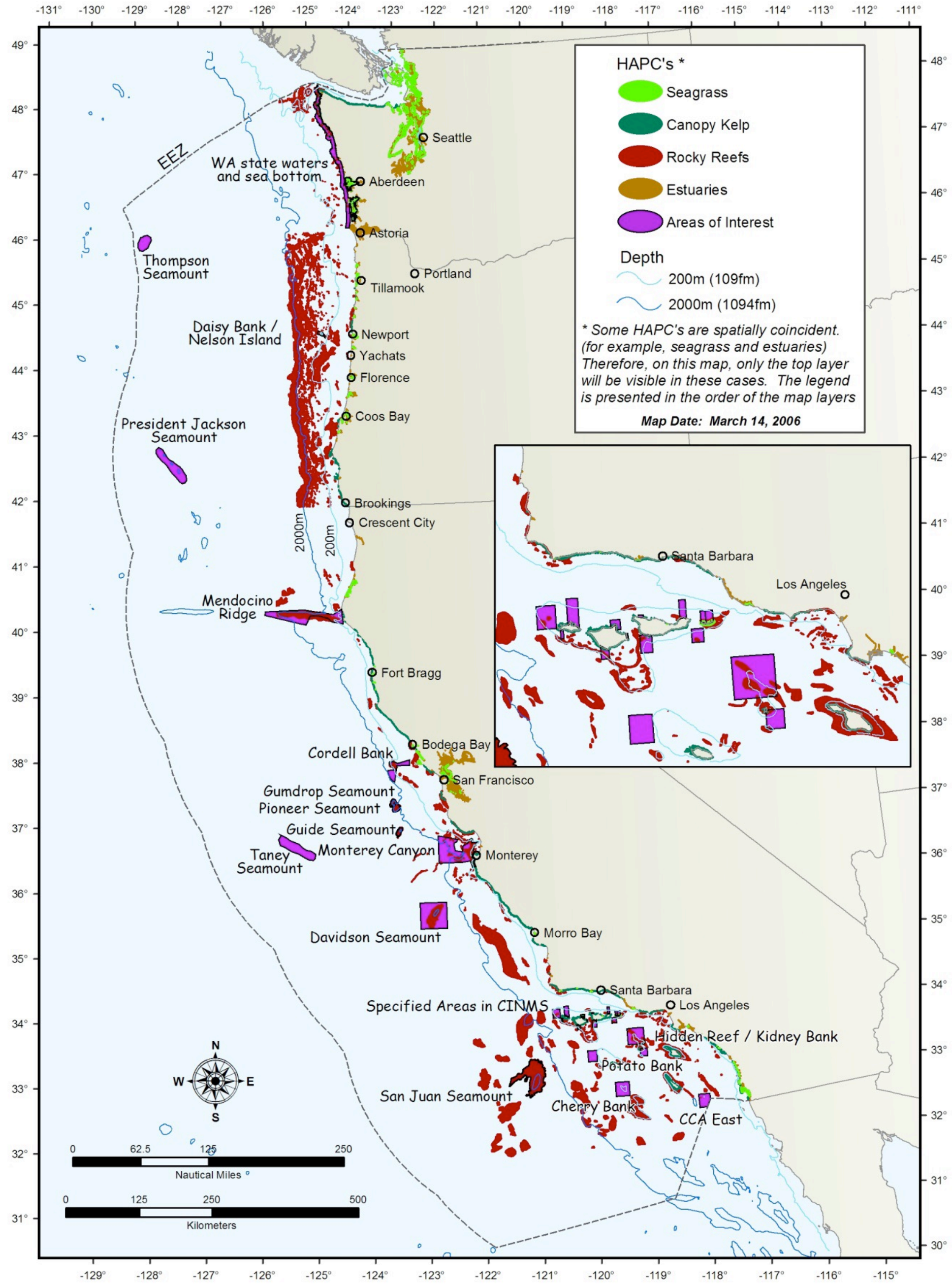
Blank cells not applicable for the species/group listed. Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2011a). * = Associated with macrophytes, algae, or seagrass. (PFMC 2014b).							
Group/Species	**Estuarine**	**Rocky Shelf**	**Non-Rocky Shelf**	**Neritic**	**Canyon**	**Continental Slope and Basin**	**Ocean**
Sablefish	SJ	A	A, LJ	SJ, L	A, LJ	A, SA	SJ, L, E
Skates/Sharks/ Chimeras							
Big Skate			A, MA, J, E			A, MA	
California Skate	A, MA, J, E		A, MA, J, E			A, MA, J, E	
Longnose Skate			A, MA, J, E			A, MA, J, E	
Leopard Shark	A, MA, J, P	A, MA, J, P	A, MA, J, P	A, MA, J, P			
Soupfin Shark	A, MA, J, P	A, MA, J	A, MA, J, P	A, MA, J, P	A, MA, J		A, MA, J
Spiny Dogfish	A, LJ, SJ, P	A, MA, LJ	A, LJ, P	A, LJ, SJ	A	A, MA	A
Spotted Ratfish	A, MA, J	A, MA, J E	A, MA, J E			A, MA, J, E	

The PFMC has identified six HAPC types. One of these types, certain oil rigs in Southern California waters, was disapproved by NMFS. The current five HAPC types are: estuaries, canopy kelp, seagrass, rocky reefs, and "areas of interest" (e.g., submarine features, such as banks, seamounts, and canyons) (PFMC 2014f).

Table H-8:
EFH and HAPC in the Southern California Bight

Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) (PFMC 2014e,f).		
Species	**EFH**	**HAPC**
Pacific Groundfish	Marine and estuarine waters less than or equal to 11,483 feet (3,500 m) to mean higher high water level or the upwater extent of seawater intrusion, seamounts in depths greater than 3,500 m, and areas designated as HAPC not identified by the above criteria.	Estuaries, canopy kelp, sea grass, rocky reefs, and other areas of interest.
Coastal Pelagic Species	All marine and estuarine waters above the thermocline from the shoreline offshore to 200 nm offshore.	No HAPC designated.
Highly Migratory Species	All marine waters from the shoreline offshore to 200 nm offshore.	No HAPC designated.
Pacific Coast Salmon	North of project area.	North of project area.

Figure H-8:
Groundfish Habitat Areas of Particular Concern



EFH identified for managed CPS is wide-ranging. It includes the geographical range where they are currently found, have been found in the past, and may be in the future. In the Southern California Bight, the CPS EFH constitutes all marine and estuarine waters above the thermocline from the shoreline offshore to the limits of the Exclusive Economic Zone with no HAPC designated. The thermocline is an area in the water column where water temperature changes rapidly with depth, usually from colder at the bottom to warmer on top. The CPS live near the surface primarily above the thermocline, and within a few hundred miles of the coast, so their designated EFH (Table H-9) is less complex than for Groundfish Managed Species. The PFMC is presently considering identifying EFH and possibly HAPC for two individual krill species, *Euphausia pacifica* and *Thysanoessa spinifera,* and for other species of krill (PFMC 2008).

Table H-9:
Coastal Pelagic Species Essential Fish Habitat

Coastal Pelagic Species and Lifestages Associated with EFH designations. A = Adults, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2014c). Blank cells not applicable for the listed group or species.			
Group/Species	**Coastal epipelagic**	**Coastal mesopelagic**	**Coastal benthic**
Krill	E, L, J, A		
Northern anchovy	E, L, J, A		
Mackerels	E, L, J, A		
Sardine	E, L, J, A		
Market Squid	L, J, A		E

Only market squid are significantly associated with benthic environments; the females lay their eggs in sheaths on sandy bottom in 33-165 feet (10-50 m) depths (PFMC 2011b). The CPS are found in shallow waters and within bays and even brackish waters, but are not considered dependent upon these habitats. They prefer temperatures in the 50-82.4 °F (10-28 °C) range with successful spawning and reproduction occurring from 57-61 °F (14-16 °C). Larger, older individuals are generally found farther offshore and farther north than younger, smaller individuals. All lifestages of CPS species are found in the Southern California Bight.

EFH for HMS (2021C) (Table H-10) such as tuna, sharks and billfish is even more extensive than for CPS (PFMC 2011c). HMS range widely in the ocean, in area and depth. They are usually not associated with the features typically considered fish habitat (estuaries, seagrass beds, rocky bottoms). Their habitat selection appears to be less related to physical features and more to temperature ranges, salinity levels, oxygen levels, and currents. For the U.S. West Coast Fisheries for HMS, EFH occurs throughout the Southern California Bight (PFMC 2011c). The PFMC has currently identified no HAPC for HMS.

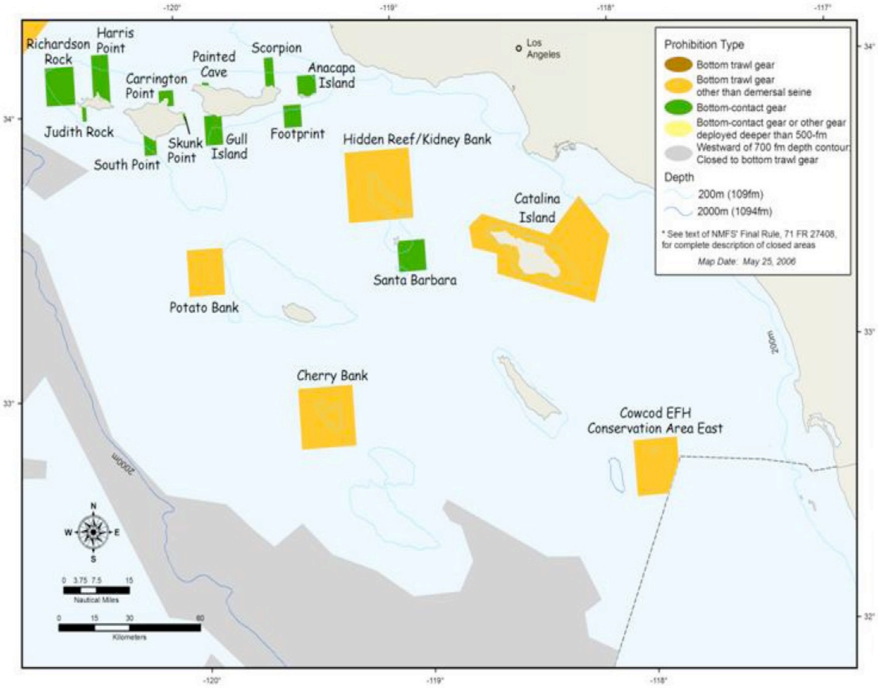
Table H-10:
Highly Migratory Species Essential Fish Habitat

Highly Migratory Species and Lifestages Associated with EFH Designations. A = Adults, SA = Sub-Adults, LJ = Late Juveniles, N= Neonate, EJ = Early Juveniles, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2014d). Blank cells not applicable for the group or species listed.

Group/Species	Coastal epi-pelagic	Coastal meso-pelagic	Oceanic epi-pelagic	Oceanic meso-pelagic
Sharks				
Blue Shark			N, EJ, LJ, SA, A	
Shortfin Mako			N, EJ, LJ, SJ, A	
Thresher Sharks	LJ, SA, A	LJ, SA, A	LJ, SA, A	LJ, SA, A
Tunas				
Albacore			J, A	
Bigeye Tuna			J, A	J, A
Northern Bluefin			J	
Skipjack			A	
Yellowfin			J	
Billfish				
Striped Marlin			A	
Swordfish				
Broadbill Swordfish			J, A	J, A
Dolphinfish				
Dorado			J, SA, A	

Rockfish Conservation Areas, closed to fishing, have been established to protect sensitive Pacific coast groundfish habitat (Figure H-10). Bottom trawling was prohibited in March 2006 in these areas out to depths of 11,482 feet (3,500 m). In Cowcod Conservation Areas (Figure H-11, from PMFC 2012), bottom trawling and other bottom fishing activities are prohibited in waters greater than 120 feet (36 m). Within these conservation areas, cowcod and other "overfished" federal groundfish species, are protected with very low incidental catch limits (CMLPA 2009). The conservation areas are expected to remain closed until "overfished" stocks are rebuilt or a new management approach is adopted.

Figure H-9:
Essential Fish Habitat Conservation Areas



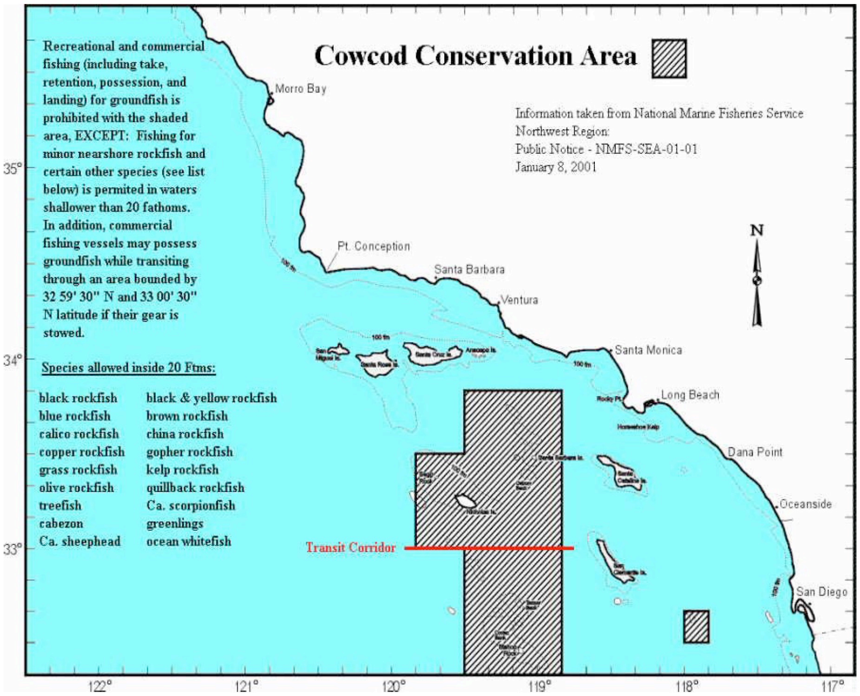
Prohibition Type
- 🟫 Bottom trawl gear
- 🟧 Bottom trawl gear other than demersal seine
- 🟩 Bottom-contact gear
- 🟨 Bottom-contact gear or other gear deployed deeper than 500-fm
- ⬜ Westward of 700 fm depth contour; Closed to bottom trawl gear

Depth
- 200m (109fm)
- 2000m (1094fm)

* See text of NMFS' Final Rule, 71 FR 27408, for complete description of closed areas

Map Date: May 25, 2006

Figure H-10:
Cowcod Conservation Area.



Recreational and commercial fishing (including take, retention, possession, and landing) for groundfish is prohibited with the shaded area, EXCEPT: Fishing for minor nearshore rockfish and certain other species (see list below) is permited in waters shallower than 20 fathoms. In addition, commercial fishing vessels may possess groundfish while transiting through an area bounded by 32 59' 30" N and 33 00' 30" N latitude if their gear is stowed.

Species allowed inside 20 Ftms:

black rockfish
blue rockfish
calico rockfish
copper rockfish
grass rockfish
olive rockfish
treefish
cabezon
Ca. sheephead

black & yellow rockfish
brown rockfish
china rockfish
gopher rockfish
kelp rockfish
quillback rockfish
Ca. scorpionfish
greenlings
ocean whitefish

Information taken from National Marine Fisheries Service
Northwest Region:
Public Notice - NMFS-SEA-01-01
January 8, 2001

H.3.6 Essential Fish Habitat Impacts

EFH regulations require analysis of potential impacts that could have an adverse effect on EFH and managed species (NMFS 2002a,b). Adverse effect is defined as an impact that reduces the quality and/or quantity of EFH (NMFS 2004a,b). Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

The PLOO could have physical impacts associated with the presence of the pipeline and diffusers on the ocean bottom, and chemical and biological impacts associated with the discharge of treated wastewater.

Physical Impacts

The Point Loma outfall pipeline is buried in a trench through the surf zone out to a distance of about 2,600 feet (792 m) offshore. Over the next 400 feet (123 m) it gradually emerges from the trench and beyond 3,000 feet (914 m) offshore it lies in a bed of ballast rock on the ocean floor. At its terminus, the pipeline connects to the diffuser section with two legs, each 2,500 feet (762 m) long. The outfall pipe and diffusers with their supporting bed of ballast rock form an artificial reef. The pipe and rock, covered with encrusting organisms (tube worms, anemones, barnacles), provide food and shelter to a variety of fish and invertebrates (Wolfson and Glinski 1986). This artificial habitat covers an area of about 22 acres (9 hectares) off Point Loma (assuming a 36-feet (11-m) width of pipe and ballast rock). Catches of rockfish could be enhanced over this area, but would probably be too small to be discernible in recreational or commercial landings.

The pipeline and diffusers represent a potential hazard to commercial fishermen using traps that can snag on the pipe and ballast rock. Lobster, crab, and fish traps are used throughout the area (Parnell et al. 2010). Since the location of the pipeline and diffusers is well-marked on navigation charts and commercial vessels are equipped with accurate positioning systems it is possible to place fishing gear a safe distance away. Nevertheless, commercial trap fishermen target the pipe area, apparently choosing to risk higher gear-loss for a better yield per trap next to the high-relief rocky habitat created by the pipe and ballast rock.

Chemical and Biological Impacts

The PLOO monitoring program provides an extensive database on marine water quality and marine biology beginning with pre-design studies in the late 1950s' (City of San Diego 2008-2016, 2018, 2020). The monitoring program at Point Loma was not designed as a research program but was established to determine compliance with local, state, and federal environmental regulations. Even so, the monitoring program has generated data with considerable utility for scientific inquiry and includes many special studies that can contribute to research endeavors. For example, Conversi and McGowan (1992) analyzed 15 years of water transparency data at 7 monitoring stations to evaluate the influence of anthropogenic influences (treated wastewater discharge) and natural oceanographic events. They concluded that anthropogenic activities had not affected transparency, while natural factors such as seasonality and distance from the coast had.

Underwater research has been conducted in the Point Loma kelp bed, 3.5 mi (5.6 km) inshore of the outfall, since the mid 1950's when Wheeler North of the California Institute of Technology and his associates at the Scripps Institution of Oceanography (SIO) began long-term investigations of kelp bed ecology (Neushul 1959, North 1964, North and Hubbs 1968). Professors Paul Dayton and researcher Dr. Ed Parnell and associates at SIO have done ecological surveys at fixed locations in the Point Loma kelp bed since 1971 (e.g., Dayton and Tegner 1984, 1990, Dayton et al. 1992, 2003, Tegner et al. 1995, 1996, 1997, Tegner and Dayton 1987, 1991, Steneck et al. 2002, Graham 2000, 2004, Hewitt et al. 2007, Parnell and Riser 2012, Parnell et al. 2005, 2008, 2010, 2019). Their research has demonstrated that large-scale, low-frequency episodic changes in oceanographic climate control kelp forest community structure. The Point Loma kelp bed has also served as a site for SIO and San Diego State University graduate student research (e.g., Neushul 1959, Gerodette 1971, Deysher 1984, Graham 2000, Mai and Hovel 2007), and for unpublished research on CA spiny lobster movements in the Point Loma kelp bed by Hovel, Lowe, Loflen, and Palaoro.

With the single exception of a temporary break in the pipeline conveying wastewater to the offshore outfall (Tegner et al. 1995), there has been no indication from the extensive research on the Point Loma kelp bed ecosystem of any impact of discharged wastewater. The 2014-2016 marine heat wave did cause massive mortality of giant kelp off San Diego, mainly due to nutrient and temperature stress. The kelp forest off San Diego has since begun to recover and future ocean climate conditions are conducive to future recovery Parnell et al 2019) (see Appendix E – Kelp Forest Monitoring Off San Diego). Nor is there any suggestion in the historical fisheries catch of outfall impacts. The Point Loma outfall ocean monitoring program, as well as other associated studies, provides significant information with which this can be evaluated and nothing has been observed that would indicate any negative impact to the fisheries as a result of the Point Loma discharge (City of San Diego 2020). The following section briefly reviews monitoring program results related to the impact on EFH and fisheries species.

The discharge of treated wastewater at Point Loma could affect EFH and fisheries species by altering water or sediment quality. Water quality parameters are monitored at stations around the outfall, in the kelp bed, along the shoreline, and at control stations to the north and south (City of San Diego 2008-2016, 2018, 2020). Strong local currents and high initial dilution (>200:1) facilitate rapid mixing and dispersion of the discharged effluent.

Unlike dissolved components of the wastewater that are swept away by the currents, particles discharged from the outfall may settle to the ocean floor. This can change the grain size and organic content of the sediments which in turn affects the abundance and diversity of marine organisms living there. Contaminants can also be introduced since many of the potentially harmful chemicals in wastewater are bound to particles.

Alterations in sediment quality in the vicinity of the PLOO (PLOO) are only apparent in areas closer than 1,000 feet (300 m) from the diffusers, where coarser sediments and higher sulfide and biochemical oxygen demand (BOD) levels have been periodically detected (City of San Diego

2008-2016, 2018, 2020). In general, only sulfide and BOD have shown any change in concentration that appear to be consistent with organic enrichment, and this occurs only immediately adjacent to where the outfall diffusers ejected flow at near ZID stations (City of San Diego 2020). The change in grain size is likely due to turbulence created as the current flows past the pipe on the bottom, wafting away the finer particles (Diener et al., 1997). The physical presence of large ocean outfalls and associated ballast materials can alter the hydrodynamic regime in surrounding areas, thus affecting sediment movement and transport, and the resident biological communities. (See Appendix C– Ocean Benthic Conditions).

Concentrations of organochlorides (e.g., chlorinated pesticides, PCBs) in sediments at Point Loma are generally near or below detection limits at all sampling stations, the notable exception being dichlorodiphenyldichloroethylene (DDE), a breakdown product of the pesticide DDT. DDE, a legacy of historical discharge, is found in sediments throughout southern California (Mearns et al. 1991, Schiff et al. 2011). Levels of DDE at Point Loma are low relative to concentrations elsewhere in the Southern California Bight (City of San Diego 2008-2016, 2018, 2020, Schiff et al., 2011, Appendix C1, table C1-2).

There is no consistent pattern of metal concentrations in the sediments as a function of distance from the outfall - the highest levels of iron, aluminum, and copper are found at the northern reference stations. Trace metals are generally very low compared to available thresholds (City of San Diego 2018, 2020).

Sediment toxicity testing was performed from 2016 through 2020 at stations that could be considered to be within the Point Loma discharge area of influence. Four (4) of these stations were adjacent to and bracketed the outfall diffuser discharge point (i.e.: Near ZID). No evidence of toxicity was observed at any station (City of San Diego 2020, Appendix C3).

Changes in sediment quality should also be reflected in the types of species living on and in the sediment. Two elements of the monitoring program provide this type of information: 1) benthic infauna, and 2) demersal (bottom-dwelling) fish and megabenthic invertebrates. Benthic infauna are collected by taking grab samples of the bottom. Demersal fish and invertebrates are gathered by trawling across the bottom. Living in close association with the sediments, these groups are classic indicators of altered conditions. Also, many important fisheries species live on the bottom and/or feed there.

The infaunal community around the outfall is dominated by an ophiuroid-polychaete assemblage typical of this depth and sediment type in southern California (Ranasinghe et al. 2012). Changes that have occurred in the soft-bottom maroinvertebrate assemblage surrounding the outfall are mainly related to large-scale oceanographic events like El Niño (Zmarzly et al. 1994, Bartlett et al. 2004, Linden et al. 2007, City of San Diego 2008-2016, 2018, 2020, Appendix C).

Abundance of the ophiuroid *Amphiodia* which is sensitive to organic enrichment has decreased at near ZID sites but this effect is also being seen region wide and outside the influence of the discharge. Other changes in community structure suggest that the impact may be due to the presence of the outfall structure itself, rather than the influence of discharged wastewater (Posey and Ambrose 1994, Diener et al. 1997). Whatever the reason, infaunal communities near the Point Loma outfall remain similar to those observed prior to discharge and are comparable to natural indigenous communities (see Appendix C3 – San Diego Sediment Quality).

Additionally using the triad method of evaluating sediment quality (evaluating chemical composition, toxicity and infaunal community structure) indicates no impairments in any sediments near the Point Loma outfall discharge (See Appendix C3-San Diego Sediment Quality).

Trawl samples at Point Loma are dominated by small flatfish and sea urchins. Though inherently more variable than infaunal data, the trawl data also indicate that normal oceanographic processes control the abundance and diversity of demersal fish and megabenthic invertebrates living around the outfall (City of San Diego 2008-2016, 2018, 2020). Patterns in abundance, biomass, and species composition have remained stable since monitoring began. The fish collected by trawling are healthy, with few parasites and a low level or absence of fin rot, tumors, and other physical abnormalities (see Appendix C).

One of the most important elements of the Point Loma monitoring program from the EFH and fisheries perspective is the measurement of chemical contaminants in fish tissues. Fish can accumulate pollutants from: 1) absorption of dissolved chemicals in the water, 2) ingestion of contaminated suspended particles or sediment particles, and 3) ingestion of contaminated food (Allen 2006, Newman 2009, Allen et al. 2011, Laws 2013). Incorporation of contaminants into an organism's tissue is called bioaccumulation (Weis 2014, Whitacre 2014). Contaminants can also be concentrated as they are passed through the food web when higher trophic level organisms feed on contaminated prey (Bienfang et al 2013, Daley et al. 2014). Bioaccumulation has potential ecological and human health implications (Klasing and Brodberg 2008, 2011, Walsh et al. 2008, California Office of Environmental Health Hazard Assessment (OEHHA) 2014a,b).

The PLOO monitoring program targets two types of fish for assessment of contaminant levels: flatfish and rockfish (see Bioaccumulation Assessment - Appendix C5). Samples are taken at various distances from the outfall and at control stations to the north and south. Flatfish and rockfish at Point Loma have concentrations of metals in liver and muscle tissue characteristic of values detected throughout the Southern California Bight (Mearns et al. 1991, Allen et al. 2011, City of San Diego 2020). There is no apparent relationship between metal levels and proximity to the outfall (City of San Diego 2020). Elevated levels of arsenic were found in fish species at both outfall and control stations. The source of this arsenic appears to be vents from natural hot springs off the coast of northern Baja California. A variety of man-made compounds including DDT (and its derivatives) and PCBs are routinely found in fish tissue throughout the area. These chlorinated hydrocarbons are ubiquitous in southern California, but their concentration in sediments and organisms is steadily decreasing in most areas (Mearns et al. 1991, Allen et al. 2011, Setty et al. 2012, SCCWRP 2014). Samples taken near the outfall do not have higher levels of DDT and PCBs than at reference sites (City of San Diego 2020). A previous study (Parnell et al 2008) found PCB contamination present in dredged material taken from San Diego Bay and deposited south of Point Loma at the LA-5 disposal site as a source of PCB contamination.

The EPA and the United States Food and Drug Administration (FDA) establish limits for the concentration of contaminants like arsenic, DDT and PCBs in seafood sold for human consumption (EPA 2014a, FDA 2014). The California OEHHA developed a general advisory for all coastal waters of California, excluding enclosed bays and coastal areas with existing advice, because of the level of mercury and PCBs found in coastal fish the length of the state (OEHHA 2020). Coastal state waters are defined as extending 3 nm from the mean low tide line and 3 nm beyond the outermost islands (e.g., the Channel or Farallon islands), including all waters between those islands and the coast, from the Oregon/California border to the United States/Mexico border.

There are no harvest closures or restrictions on seafood taken specifically from the coast off Point Loma that are unique to that area and related to the Point Loma discharge.

In summary, monitoring data show effects of the Point Loma discharge only in deep water near the outfall where minor water and sediment quality alterations have been observed only very close to the outfall. Marine communities in the Point Loma region remain characteristic of natural conditions with no suggestion of environmentally-significant changes.

Cumulative Impacts

Cumulative impacts are defined in the National Environmental Protection Act (NEPA) (42 USC § 4321 *et seq*. and 32 CFR 775 respectively) as: the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7).

In general, the effects of a particular action or group of actions must meet all of the following criteria to be considered cumulative impacts:

- Effects of several actions occur in a common locale or region
- Effects on a particular resource are similar in nature, such that the same specific element of a resource is affected in the same specific way
- Effects are long-term as short-term impacts dissipate over time and cease to contribute to cumulative impacts

The discharge of treated wastewater from commercial activities, including municipal wastewater treatment plants, power generating stations, industrial plants (e.g., desalination plants), and storm water from drains into open ocean waters, bays, or estuaries can introduce chemical and biological constituents potentially detrimental to estuarine and marine habitats (Perry 2009, Hutchison et al. 2013). These constituents may include pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, and toxic chemical compounds (Stein and Cadien 2009, Setty et al. 2012). Treated wastewater discharges have been regulated under increasingly stringent requirements over the last 50 years and mass emissions of most constituents have been significantly reduced (Lyon and Sutula 2011, SCCWRP 2012, 2014). Nonpoint source/storm water runoff, on the other hand, has not been managed as effectively and continues to be a substantial remaining source of contamination of coastal areas and the ocean (Setty et al. 2012, Howard et al. 2014).

Potential cumulative threats to EFH and fisheries species include degradation of water quality, habitat modification, pollution (chemicals, marine debris, etc.), introduction of exotic species, disease, natural events, and global climate change (Field et al. 2003, Horn and Stevens 2006, O'Shea and Odell 2008, Pinnegar and Engelhard 2008, Crain et al. 2009, Halpern et al. 2009, Hoegh-Guldberg and Bruno 2010, Thrush and Dayton 2010, Doney et al. 2012, Hazen et al. 2012, Howell et al. 2012, SCCWRP 2012, NMFS 2013a, Howard et al. 2014, Maruya et al. 2014). Cumulative impacts could alter the physiology, behavior, growth, and reproduction of individual species, shift patterns of larval dispersal and recruitment, modify the composition of ecological communities, and, change the structure, function, productivity, and resilience of marine ecosystems.

In addition, fishing and non-fishing activities, individually or in combination, can adversely affect EFH and fisheries species (Jackson et al. 2001, 2011, Dayton et al. 2003, Hanson et al. 2003, Chuenpagdee et al. 2003, Jackson 2008, Baum and Worm 2009, Worm et al. 2009, Norse 2010, Hilborn and Hilborn 2012, NMFS 2013b, Laugen et al. 2014). Potential impacts of commercial fishing include over-fishing of targeted species, and bycatch, both of which negatively affect fish stocks (Barnette 2001, NRC 2002, Dieter et al. 2003, PFMC 2004, Hseih et al. 2006, Carretta and Enriquez 2012, PFMC and NMFS 2012). Mobile fishing gears such as bottom trawls (now prohibited to deeper than 3,500 feet) disturb the seafloor and reduce structural complexity (Auster and Langton 1998, Johnson 2002, Lindholm et al. 2011). Indirect effects of trawls include increased turbidity; alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (continued catch by lost or discarded gear), and generation of marine debris (Hamilton 2000, Reeves et al. 2013). Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats (NMFS 2013b). Recreational fishing also poses a threat because of the large number of participants and the intense, concentrated use of specific habitats (Coleman et al. 2004, Ihde et al. 2011, United Nations Food and Agricultural Organization (UNFAO) 2012, Arlinghaus et al. 2013).

Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal (Davidson et al. 2011, Hutchinson et al. 2013, Moore et al. 2013). Natural stresses include storms and climate-based environmental shifts, such as algal blooms and hypoxia (Kim et al. 2009, SCCWRP 2013).

Allen et al. (2005) analyzed fish population trends from 20- to 30-year fish databases (e.g., power generating station fish impingement and trawl monitoring, recreational fishing, and publicly owned treatment works (POTW) trawl monitoring). Combined, these databases provided information on 298 species of fish. A number of long-term environmental databases (e.g., CalCOFI oceanographic data, shoreline temperature, coastal runoff, and POTW effluent contaminant mass emissions) were used to identify influential, independent environmental variables (e.g., PDO; ENSO; offshore temperature; upwelling in the north, Southern California Bight, and south; coastal runoff; and contaminant mass emissions). Most southern California fish had population trends that followed changes in natural oceanic variables not anthropogenic inputs. The most important environmental variables were PDO (positive and negative responses), upwelling in the Southern California Bight, offshore temperature, and ENSO. The

PDO was the dominant influence for most species in these databases, with the presence or absence of upwelling during the warm regime having an important effect on others (Mills and Walsh 2013). Recent analyses of long-term fish population dynamics in the Southern California Bight also indicate that the primary driver of shifting trends in local fish populations is natural climatological change rather than anthropogenic influence (Miller and Schiff 2012, Koslow et al. 2013, Miller and McGowan 2013, Parnell et al 2019).

Removal of fish by fishing can profoundly influence individual populations, their survival, and the composition of the community in which they live (Jackson 2008, Jackson et al. 2011, Hilborn and Hilborn 2012). In a seminal study of retrospective data, Jackson et al. (2001) analyzed paleoecological records of marine sediments from 125,000 years ago to present, archaeological records spanning 10,000 years, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer term data and information, they concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems including pollution, degradation of water quality, and anthropogenic climatic change.

Underwater research has been conducted in the Point Loma kelp bed, 3.5 mi (5.6 km) inshore of the outfall, since the mid 1950's when Wheeler North of the California Institute of Technology and his associates at the Scripps Institution of Oceanography (SIO) began long-term investigations of kelp bed ecology (Neushul 1959, North 1964, North and Hubbs 1968). Professors Paul Dayton, researcher Dr. Ed Parnell and associates at SIO have done ecological surveys at fixed locations in the Point Loma kelp bed since 1971 (e.g., Dayton and Tegner 1984, 1990, Dayton et al. 1992, 2003, Tegner et al. 1995, 1996, 1997, Tegner and Dayton 1987, 1991, Steneck et al. 2002, Graham 2000, 2004, Hewitt et al. 2007, Parnell and Riser 2012, Parnell et al. 2005, 2008, 2010, 2020). Their research has established a long-term database unique in the world, demonstrating that large-scale, low-frequency episodic changes in oceanographic climate control kelp forest community structure. With the single exception of a temporary break in the pipeline conveying wastewater to the offshore outfall (Tegner et al. 1995), there has been no indication in the scientific studies of any impact of the discharged wastewater at Point Loma on the kelp bed ecosystem.

A number of factors influence water quality and biological conditions in the Point Loma area. Key potential influences on water quality include the Point Loma treated wastewater discharge, regional non-point source discharges, local river outflows, and other local non-point sources such as harbors, marinas, storm drains, and urban runoff (Bartlett et al. 2004, Parnell et al. 2008, Parnell and Riser 2012).

The effects of the Point Loma discharge on water quality and biological conditions are evident only in deep waters within or near the zone of initial dilution (ZID) (City of San Diego 2008-2016, 2018, 2020). Organic enrichment of the sediments due to the outfall discharge is not occurring beyond the ZID. Contaminant loading of sediments is not evident in the discharge vicinity. Sediment chemistry is comparable to reference areas along southern California's outer continental shelf. Biological conditions do not indicate any environmentally-significant changes associated with the discharge. A balanced indigenous population of shellfish, fish and wildlife exist immediately beyond the ZID.

While significant natural variations in fish populations are observed (in response to factors such as water temperature, such as the warm water period in 2014-2016 where Sea Urchin populations were decimated in the Point Loma kelp beds (Parnell 2019), the Point Loma wastewater discharge is not having any significant effect on demersal fish assemblages off Point Loma. Fish populations are healthy and lack physical abnormalities such as fin erosion or tumors. Levels of trace metals and chlorinated hydrocarbons, such as pesticides and PCBs, are relatively low, with concentrations within the range found in fish throughout the Southern California Bight. Overall, no outfall-related effects are evident from bioaccumulation data. Contaminants in fish tissues in the Point Loma area are similar to those at reference sites beyond the influence of the discharge City of San Diego 2018, 2020, Appendix C).

Based on scientific research and oceanographic monitoring at Point Loma, the impact on EFH from the discharge of treated wastewater is expected to be minimal. There should be no significant cumulative, incremental, or synergistic effects on present or reasonably foreseeable future uses of the Point Loma marine environment.

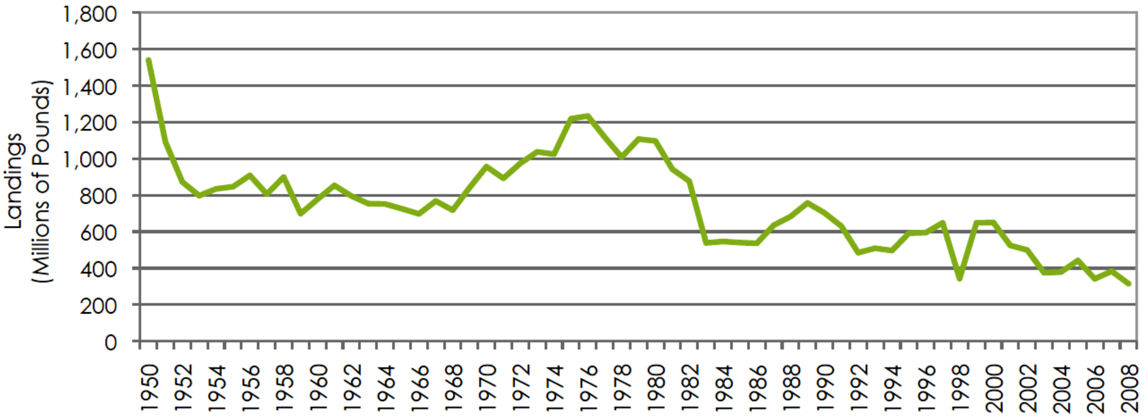
Conclusions

The proposed operation of the PLOO should not reduce the quality or quantity of EFH. Extensive monitoring and scientific studies indicate little or no alteration of physical, chemical, or biological conditions of the waters or substrates. Impacts on marine organisms, prey species, their habitat, and other ecosystem components are minimal. Wastewater discharged from the outfall makes an insignificant contribution to regional cumulative impacts on EFH or fisheries species. Thus, the discharge of treated wastewater from the PLOO should not have an adverse effect on EFH.

H.3.7 Commercial Fishing

Fisheries along the California coast have historically targeted over 285 species in four main groups: groundfish, coastal pelagic fish, highly migratory fish, and invertebrates (California Fisheries Fund 2014). Changing economic conditions and management restrictions have significantly reduced commercial fishing and fishery landings over the last half century (Figure H-12, from Port of San Diego (POSD) 2009).

**Figure H-11:
California Commercial Landings: 1958-2008**



Commercial fishing has been affected by seasonal closures, quota reductions, and restrictive long-term stock-building plans (CMLPA 2009). Salmon fishing quotas diminished following the listing of five California salmon population types under the federal ESA. Tuna landings have fallen with the relocation of the fishery to less costly venues in Samoa and Puerto Rico. And, decreasing abalone stocks led to the total commercial fishing ban of abalone south of San Francisco in 1997.

When reviewing the commercial fish landings in recent years, it must be put into context with the recent and ongoing coronavirus pandemic. With restaurants and supply chains disrupted due to the pandemic commercial fish landings were severely reduced. Sales of fish and gear were down as much as 95% as many commercial boats have simply stayed dockside (Rutgers University 2020, Reiley 2020).

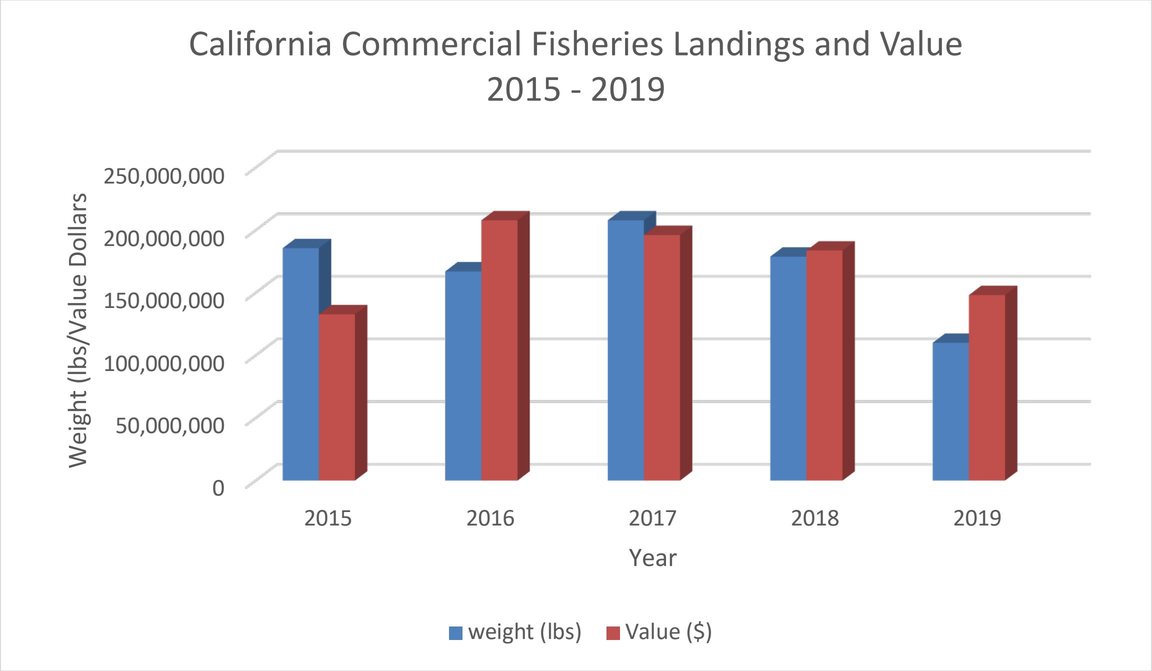
Increasing regulation will likely reduce fisheries catch and landings in the future. The CMLMA resulted in permit suspensions in the nearshore fishery and further access restrictions were imposed by the squid management plan (CDFW 2014e). The CMLPA authorized new protections for ocean habitats and wildlife. It created a network of marine protected (fishing-restricted) areas along the coast to help revive depleted fish stocks (National Ocean Economics Program (NOEP) 2005, 2009). The increasing use of waterfront property for recreational boating, tourism, and housing limits the availability of shore-side space for commercial fishing support facilities.

Despite the general decline of landings in California, some fisheries have been relatively resilient. For example, increased international demand for squid has enhanced landings during non-El Niño years, attracting participation from former salmon fishermen. Specialized fisheries for sea urchin, sea cucumber, Pacific herring, and live rockfish have grown in recent years as well (NOEP 2009, Hackett et al. 2009).

Even though the commercial fishing industry in San Diego has contracted, local landings continue to be important to the regional economy. There have been more than 130 commercial fishermen in San Diego whose catch includes lobster, sea urchin, swordfish, spot prawn, white sea bass, rockfish, rock crab, shark, and tuna. In 2009, the Port of San Diego developed and began implementing a Commercial Fisheries Revitalization Plan to address the economic opportunities and potential constraints facing the local commercial fishing industry (POSD 2009).

From 2014 through 2019, California commercial fisheries landings continue to be in the 100 to over 200 million pounds per year (Figure H-13). The value of the California commercial fisheries catch varied during the period from 130 million dollars to nearly 200 million dollars (Figure H-13). The value is ex-vessel, that is, whole fish at wholesale price. The overall economic contribution of the product may be as much as three to four times higher as it passes through the economy (NOEP 2005, 2009, Hackett et al. 2009). Variations in the species caught and total pounds landed can be influenced by episodic changes in large scale ocean conditions such as marine warming events (OEHHA 2020, Parnell et al 2019). Additionally, market demand can affect the number of active commercial fisherman thereby lowering the landings, such as the severe negative impact the COVID19 pandemic had on commercial fishing (Rutgers 2020, Reiley 2020).

Figure H-13:
California Commercial Fisheries Landings and Value 2015-2019



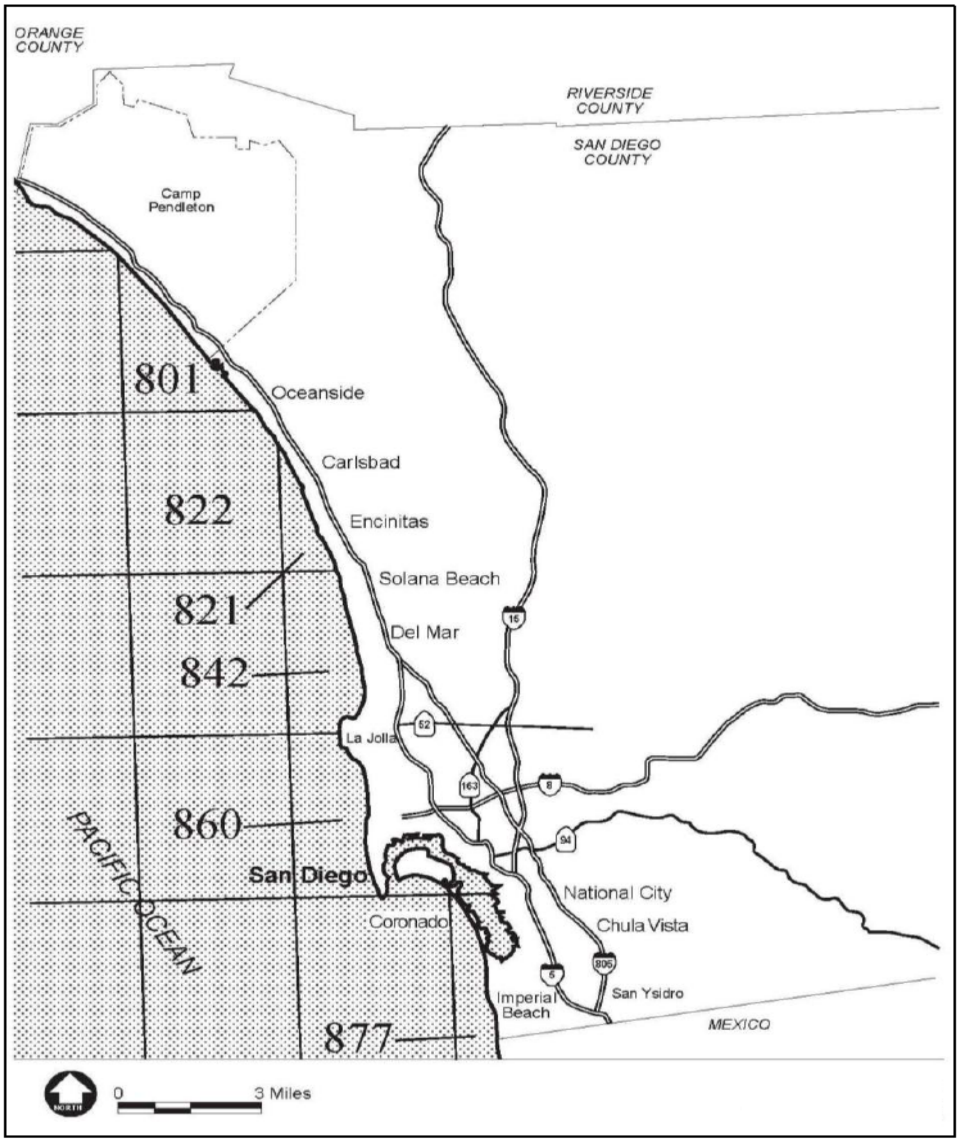
The major commercial fisheries of the Southern California Bight, their seasons, and harvest gear are listed in Table H-11.

Table H-11:
Commercial Fisheries Groups, Seasons, and Harvest Methods

Fishery	Season	Harvest Methods
Coastal Pelagic Species		
Anchovy, mackerels, sardine, squid	Year round, seasonal by species, some with harvest guidelines	Purse seine, drum seine, gillnet, dip net, some line gear (mackerel)
Highly Migratory Species		
Tunas, sharks, billfish, swordfish, dolphin	Year round, seasonal by species and region	Gillnet, purse seine, set net, drift net, troll, hook and line, harpoon (swordfish)
Groundfish Species		
Flatfish, rockfish, thorneyheads, roundfish, scorpionfish, skates, sharks, chimeras	Year round, seasonal by species and region	Trap, troll, gillnet, set net, hook and line
Other Finfish		
CA halibut, CA sheephead, white seabass	Year round, seasonal by species	Set gillnet, drift nets, trap, hook and line
Invertebrates		
Lobster, urchin, prawn, crab, shrimp	Year round, seasonal by species	Trap and diver

Fishery catch statistics are reported for large fishery blocks, providing sufficient ambiguity to protect commercial fishers' "secret spots". Additionally, reported landings can be redacted by CDFW in accordance with confidentiality requirements in Fish and Game Code 8022. Fish blocks are 9-mi by 11-mi rectangles. Figure H-14 depicts CDFW nearshore fish blocks in the San Diego area.

Figure H-12:
San Diego Nearshore Fish Blocks.



From catch data supplied by commercial fishermen, CDFW accumulates the weight and dollar value of commercial fish landed by species in California. The fish block off Point Loma is block 860. Historically sea urchin, market squid and lobster have dominated the catch by weight in block 860. An example of fish catch (with some species weights redacted) for block 860 is presented in Table H-12.

Table H-12:
Yearly Fisheries Catch Reported from Fish Block 860

SPECIES	Annual Fish Catch in Pounds (lbs)				
	2015	2016	2017	2018	2019
Bonito, Pacific	26	453			511
Cabezon	153	33	152	208	
Crab, armed box				92	
Crab, box				126	33
Crab, rock	37,242	9,991	14,762	76,541	41,358
Crab, spider	7,233	7,805	8,039	14,250	12,111
Dolphinfish	451		171		
Eel, moray	168				
Halibut, CA	1,274	4,296	14,843	12,217	6,632
Jacksmelt					
Lingcod	36	52	36	145	136
Lobster, CA	119,201	96,253	117,798	111,890	90,155
Mackerel, Jack					252
Mackerel, Pacific	218		350	1241	2,857
Mackerel unspecified				320	
Octopus	351	1,113	203	377	219
Rockfish, all	3,254	1,177	1,128	1,090	3,805
Sablefish	75	306			
Scorpionfish, CA	29		9		
Sea cucumber			10,567	9,945	9,403
Seabass, white	1,428	7,284	3,799	3,974	6,739
Shark, Pacific angel				360	
Shark, shortfin mako	751	1,277		2,598	
Shark, soupfin					415
Shark, thresher	1,883	3,126			214
Sheephead	19,165	9,728	10,657	16,039	13,395
Snail, top		334			157
Surfperch				129	237
Swordfish				9,977	4,335
Tuna, bluefin	1,649	6,249	3,014	2,828	5,998
Tuna, yellowfin	1,827		93		663
Urchin, purple			5480		
Urchin, red	311,235	189,981	87,168	85,634	347,151
Whelk, Kellet	3,306	9,879	5,623	17,284	19,230
Whitefish, ocean	235	54	108	679	1,346
Yellowtail	11,762	9,596	4,897	2,487	2,500

Table H-12 Notes:

Source data: California Department of Fish and Wildlife. (CDFW 2021)

Some species/data may be absent from the table due to redactions by CDFW in accordance with confidentially requirements set by Fish and Game Code 8022 and may be represented by blank cells.

Other catch reported as taken by commercial fisherman during 2015-2019 in block 860; but not shown in table 12 because the total weight of the catch was redacted include: Mackerel (unspecified), jack Mackerel, Swordfish, leopard Shark, soupfin Shark, bat Ray, shovelnose Guitarfish, Jacksmelt, speckled Sanddab, Sanddab, Rockfish (unspecified and several other species), Thornyheads, Triggerfish, Opah, Opaleye, Blacksmith, black Surfperch, rubberlip Surfperch, top Snail, spot Prawn, and California Barracuda.

Many commercially important fisheries species are taken in block 860. Not all fish caught from block 860 are brought to port (landed) in San Diego. For example, historically market squid from block 860 has mostly been taken by Los Angeles area fishing vessels that return to ports in that area to offload their catch. So the proportion of the catch from block 860 that contributes to San Diego's economy cannot be completely quantified.

However, landing data are collected at the two harbors adjacent to Point Loma: Mission Bay and San Diego Bay. Landings at these locations include block 860 and other adjacent locations off the San Diego coast. This data provides an estimate of the economic contribution of the local fisheries to the local economy.

The annual dollar value for the top 6 commercial fisheries species landed at Mission Bay and San Diego Bay from 2015 to 2019 is presented in Table H-13.

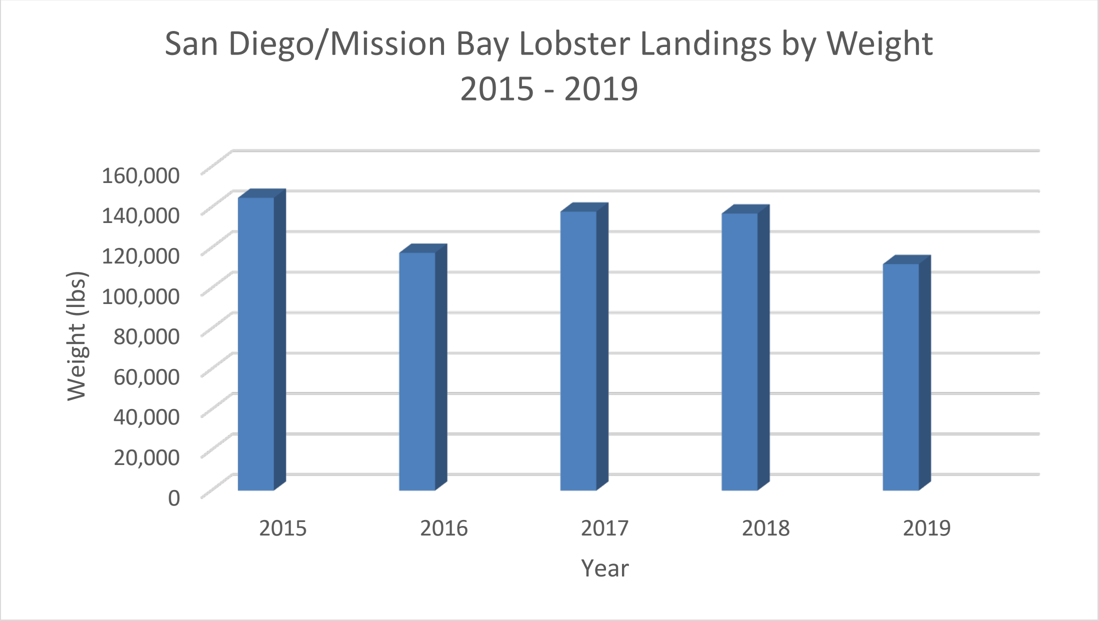
Table H-13:
Top 6 Fisheries Species Value at Mission Bay/San Diego Bay 2015-2019

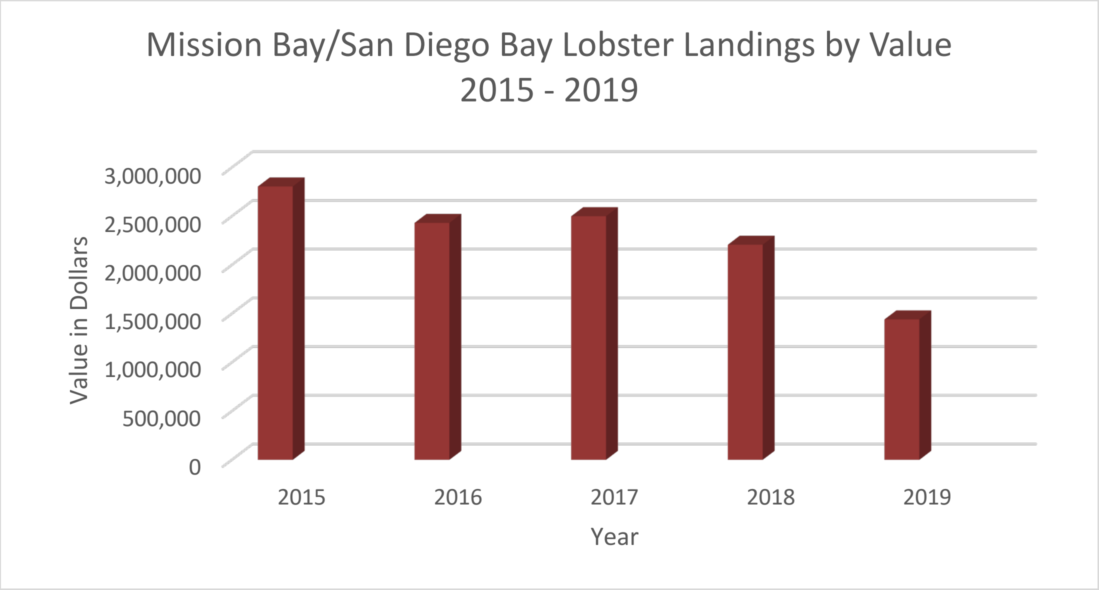
Species	2015	2016	2017	2018	2019
Lobster	$ 2,804,978	$2,431,036	$2,499,424	$2,207,285	$1,441,296
Tuna, Bigeye	$ 1,715,853	$2,002,529	$2,007,305	$2,704,457	$3,475,039
Urchin	$549,172	$305,114	$187,979	$222,592	$813,155
Spot Prawn	$473,774	$1,032,791	$921,480	$1,011,066	$741,451
Swordfish	$ 330,962	$874,290	$ 706,135	$ 838,031	$ 766,890
Opah	$385,881	$475,907	$350,589	$475,907	$565,132

Source data: CDFW 2021

California spiny lobster has historically been a premier commercial catch in San Diego. Figure H-15 shows the weight and value of lobster landed at Mission Bay and San Diego Bay from 2015-2019.

Figure H-15:
San Diego/Mission Bay Lobster Landings by Weight/Value 2015 - 2019





Source data: CDFW 2021

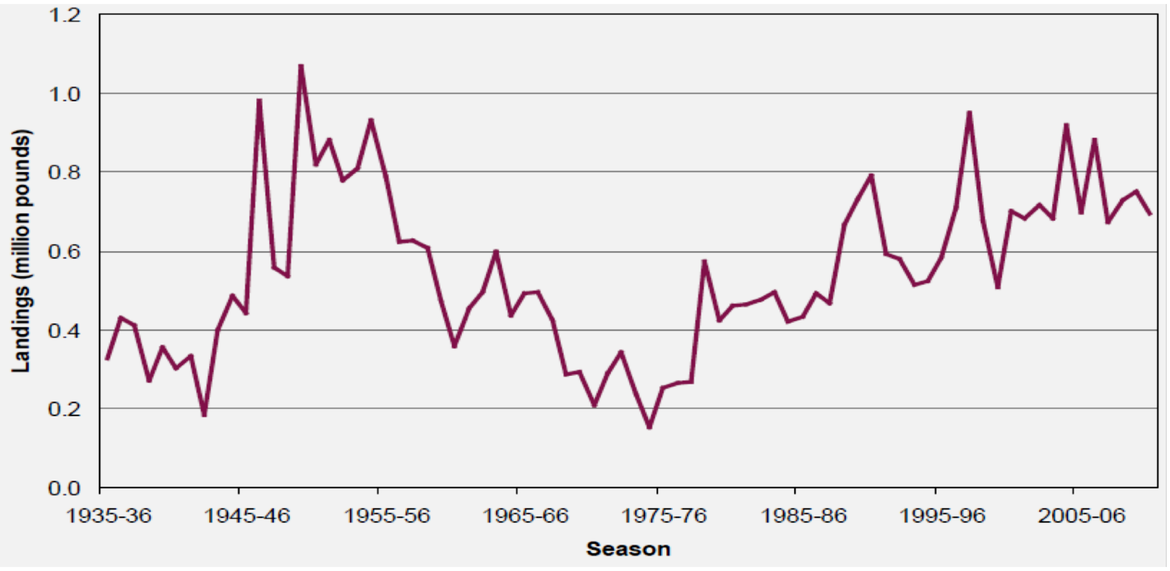
The wholesale value of lobster landed at Mission Bay and San Diego Bay averaged about 2.3 million dollars per year during the period 2015-2019. This represented a large percentage of the total value of all commercial species landed in San Diego County.

The California spiny lobster (*Panulirus interruptus*) ranges from Monterey, California south to Magdelena Bay, Baja California (Mai and Hovel 2007, CDFW 2013a). They occur from the intertidal zone to a depth of about 200 feet (60 m) and are usually associated with eel grass and kelp beds in rocky areas (Leet et al. 2001). Spiny lobster are a major predator of benthic invertebrates including mussels and sea urchins and act as a keystone species along rocky shores and in kelp forests. Primary predators of lobster include sheephead and black sea bass (Neilson 2011). Lobster are nocturnally-active, sheltering under rocks and in crevices during the day and foraging at night. The females migrate to shallow water during spring and summer to spawn; in fall they move to deeper water to mate.

Lobster have been fished commercially in California since the late 1800s. They are caught in traps set along the inner, middle, and outer edges of kelp beds, and over hard-bottom, mostly in depths of 30-120 feet (9-36 m) (CDFW 2014f). Open season runs from the 1st Wednesday in October to the 1st Wednesday after March 15. Early in the season traps are set from just outside the surf line to the inner edge of kelp beds. As winter storms approach, traps are moved farther offshore into the kelp bed and along their outer edge.

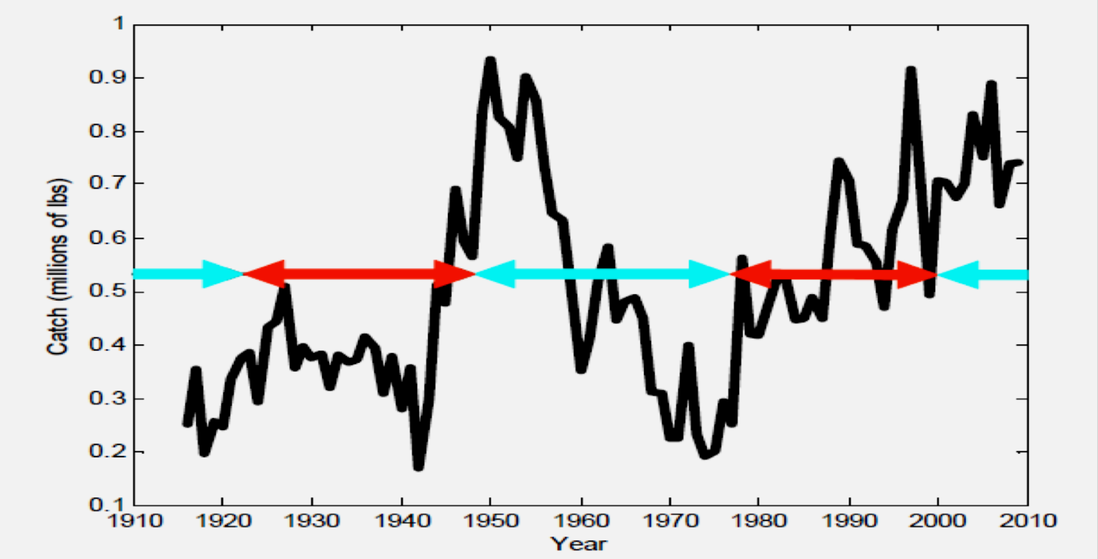
Figure H-16, from CDFW 2013a, shows California spiny lobster commercial landings from 1936-2011.

Figure H-16:
CA Historical Spiny Lobster Landings 1936 - 2011



The lobster catch in California is influenced by the prevailing oceanographic regime. Figure H-17, from Neilson 2011, contrasts periods of warm and cold water associated with the PDO with lobster landings from 1916 to the present.

Figure H-17:
Warm and Cold Water Regimes and Historical Lobster Catch



Another historically valuable marine organism landed at Mission Bay and San Diego Bay is sea urchin (Table H-13).

Sea urchin are harvested for their roe, which is known as “uni”. Harvesting is done by divers, usually in or around kelp bed, at depths of 30-70 feet (9-21 m) using a hookah breathing system connected to a surface vessel or platform.

The overall California catch of sea urchin has varied considerably during the past 40 years (Figure H-18, from CalCOFI 2013). Variations are due to a number of factors including limited development of the fishery prior to the mid-1980s, a strong 1982-1983 El Niño, a rush into the unrestricted fishery precipitated by a rapidly developing Japanese market for "uni" during the late 1980s and early 1990s, subsequent limited access permitting in response to resource depletion combined with weak El Niños in 1987 and 1992, and additional catch restrictions. The continued diminished urchin harvests in 1997-1998 were a result of the loss of kelp, their primary food source, during the prevailing strong El Niño (Wolfson and Glinski 2000). Recently the urchin population off San Diego was decimated during the warm water period of 2014-2016 due primarily to lack of kelp as their food source. The warming ocean waters, due to an episodic change in currents, severely damage the kelp forests in the area. They have since began to recover and as a result Urchin recruitment appears to be strong (Parnell et al 2019). Figure H-19 shows Mission Bay/San Diego Bay urchin Landings and value from 2015-2019 that includes the population reduction due to the warm water period, as well as indications of the initial recovery.

Figure H-18:
California State Urchin Catch 1970-2012

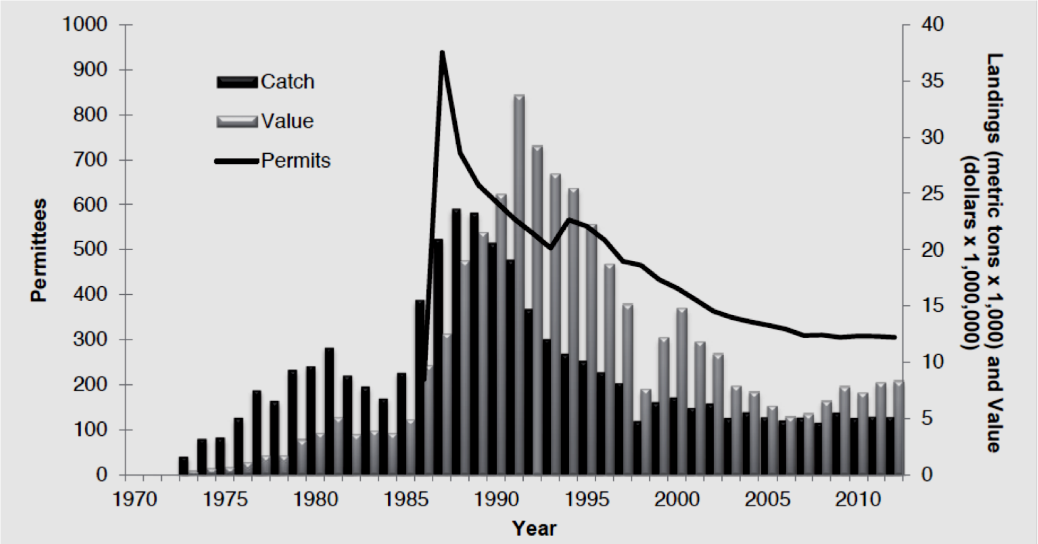
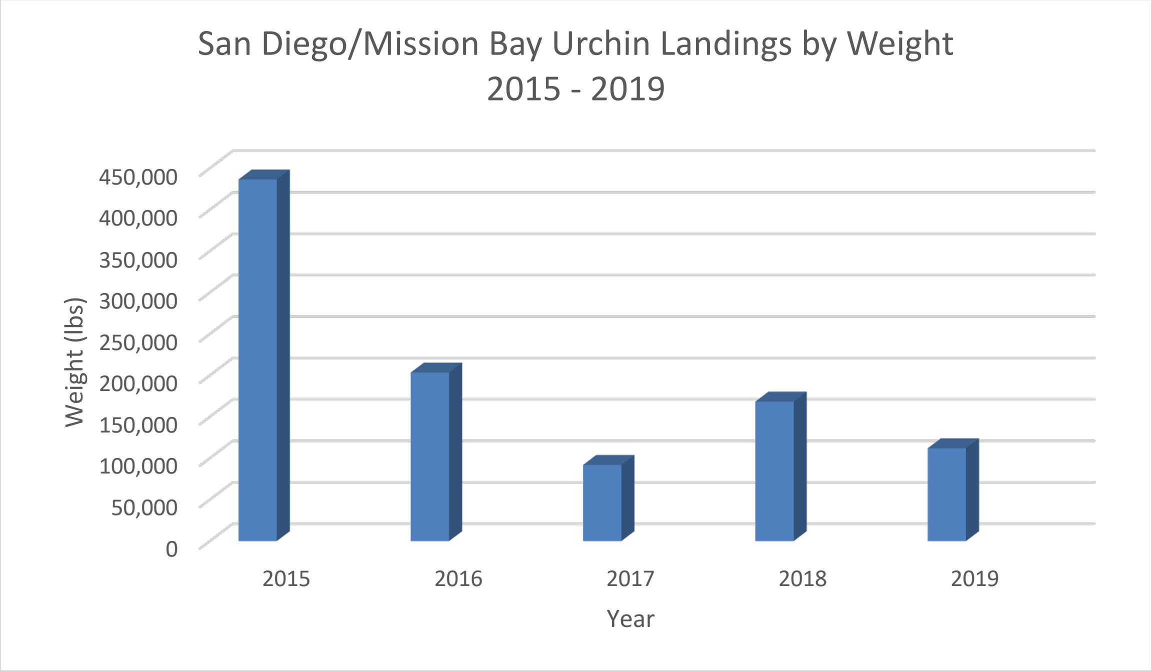
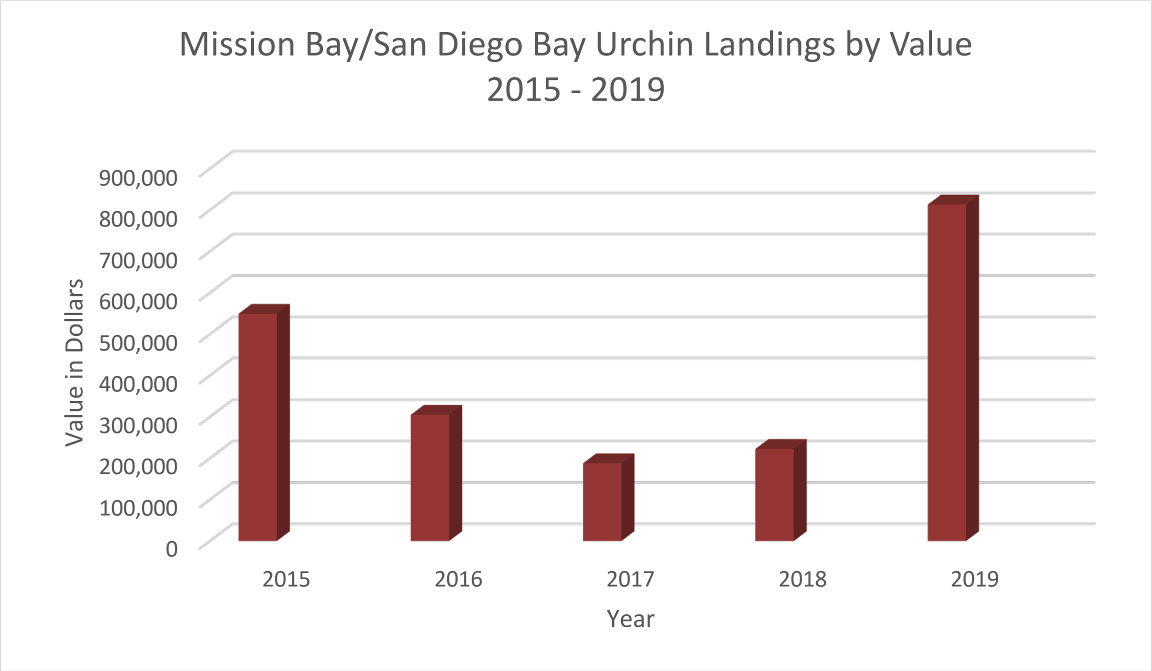


Figure H-19:
Mission Bay/San Diego Bay Sea Urchin Landings by Weight/Value 2015-2019





Source data: CDFW 2021

Both the lobster and urchin fisheries occur near or in the kelp beds, which are limited to maximum depths of about 90 feet (18 m) over consolidated bottom (out to about 1 mi (1.6 km) from shore). Thus, these fisheries take place at a distance of 3.5 mi (5.6 km) or greater from the PLOO.

Swordfish has been another valuable seafood commodity landed at Mission Bay and San Diego Bay during the 5-year period from 2015-2019. Swordfish (*Xiphias gladius*) are found in tropical and temperate ocean waters (Leet et al. 2001). They migrate north from Baja California into California coastal waters in springtime then move south in the fall to spawn and over-winter. Swordfish grow to 1,200 lbs (544 kilograms (kg)) and 14 feet (4.3 m) in length. Adult swordfish eat squid and pelagic fish. They are caught near the surface, mostly at night.

Swordfish are taken well off Point Loma every year. Prior to the early 1980s harpooning swordfish at the surface was the primary harvest method. Only a few boats still use harpoons. West coast longliners are prohibited from fishing in the Exclusive Economic Zone, or anywhere for swordfish using this method.

Spot prawn consistently rank as a valuable seafood landed at ports adjacent to Point Loma from 2015-2019. Spot prawn (*Pandalus platyceros*) are shrimp. They have four bright white spots, hence the name. As of April 1, 2003 the use of trawl nets to take spot prawn has been prohibited. The season for spot prawn south of Point Arguello, Santa Barbara is closed November 1 through January 31. Today, most spot prawn are caught in traps set on the sea floor at depths of 600-1,200 feet (183-366 m). Much of the spot prawn catch off Point Loma goes to supply restaurants featuring live display.

Over the past twenty-five years there has been a steady increase in demand for "live" finfish. This began primarily to serve members of the Asian community and has since grown to include many markets and Asian restaurants. The "live" finfish industry has grown as an alternate, off-season opportunity for many in the lobster fishery and increased in 1994 with the gillnet closure within 3 nm (5.6 km) of shore. Traps will catch practically any species willing to enter a small space for food. The primary target species generally weigh 1-3 lb (0.5-1.4 kg) and include sheephead, halibut, scorpionfish, cabezon, lingcod, and several members of the genus *Sebastes* (rockfish). These live fish, presented in salt water aquaria for individual selection, bring several times the value of their filleted colleagues. A "Nearshore Finfish Trap Endorsement" is required to catch finfish in baited traps for the "live" market.

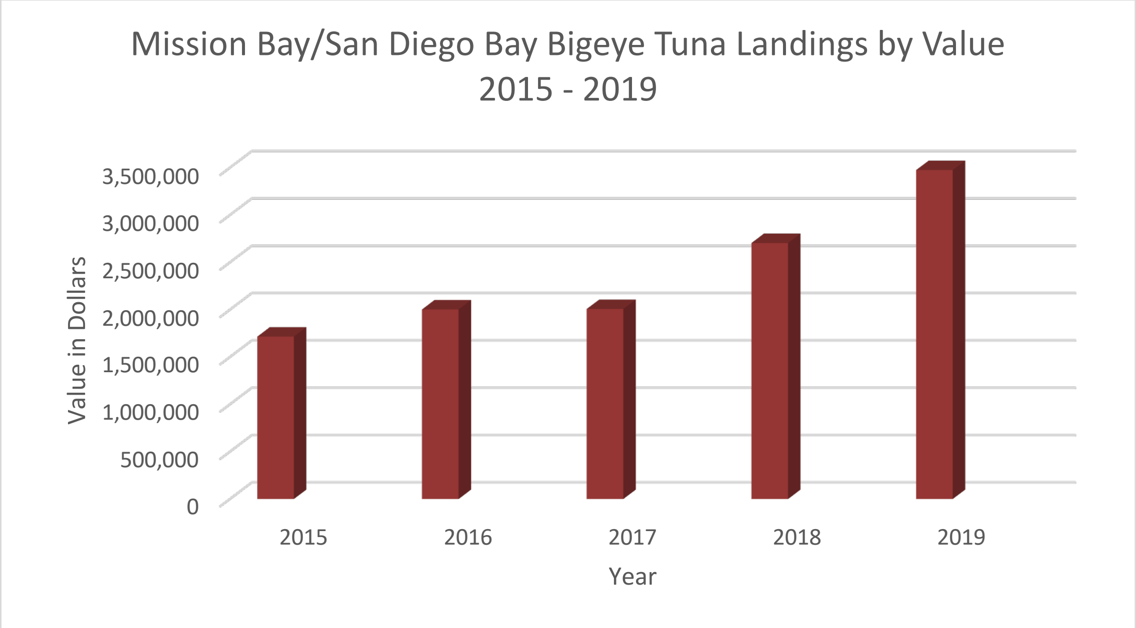
Sheephead have historically been a valuable commercial catch landed at Mission Bay and San Diego Bay. The California sheephead, *Semicossyphus pulcher*, is a large, colorful wrasse. Male sheephead reach a length of 3 feet (0.9 m), a weight of 36 lb (16 kg), and have a white chin, black head, and pinkish to red body. Females are smaller, with a brownish red to rose-colored body. California sheephead begin life as a female with older, larger females developing into secondary males. Female sexual maturity may occur in three to six years and fish may remain female for up to 15 years. Timing of the transformation to males involves population sex ratio as well as size of available males and sometimes does not occur at all (Leet et al. 2001). California sheephead show high site fidelity and a small home range, but increase their movement range with warmer seasonal waters (Topping et al. 2006).

Populations of California sheephead off southern California have declined because of fishing pressure. Large males are now rare because they are sought by recreational spear fishermen. Sheephead are taken commercially by traps and kept alive for display in restaurant aquaria where patrons select a specific fish for preparation. Although most commercially landed sheephead are caught by trap some are taken by hook-and-line, and also as bycatch in the gill net fishery. The red color and soft, delicate flesh are especially prized in Asian cuisine.

During 20015 – 2019 two other species became among the top value landings at ports in the San Diego Area. Bigeye tuna and Opah.

Bigeye tuna (*Thunnus obesus*) occur in tropical waters in both the Western and Eastern Pacific. They can be found offshore, as well as inshore rocky reef areas. Whereas they can be found off California, episodic changes warm ocean water currents most likely resulted in their appearance in greater numbers near San Diego in recent years. They are considered a good seafood choice because they are sustainably managed and harvested under U.S. regulations. They are taken by hook and line, pelagic long line, troll gear and purse seine. Populations in the eastern Pacific hit a low in around 2004; but have now recovered and are above its target population level (NOAA 2021a). Although not always seen in large numbers in previous years, during 2015 – 2019 they were the number two fish in value landed at Mission Bay/San Diego Bay (Table13, Figure H-20).

Figure H-20: Mission Bay/San Diego Bay Bigeye Tuna Landings by Value 2015 - 2019



Source: CDFW 2021

Opah (*Lampris guttatus*) are also known as moonfish. They also are considered a good seafood of choice. Also preferring warm waters it is assumed that the increase in their landings in the San Diego area are also a result of episodic current changes. Although they have never been assessed, but there is no evidence that populations are in decline or that fishing rates are too high. Despite the opah's value to commercial and recreational fishermen, little research on the basic biology and ecology of opah has been conducted. To begin to fill some of the data gaps, NOAA's Southwest Fisheries Science Center began collecting biological samples from opah in 2009 and initiated an electronic tagging program in 2011. Scientists hope to continue tagging opah to learn about their movements and range. This research will provide the basic life history information necessary for future population assessments and management. While there is no directed fishery for opah, they are harvested in small but significant quantities. U.S. fishermen catch them incidentally in tuna and swordfish fisheries around the U.S. Pacific Islands and off southern California (NOAA 2021b).

Other notable commercial fisheries in San Diego marine waters include rock crabs, sea cucumbers, Kellet's Whelk, rockfish, thornyheads, white seabass, California halibut, albacore, thresher shark, sablefish, hagfish, market squid, sardines, anchovies, mackerel, and mariculture.

Rock crabs off Point Loma are mostly caught in traps at depths out to 300 feet (90m). The predominant species taken is the yellow rock crab, *Cancer anthonyi*. They range from Magdalena Bay, Baja California to Humbolt Bay, California, but are abundant only as far north as Point Conception. In southern California, rock crab are most common on rocky bottoms at depths of 30-145 feet (9-44 m), but are also found on open sandy bottoms where they partially bury themselves when inactive. Over sand, adults feed on live benthic prey and scavenge dead organisms that fall to the bottom.

Two species of sea cucumbers are taken in the commercial fishery: the California sea cucumber (*Parastichopus californicus*), also known as the giant red sea cucumber, and the warty sea cucumber (*P. parvimensis*). They inhabit the low intertidal to 300 feet (90 m) deep. Sea cucumbers feed on organic detritus, sea stars and other small invertebrates. The warty sea cucumber is fished almost exclusively by divers, and populations at fished sites have declined due to fishing mortality (Schroeter et al. 2011). The California sea cucumber is caught principally by trawling in southern California. A special permit to commercially fish for sea cucumbers was required beginning with the 1992-1993 fishing season. There is no significant sport fishery for sea cucumbers in California and sport fishing regulations forbid their take in nearshore areas in depths less than 20 feet (6 m) (Leet et al. 2001).

Kellet's Whelk (*Kelletia kelletii*) is a large subtidal snail that occurs intertidally to 230 feet (70 m) on rocky reefs, gravel bottoms, kelp beds, and sand from Baja California, Mexico to Monterey Bay (Leet et al. 2001). The Kellet's whelk fishery is growing rapidly. They cannot be taken within 1,000 feet (305 m) from the shore, except incidentally by lobster and/or rock crab traps.

Rockfish are non-migratory, and many species of rockfish are caught in the offshore area of Point Loma. Numerous rockfish stocks in both northern and southern California are considered depleted, and in an effort to better regulate the stocks, rockfish were divided into nearshore, shelf and slope groups in 2001. The shelf group is comprised of 32 fish of the genus *Sebastes*. They are most commonly caught by trap and hook and line over the continental shelf from depths of 120-900 feet (36-274 m). Live catches bring top prices and are often sold live to Asian restaurants.

Shortspine thornyheads (*Sebastolobus alascanus)* are found off California in waters ranging from 100-5,000 feet (30-1524 m) deep. They migrate to deeper water as they grow and are closely associated with the bottom. They are usually fished from bottom waters 1,200-4,200 feet (366-1,280 m) deep with peak abundance generally in the 1,800-3,000 feet (547-914 m) range. Like rockfish, they are members of the family Scorpaenidae and are primarily exported to Japan for sushi.

White seabass (*Atractoscion nobilis*) are the largest members of the croaker family (Sciaenidae) in California. They can grow to 90 lb (41 kg), although fish over 60 lb (27 kg) are rare. Adults school over rocky areas or near and within kelp beds. They can be caught at the surface and to depths of nearly 400 feet (122 m). Other common names for white seabass are king croaker, weakfish and sea trout (juveniles).

California halibut (*Paralichthys californicus*), a regular component of the fisheries catch off Point Loma, are a prized, non-schooling flatfish. Known as the left-eyed-flounders, about 40% are actually right-eyed. They range from Baja California to British Columbia. Halibut feed almost exclusively on anchovies and other small fish. They spawn in shallow waters from April-July. In the San Diego area they are caught in depths to about 300 feet (91 m), by hook and line, directed longline, and set gill nets in federal waters (>3 nm (5.6 km)). The best catches are usually in springtime over sandy bottom. The fishing season is mid-June to mid-March. California halibut range in size up to a maximum of about 70 lb (32 kg), although most are much smaller.

Albacore (*Thunnus alalunga*) are found worldwide in temperate waters; in the eastern Pacific they range from south of Guadalupe Island, Baja California to southeast Alaska (Eschmeyer et al. 1985). Their food varies but consists mostly of small fish, and sometimes squid and crustaceans. In southern California albacore are usually found 20-100 mi (32-160 km) offshore. Normal catch size is 20-40 lb (9-18 kg). Albacore is the most abundant tuna caught in commercial fisheries and recreational fisheries in California and along the West Coast. In the commercial fishery albacore are caught primarily using hook and line gear (jigs, bait, or trolling), but they are also taken in drift gill nets or round haul gear.

Thresher shark (*Alopias vulpinus*) is the most common and valuable shark taken in California commercial fisheries. Commercially-caught thresher shark are principally taken in offshore gill net fisheries.

Sablefish (*Anoplopoma fimbria*) are caught by trawls, nets, trap, and hook and line. Different regulations apply for each method. Sablefish are found in depths of 900-4,200 feet (274-1,280 m), with greatest densities in the 1,200-1,800 feet (366-549 m) range. Sablefish can live 50 years and can weigh up to 126 lb (57 kg). They enter the fishery as early as 1 year of age and most are taken by the trawl fishery by years 4 - 6, at a weight of less than 25 lb (11 kg). Traps and long-line hook fisheries generally catch the older, larger fish. Most of the catch is exported to Japan where it is served as sushi. In the U.S., sablefish are often marketed as black cod, the smaller ones are often filleted and sold as butterfish.

The Pacific hagfish (*Eptatretus stoutii*) is the target of an emerging commercial fishery in California (Bell 2009). Hagfish are unlike any other saltwater finfish. They have four hearts and up to 16 pairs of gill pores along their body. Hagfish feed on dead and dying fish and marine mammals, burrowing into their prey by making a hole with their rasping teeth, or entering through an existing opening (e.g., mouth or gills). They consume prey from the inside, leaving only skin and bones when finished. Moving with a snakelike motion, using their paddle-shaped tails, hagfish resembles an eel, but are not related. The hagfish produces large quantities of slime when agitated, giving it the common name "slime eel." Hagfish occur at depths ranging from 30-5,600 feet (9-1,707 m), but are more common at depths exceeding 300 feet (90 m). The California fishery began in 1982, when Koreans were looking for outside sources of hagfish due to local depletions. Prior to this, California fishermen had only considered hagfish a nuisance because they would eat and destroy their bait and catch. Commercial fishermen usually fish for hagfish at depths of 300-1,800 feet (90-589 m) using strings of baited traps.

The California market squid (*Loligo opalescens*) has been harvested since the 1860s and has become the largest fishery in California in terms of tonnage and dollars since 1993 (Zeidberg et al. 2006). Squid landings decreased substantially following the large El Niño events in 1982-1983 and 1997-1998, but not the smaller El Niño events of 1987 and 1992. Market squid are small (6 inch mantle length). They occupy the middle trophic level in California waters, and may be the state's most important marine forage species. They are short-lived (about 10 months). Market squid are primary prey for at least 19 species of fish, 13 species of birds, and six species of mammals (Morejohn et al. 1978).

Since the decline of the anchovy fishery, market squid is possibly the largest biomass of any single marketable species in the coastal environment of California. The majority of squid landings occur around the California Channel Islands, from Point Dume to the Santa Monica Bay, and in the southern portion of the Monterey Bay (Zeidberg et al. 2006). The fishery has varied through the years due to El Niño events and rapid fluctuations in market value. El Niño events have traditionally depleted the market squid fishery and driven up the value due to poor landings (Leet et al. 2001). They are generally caught near the surface, but can be found to depths of 800 feet (244 m). During the 1990s, purse seines became the dominant gear used to harvest market squid. Currently, market squid are fished year-round with increased catch rates from September through February in southern California.

Sardines (*Sardinops sagax*) are small, pelagic, schooling fish that are members of the herring family. The California fishery peaked in 1936-1937 and vanished from southern California during the 1950s. Fishing pressure was first suspected as the cause, but it was subsequently determined that cooling ocean temperatures contributed to the decline. The late 1990s warm water cycle has brought the sardine back to southern California, where the purse seine fishing season for sardines now runs year-round.

Northern anchovy (*Engraulis mordax*) are small, short-lived pelagic fish found throughout the eastern Pacific Ocean. They are active filter feeders, and consume various types of plankton. Anchovies are ecologically important as prey for many species of birds, mammals, and fish. Historically in California, anchovy supplied a large reduction fishery, which produced fish meal, oil, and soluble protein. They are currently utilized for human consumption, bait, and pet food. Large-scale anchovy landings were first seen in the early 1900s during times of low sardine availability. Commercial landings have been low since the 1980s due to market constraints rather than biological factors.

Pacific mackerel (*Scomber japonicus*) are a schooling seasonal species in the San Diego area. In the eastern Pacific they range from Chile to the Gulf of Alaska. They feed on larval, juvenile and small fish, and, occasionally on squid and crustaceans. Dense schools of Pacific mackerel are caught in surface waters by the purse seine fleet. Most Pacific mackerel caught off California weigh less than 3 lb (1.4 kg). This fish is known as a "wet fish" because it requires minimal processing prior to canning. The catch is mainly targeted for human consumption and for use as pet food. A small amount is sold at fresh seafood markets.

Giant kelp (*Macrocystis pyrifera*) has been harvested from the Point Loma kelp bed since 1929 by cutter barges that harvest the upper kelp canopy down to a depth of about 4 feet (1.2 m) below the water surface. During the 1980s and 1990s it was the single most valuable fishery in the vicinity of Point Loma because of the high value of products created from it. Algin, extracted from kelp, is used as a binder, stabilizer, and, emulsifier in pharmaceutical products, in cosmetics and soaps, and in a wide variety of food, drink, and industrial products (McPeak and Glantz 1984). Some of the statewide kelp harvest is also used to feed abalone in mariculture operations (MBC 2012).

The Point Loma kelp bed, the largest kelp bed in San Diego County, was particularly important because of its proximity to the kelp processing plant in San Diego Bay. Although the poundage and landed value was proprietary, Wolfson and Glinski (2000) estimated a commercial value of $5-$10 million/year for the Point Loma kelp bed. In 2005, after 76 years of operation, the San Diego kelp harvesting and processing operation was shut down and moved to Scotland.

Kelp harvesting in California is regulated by the CDFW. As a result of restrictions on harvesting activities, commercial kelp harvest decreased by 96% from 2002 to 2007 (U.S. Army Corps of Engineers (USACOE) 2013). Two kelp beds, one located from the California/Mexico International Boundary to southern tip of San Diego Bay, and one located from the southern tip of San Diego Bay to the southern tip of Point Loma, are considered open, which means they may be harvested by anyone with a kelp harvesting license. Kelp beds at Point Loma and Mission Bay are currently available for lease from the state (USACOE 2013).

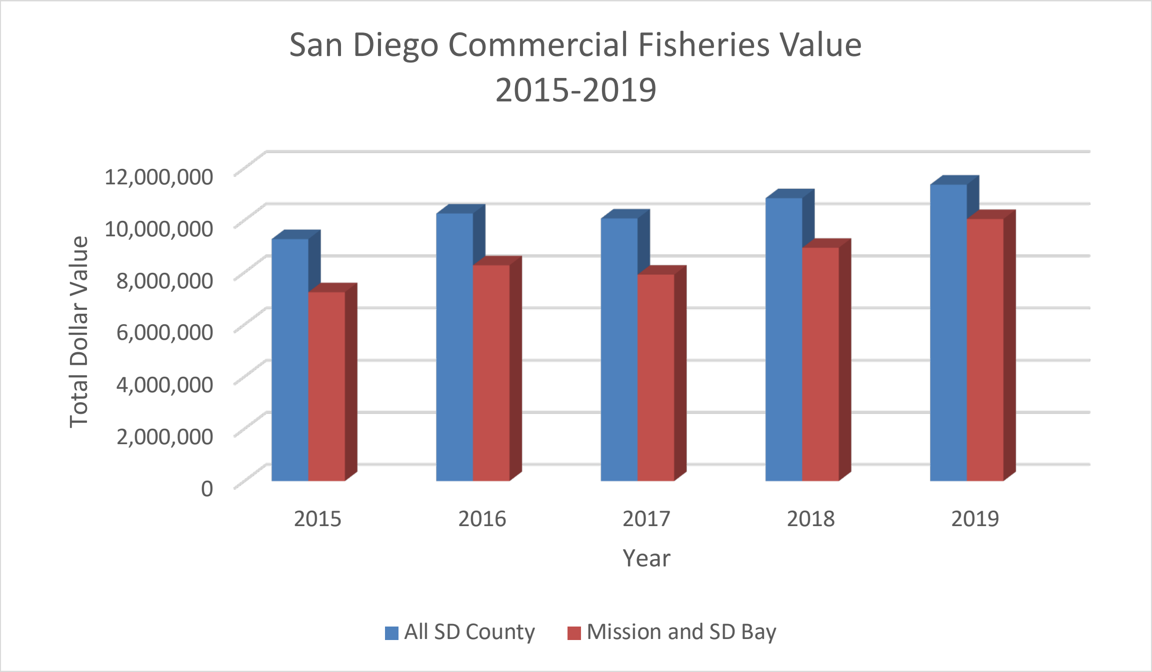
The CDFW is the principal authority issuing permits for marine aquaculture (mariculture) in California. The California State Lands Commission and various municipal entities may grant tideland leases, but if aquaculture is involved, the operation must be registered with the CDFW.

Most mariculture in San Diego is located in lagoons and bays. The Hubbs-SeaWorld Research Institute operates a white seabass hatchery at the Agua Hedionda Lagoon in Carlsbad (27 mi (43.5 km) north of the outfall). This marine fish hatchery was the first commercial scale marine fish hatchery on the west coast and is capable of producing several million juvenile white sea bass annually. Since beginning operation it has released over 2.5 million juvenile white sea bass into the coastal waters of Southern California. (Hubbs-SeaWorld Research Institute 2021). Also located there is Carlsbad Aquafarms, which grows mussel, oyster, clam, abalone, scallop and culinary seaweed (Carlsbad Aquafarms 2021). Sea World also sponsors mariculture research at its Mission Bay facility.

Recently another entity has proposed a major Aquaculture operation off the San Diego coast. Rose Canyon Fisheries is proposing a sustainable aquaculture project that would could use difference types of large cages to raise Yellowtail jack, White seabass and Stripped bass. The current proposed project location is about 3 mi to the north of the Point Loma discharge and a similar distance offshore. This puts it 4.5 mi west of the entrance to Mission Bay. They have assessed the water quality and other factors at that location and found it conducive to an aquaculture project (Marine Research Specialists 2014).

The total annual value of all San Diego County commercial landings from 2015-2019 is shown in Figure H-21. The overall positive health of the commercial fishing industry in San Diego is shown by the steadily increasing value over the period. Also shown in Figure H-21 is the proportion of San Diego County commercial landings from Mission Bay and San Diego Bay, which made up over 80% of all landed value of commercial fishery species in San Diego County.

Figure H-21:
San Diego Commercial Fisheries Value 2015 - 2019

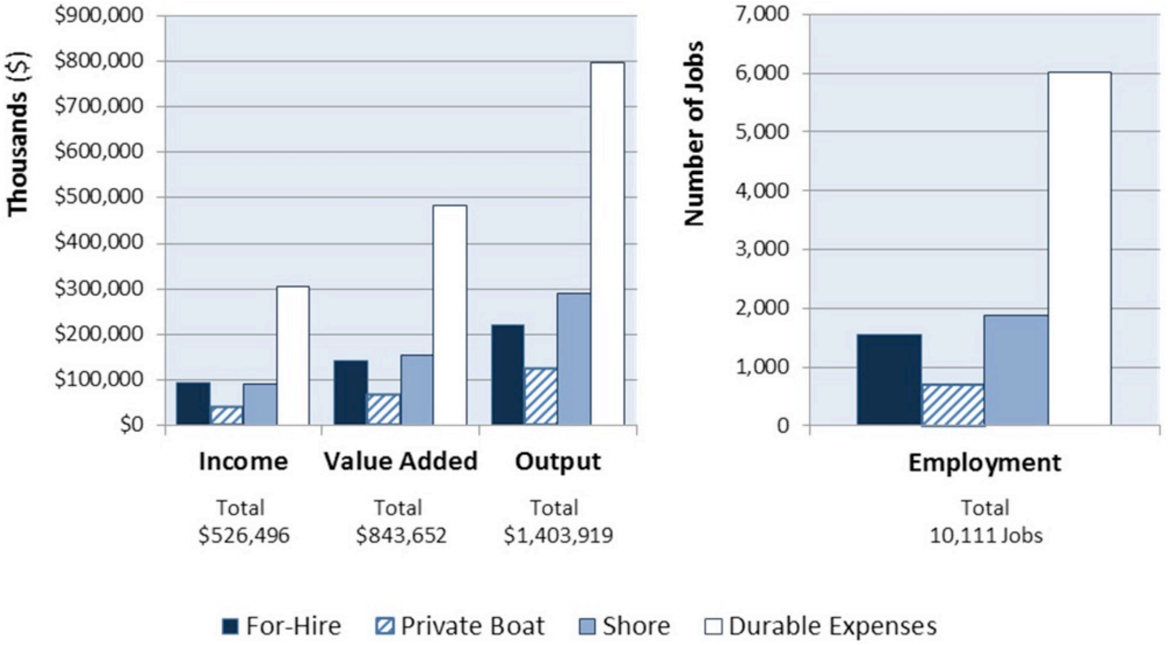


Source: CDFW 2021

H.3.8 Recreational Fishing

Marine recreational fishing and diving activities along the San Diego coast include surf and shoreline fishing, pier fishing, party commercial passenger fishing vessels (CPFVs), private boat fishing, snorkeling, and SCUBA diving. For the period 2015 through 2019 the average annual number of sportfishing fishing licenses of all types issued in California was over 2.5 million, with an average associated revenue estimated at over 65 million dollars. The COVID19 pandemic may have recently affected these numbers and NOAA recreational fisheries has just begun to assess any of the resulting impacts (NOAA 2021c). The direct economic impact of recreational fishing expenditures in California for the most recent year available (2011) totaled more than $1.4 billion and supported more than 10 thousand jobs (Figure H-23, from Lovell et al. 2013) (NOAA 2014f).

Figure H-22:
Economic Value of California Recreational Fishing in 2011



The most common target species for beach fishing are barred surfperch, yellowfin croaker, opaleye, and jacksmelt (CMLPA 2009). Fishers from man-made structures catch Pacific mackerel, Pacific sardine, northern anchovy, queenfish, jacksmelt and other nearshore fish. Rented and chartered boat fishing seek offshore species, especially mackerel, croaker, bass, and rockfish (NOAA 2014f). There is a small contingent of operators specializing in half-day and 1-day charters that typically fish nearshore areas and kelp beds. These operators target sand and kelp bass and California halibut. Oceanside harbor has a few boats in this fishery while Mission Bay and San Diego Bay have larger charter fleets. Fishing occurs year-round, although effort markedly increases in the summer months, peaking in July.

Sport diving and spearfishing activities mostly occur in the nearshore waters, and the number of diving trips in San Diego in the early 1990s was about 30,000 per year (USACOE 2013). This rate has likely increased in recent years. Most diving occurs where marine life flourishes; especially in kelp beds and rocky areas. Some of the premier diving in San Diego includes trips to locations only accessible by boat, including the outer reaches of kelp beds, vessels intentionally sunk as artificial reefs in "Wreck Alley" off of Mission Beach, and offshore islands and banks. Shoreline diving is also popular.

Much of Point Loma is a military reservation with restricted shoreline access - thus shore fishing is limited and the vast majority of sport fishing is from boats. Typical species targeted by recreational anglers include rockfish, Pacific mackerel, kelp bass, sand bass, California barracuda, Pacific bonito, California sheephead, white seabass, California halibut, yellowtail, rockfish, and seasonal, migratory species like tunas.

Of all the California fisheries, the most profound changes in catch composition have occurred in the southern California private vessel and CPFV fisheries (Love 2006, Hackett et al. 2009). There has been a sharp decline in the numbers of rockfish caught, particularly bocaccio, olive rockfish, and blue rockfish. Once mainstays of the fishery, bocaccio, olive rockfish, and blue rockfish have practically disappeared from the recreational catch. This was likely caused by overfishing (recreational and commercial) coupled with 25 years of juvenile recruitment failure from suboptimal oceanographic conditions (Love et al. 1998a,b, Schroeder and Love 2002). During the same period, a number of warm-water species, such as yellowtail, Pacific barracuda, California scorpionfish, ocean whitefish, vermilion rockfish, and honeycomb rockfish became much more abundant. The most fundamental, recent change in the California fishing industry is the emergence of the private recreational vessel fleet, which is now the single largest component of the recreational fishery.

At Point Loma, the extensive kelp bed remains the primary focus of sport fishing. A flourishing CPFV and private fishing vessel fleet, based in San Diego Bay and Mission Bay, operates in the vicinity of Point Loma. CPFVs provide bait, gear rental, food service, fish cleaning, and transportation to fishing grounds for paying passengers on half-day and full-day trips. CPFVs mainly fish the outside edge of the kelp bed, as do the majority of private sport fishing boats (Wolfson and Glinski 1986, 2000).

Catch data (species and number of fish caught) gives an example of the various kinds of fish caught by the CPFV fleet in Mission Bay and San Diego Bay during 2019. It appears below in Table H-14. The table is not all inclusive because some data has been redacted by CDFW in accordance with the confidentiality requirements of Fish and Game Code 8022.

Table H-14:
San Diego Bay/Mission Bay CPFV Fish Caught 2019

Species	Mission Bay (Number)	San Diego Bay (Number)	Total (Number)
Barracuda, California	126	823	949
Bass, barred sand	150	5,090	5,240
Bass, kelp	1,187	5,428	6,615
Blacksmith		275	275
Bonito, pacific	342	2931	3,273
Cabrilla, spotted		110	110
Crab, rock		276	276
Crab, spider		7	7
Croaker, yellowfin		58	58
Dolphin (fish)	73	4,998	5,071
Grouper		383	383
Halibut, California	51	121	172
Halibut, pacific		7	7
Jack, almaco		9	9
Jacksmelt		12	12
Lingcod	490	838	1,328
Lobster, California spiny	23	1887	1,910
Mackerel, pacific	61	650	711
Marlin, stripped		6	6
Rockfish (all)*	15,682	95,224	110,906
Sanddab	90	98	188
Scallop, rock		104	104
Scorpionfish, California	119	5519	5,638
Urchin, purple		24	24
Seabass, white	14	165	179
Shark, shortfin mako	7	4	11
Shark, spiny dogfish	3		3
Sheephead, California	289	1,376	1,665
Snapper, Mexico		69	69
Surfperch, unspecified		481	481
Swordfish		3	3

Table H-14: Notes:

Source data: CDFW 2021

Some species/data is absent from the table due to redactions by CDFW in accordance with confidentially requirements set by Fish and Game Code 8022 and may be represented by blank cells in the table.
*Reported number may be less than actual count due to redactions.

Other fish caught, but not appearing in Table H-14 because the total number was redacted include: Rockfisk (several species), spotted sand Bass, California Corbina, shortfin Corbina, black Crocker, white Crocker, kelp Greenling, Halfmoon, Halibut (unspecified), Kelpfishes, Pacific Lamprey, jack Mackerel, striped Mullet, Octopus (unspecified), Opah, bat Ray, Ray (unspecified), Sablefish, Chinook Salmon, Pacific Sanddab, Sargo, yellowchin Sculpin, warty Sea cucumber, Sea Cucumber (unspecified), blue Shark and black Surfperch.

For the five years from 2015 through 2019 the CPFV fleet made over 49,000 individual trips, averaging over 9,800 per year. During that period they served almost 1 million anglers, averaging nearly 200,000 per year, which is an increase of the over 127,000 served just as recently as 2013. Figure H-23 shows the individual CPFV trips per year originating from Mission Bay and San Diego Bay during 2015-2019 (Source CDFW).

Figure H-23:
CPFV Trips by Year from Mission Bay and San Diego Bay

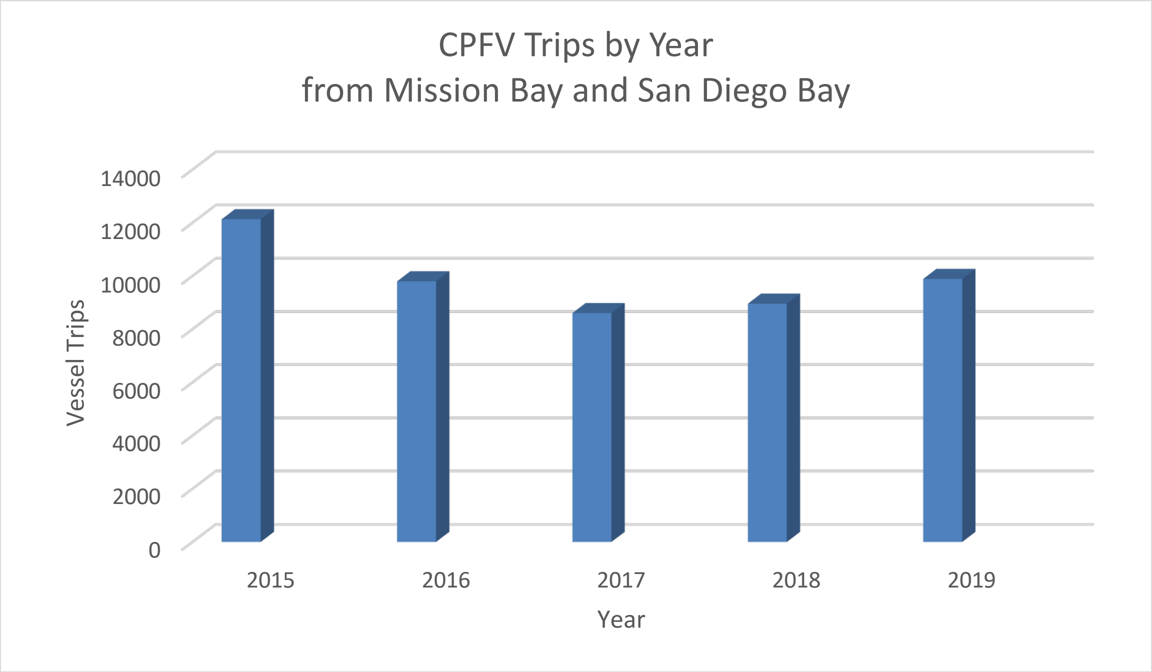
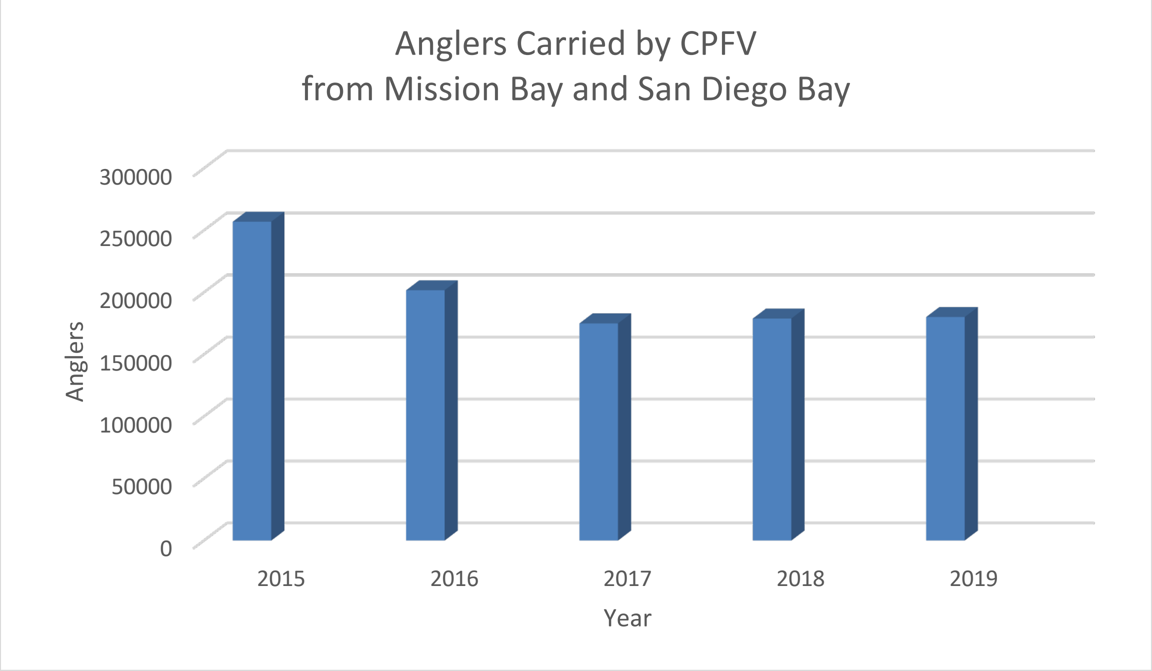


Figure H-24 shows the number anglers carried by CPFV during the period 2015-2019 (Source CDFW).

Figure H-24:
Anglers Carried by CPFV from Mission Bay and San Diego Bay



The Recreational Fisheries Information Network (RecFIN) Program includes recreational fishing data from California, Oregon, and Washington. The Recreational Fisheries Information Network is a project of the Pacific States Marine Fisheries Commission (PSMFC) (PSMFC 2014). California data, available from 1980 to the present, represent the best available information regarding recreational catch off California. RecFIN incorporates data from two recreational fishery sampling programs—the Marine Recreational Fisheries Statistical Survey (MRFSS), which operated from 1980 to 2003, and the California Recreational Fishery Survey (CRFS) initiated by the Department of Fish and Wildlife in 2004.

The California Recreational Fisheries Survey (CRFS) is a statewide sampling program designed to collect catch/effort data on all modes of marine recreational finfish fishing. A collaborative effort of the CDFG and the Pacific States Marine Fisheries Commission, this survey provides information dating back to 1999. It includes data collected from CPFVs, harbors, marinas, piers, landings and from shore and other shore structures (PSMFC 2014). Table H-15 shows the estimated marine recreational catch for all species of fish for the southern district (Los Angeles, Orange and San Diego counties) in 2013.

Table H-15:
Marine Recreational Fish Catch for Southern District in 2013

Fishing Mode				
Man-made Structures	**Beaches and Banks**	**CPFVs**	**Private and Rental Boats**	**District Total**
489,440	256,505	1,327,829	205,031	2,278,805

Data source: Pacific States Marine Fisheries Commission

Because much of Point Loma is a restricted military installation, the proportion of recreational fishing from beaches and man-made structures is substantially reduced compared to the estimates for southern district shown above.

In recreational boat observations off Point Loma, Wolfson and Glinski (1986) found that fishing from private boats concentrated on the kelp bed (often mirroring CPFVs positions). This results in similar species being caught, with the exception of shellfish species (lobster, crab, rock scallops, and sea urchin) which are taken by sport divers in the nearshore zone.

Sport fishing by divers, both free-divers and SCUBA, at Point Loma also takes place in and around the Point Loma kelp bed. Abalone can no longer be collected, but lobster and scallops continue to be harvested (by hand) and a variety of fish are taken by spear. The rip rap boulders covering the outfall pipeline form an artificial reef providing good nearshore recreational fishery catch.

Recreational fishermen are allowed to catch lobster by hand when skin or scuba diving, or by using hoop nets. Historically, diving was the dominant recreational method for catching lobster in southern California, but hoop nets now account for more of the recreational lobster catch than divers (CDFW 2013a). Hoop nets can be deployed by divers and from boats. Kayaks are increasingly being used to fish for lobster using hoop nets.

Table H-16 categorizes typical catch zones for recreational fisheries species caught in the vicinity of Point Loma and offshore.

Table H-16:
Typical Catch Zones for Recreational Species

Category	Species	Surface	Mid-Water	Bottom
Fish	Barracuda	X	-	-
	Bass, sand	-	-	X
	Bass, kelp	X	X	X
	Bonito	X	X	-
	Flatfish	-	-	X
	Lingcod	-	X	X
	Mackerels	X	-	-
	Rockfish	-	-	X
	Scorpionfish	-	-	X
	Sheephead	-	-	X
	Tunas, all	X	X	-
	Whitefish	-	-	X
	Yellowtail	X	-	-
Shellfish	Crab	-	-	X
	Lobster	-	-	X
	Sea snail	-	-	X
	Sea Urchin	-	-	X

Recreational fishing varies seasonally and is weather related, especially when fishing from boats, as is the case off Point Loma. Summer months have greatest fishing activity in both state and federal waters. Inshore recreational fishing gradual increases throughout the calendar year beginning in March and ending in February. Recreational fishing trips generally peak during the summer months.

H.4 RECREATIONAL ACTIVITIES

The embracing climate, beaches, bays, and temperate ocean waters of San Diego provide exceptional opportunities for marine recreation (Lew and Larson 2005). San Diego County in 2020 was home to more than 3.3 million residents primarily concentrated in the coastal regions (SANDAG; San Diego Association of Governments 2021). San Diego County, like the rest of southern California, had slower population growth in the 2000s due to the recession in the early part of the decade, but growth still occurred. The County experienced a net population increase of 10% between 2000 and 2010, and is expected to grow by over another 30% by 2050 (SANDAG 2021).

California is the number one travel destination in the United States. In 2012 there were over 32 million visitors to San Diego who spent nearly $8 billion dollars (San Diego Convention Center and Visitors Bureau 2014); by 2019 those figures increased to over 35 million visitors spending over $11 billion annually (San Diego Convention and Visitor Bureau 2021). The economic total impact of the visitor industry on the San Diego regional economy has annually been more than $18 billion dollars. Whereas tourism accounted for 160,000 jobs in 2012, by 2019 it accounted for more than 199,000 jobs. (San Diego Tourism Authority 2012, San Diego Convention and Visitor

Bureau 2021). This put the tourism sector, along with the U.S. Military and the research and technology sector, as the largest employers San Diego County.

San Diego's tourism is driven by many factors but excellent weather, as well as significant recreational opportunities associated with the coastal setting are obviously major factors for the very high visitation rate. With 17 mi of coastline San Diego offers a wide of ocean related amenities. All economic activities associated with coastal recreation are linked to good water quality. Protecting coastal uses such as swimming, surfing, boating, and fishing has a direct economic benefit. Burgeoning coastal recreation increases revenue flows to hotels, restaurants, and service industries. The fact that the visitation rate has historically been very high and continues to increase is evidence that the beneficial uses associated with the local San Diego coastal waters are being well protected.

Ocean recreation at directly adjacent to Point Loma includes aesthetic enjoyment, sightseeing, sunbathing, hiking, picnicking, tide-pooling, whale watching, boating, sailing, and sport fishing. These types of activities are designated as non-contact water recreation by the RWQCB and are defined as "involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible" (RWQCB 2021).

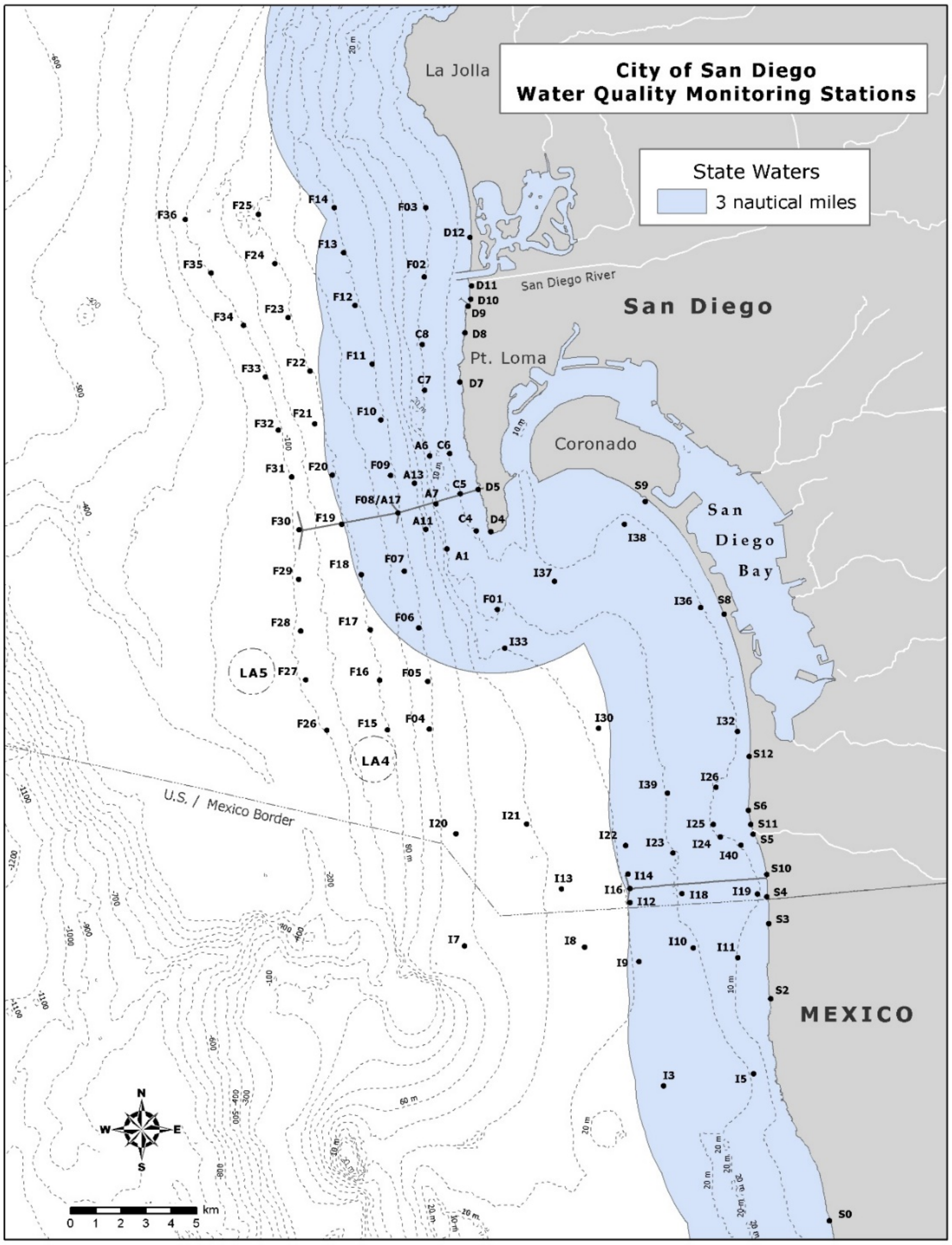
Ocean recreation off Point Loma also includes swimming and wading, skim boarding, water skiing and wake boarding, snorkeling, surfing, sail boarding, kite-sailing, kayaking, outrigger canoeing, paddle boarding, free diving, SCUBA diving, and personal watercraft (PWC) (jet ski) operation. These activities are designated by the RWQCB as water contact recreation and are defined as "involving body contact with water, where ingestion of water is reasonably possible" (RWQCB 2021).

The only data on specific locations of recreational activity off Point Loma comes from field observations made in the mid 1980's by Wolfson and Glinski (1986). They identified and plotted the position of individual boats and watercraft during the summer of 1986. Most ocean recreation in the vicinity of Point Loma occurred in the nearshore area, with fishing and diving concentrated in the kelp bed and along its' margins. Power boating and sailing were the only recreational activities observed with any regularity beyond the outer edge of the kelp bed (1 mi (1.6 km) from shore). The intensity of these recreational activities rapidly diminished with increasing distance offshore.

The territorial waters of the State of California extend to 3 nm offshore (Figure H-6). The United States Federal Government has exclusive jurisdiction from 3-12 nm offshore (DOALOS 2014). Although no studies have been conducted of recreational use in federal waters off Point Loma, information is available from observations of the crews of the San Diego Metropolitan Wastewater Department's monitoring vessels. The monitoring vessels currently average 200 or more days per year in the coastal waters of San Diego and have been active in the area for decades.

The PLWTP ocean monitoring program conducts water quality sampling along 6.2 mi (10 km) of shoreline and at a grid of offshore stations extending from 3 mi (4.6 km) south of the outfall to 8 mi (12.7 km) north of the outfall (Figure H-25). The offshore sampling stations range in depth from 30 feet (9 m) to 380 feet (116 m) and extend from .3 mi (.5 km) to 6.8 mi (11 km) from shore (Figure H-25). Figure H-25 shows the extent of California state waters (within 3 nm from shore) in blue.

Figure H-13:
City of San Diego Water Quality Monitoring Stations.
(Including sites associated with the South Bay Ocean Outfall)



Large vessels, principally Navy and Coast Guard ships, commercial carriers (cargo transports, oil tankers, barges), and cruise ships generally transit the Point Loma area beyond 5 mi offshore. Most ship traffic funnels into and out of San Diego Bay well to the south of the outfall area. Recreational vessels (fishing and pleasure boats) in federal waters off Point Loma are usually heading to or returning from offshore fishing banks and islands. Power and sail boats traversing the Point Loma area generally cruise along the outer edge of the kelp bed and are rarely seen more than a mile and a half offshore.

Recreational fishing in Point Loma ocean waters takes place primarily in the nearshore zone and in the kelp bed area. The monitoring crews report occasionally seeing CPFVs and sport fishing craft as far out as the decommissioned outfall (2 mi offshore) but practically never further offshore.

Swimming, surfing, and snorkeling occur in shallow water, inside the kelp bed. The vast majority of PWC operators, water skiers, wake boarders, board sailors, kite boarders, kayakers, canoers, and paddle boarders are seen inshore of the kelp bed.

Recreational SCUBA diving off Point Loma is focused on the kelp bed, with dive boats rarely sighted beyond a mile and a quarter offshore. State waters transitions to federal waters at a bottom depth of about 260 feet (80 m) off Point Loma well beyond recreational SCUBA diving limits.

Table H-17 shows where water contact recreation takes place off Point Loma, based on monitoring crew observations and information from this recreational use assessment. Virtually all swimming, surfing, diving, paddling, fishing from paddle craft, board sailing, water skiing, and PWC operation is confined to waters less than 2 nm from shore. The monitoring crews do not recall seeing a single incident of water contact recreational use occurring in federal waters.

Table H-17:
Water Contact Recreation in the Vicinity of Point Loma

Activity	Inshore (to a depth of 0 to 10 feet)	Nearshore (to a depth of 10 to 30 feet)	Kelp Bed (to a depth of 100feet. As far as 1 mi offshore)	Offshore State Waters		Federal Waters (3-12 nm)
				(1-2 nm)	(2-3 nm)	
Swimming and wading	X	-	-	-	-	-
Skim boarding	X	-	-	-	-	-
Water skiing and wake boarding	X	X	-	-	-	-
Snorkeling	X	X	-	-	-	-
Surfing	X	X		-	-	-
Sail/Kite board	X	X	X	-	-	-
Kayak/canoeing	X	X	X	-	-	-
Paddle boarding	X	X	X	X	-	-
Free diving	-	X	X	X	-	-
SCUBA diving	-	-	X	X	-	-
PWC	-	-	X	X		-

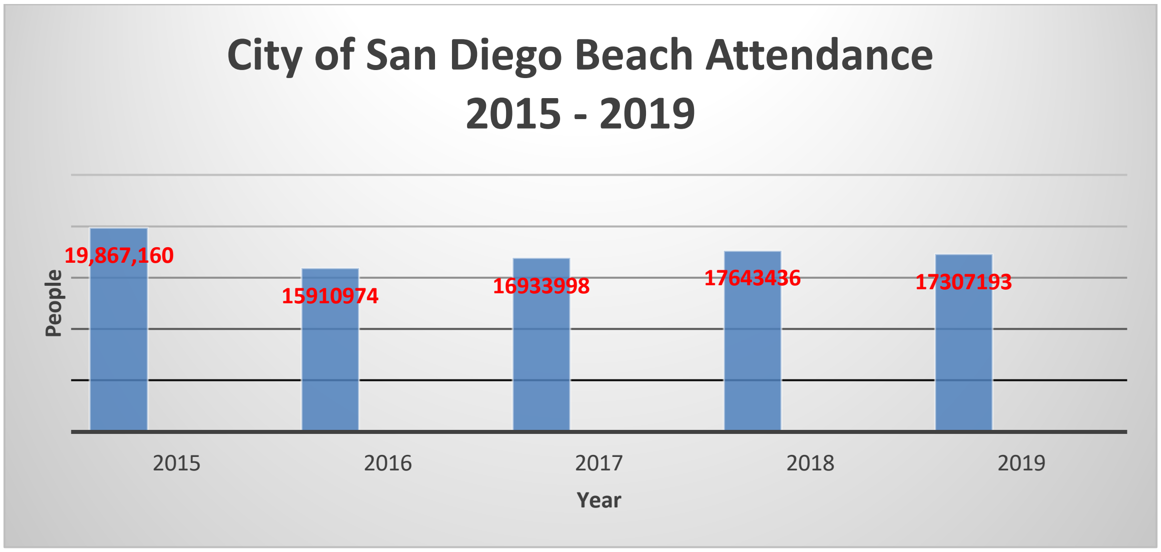
H.4.1 Swimming and Wading

The majority of swimming and wading (walking through the water) in the vicinity of Point Loma takes place at Ocean Beach, about 6 mi (9.6 km) north of the PLOO. Ocean Beach is a mile long, with several rock jetties and a public pier for strolling and fishing. Although some people swim at remote "pocket beaches" along Point Loma, Ocean Beach has virtually all the amenities sought by beach-goers - proximity to major highways, an expansive, gently sloping sandy beach with easy access, a large parking lot, showers, restrooms, a pavilion, and lifeguards.

Dog Beach, a sandy area at the north end of Ocean Beach, is one of only two San Diego 24-hour beaches where dogs are permitted without a leash. Dog owners are responsible for control and clean-up of their dogs. Standard dog laws apply on other portions of Ocean Beach and are strictly enforced. There is a long ocean pier that is no longer open its full length due to storm damage, but part of its length can be available for walking and fishing. It has a cafe and bait shop and fishing from the pier does not require a fishing license, but catch regulations are enforced.

North of Ocean Beach, San Diego City Lifeguards also service Mission Beach, Pacific Beach, Windansea, La Jolla Cove, La Jolla Shores, and Black's Beach (City of San Diego 2021). Figure H-26 plots annual beach attendance statistics for City of San Diego Beaches (United States Lifesaving Association 2021).

Figure H-26:
City of San Diego Beach Attendance 2015 - 2019



California has the most extensive and comprehensive monitoring and regulatory program for beaches in the nation (SWRCB 2021). Monitoring is performed by county health agencies, publicly owned sewage treatment plants, other dischargers along the coastal zone, environmental groups, and numerous citizen-monitoring groups.

In San Diego County, the Department of Environmental Health monitors recreational beaches and informs the public when water quality standards are exceeded (County of San Diego 2021).

This information, along with data from four other San Diego County agencies (the City of Oceanside, the City of San Diego, the Encina Wastewater Authority, and the San Elijo Joint Powers Authority) is used by Heal the Bay, a non-profit environmental group, to prepare an annual Beach Report Card™ (Heal the Bay 2020). Heal the Bay's Beach Report Cards summarize beach water quality information by grading monitoring locations from Humboldt County to San Diego County.

In the most recent Heal the Bay's Beach Report Card for 2019 - 2020, beach water quality during summer dry weather in San Diego County was generally excellent with 90% of the beaches receiving A or B grades. The County's water quality grades during winter dry weather were also good with 88% of monitoring locations receiving A or B grades. During wet weather events 82% of the beaches received A or B grades (Heal the Bay 2020). Open beaches near and adjacent to the PLWTP from the southern tip of Point Loma to Pacific Beach in the north all received A and A+ grades with the exception of a wet weather runoff issue at sunset cliffs. Table H-18 shows the grades for beaches adjacent to the Point Loma Treatment Plant, including a sampling station right at the plant site.

The San Diego County Department of Environmental Health posts notices and closes beaches in San Diego County when monitoring indicates bacteria levels exceed state standards. The vast majority of closure events and extended durations of closure are in the vicinity of the Tijuana River. None of the beach closures were related to the operation of the PLOO (County of San Diego 2021).

Table H-18:
San Diego Coastal Beach Grades 2019 – 2020

Beach	Winter Dry	Wet Weather
Pt. Loma Lighthouse (Southern tip of Pt. Loma)	A	A
Pt. Loma Treatment Plant	A+	A
Sunset Cliffs	A	D
Ocean Beach Pier	A	A
Ocean Beach	A	A
Ocean Beach sub jetty	A	A
Mission Beach	A+	A+
Pacific Beach	A+	A+

Source: Heal the Bay, 2020.

Bacterial Source Identification Studies have determined the beaches of southern San Diego County, and especially in the border town of Imperial Beach are frequently affected by sewage that flows up the coast from Mexico and through the Tijuana River Valley into the Pacific Ocean. The Imperial Beach coastline has experienced over 150 days of beach closures in 2020 due to sewage pollution and dangerously high levels of fecal bacteria (Surfrider 2020).

Water quality standards to protect human health in recreational waters have traditionally been assessed by measuring the concentration of "indicator bacteria" to infer the presence of fecal matter and associated fecal pathogens. Fecal matter originates from the intestines of warm-blooded animals, and the presence of fecal bacteria in surface waters is used as an indicator of human pathogens that can cause illness in recreational water users (Boehm and Soller 2013, Harwood et al. 2013, EPA 2014b). Indicator bacteria may not cause illness themselves, but have been linked to the presence of harmful pathogens (Arnold et al. 2013, EPA 2014d). Indicator bacteria are used as a surrogate for human pathogens because they are easier and less costly to measure than the pathogens themselves.

With the exception of short-term sewage spills and the chronic contamination emanating from the Tijuana River, elevated bacteriological levels at beaches in San Diego County have been demonstrated to come from sources unrelated to the offshore discharge of treated sewage. Sources include short term events like contaminated wet weather runoff and sewage spills and chronic contamination emanating from the Tijuana River. Beaches in San Diego with generally "compromised" water quality are located downstream of watersheds. Bacteria entering estuaries, bays, and the ocean originate from a wide variety of sources including natural sources such as feces from aquatic and terrestrial wildlife, and anthropogenic sources such as sewer line breaks, leaking septic systems, pets, trash, and homeless encampments. Once in the environment, bacteria also re-grow and multiply (City of San Diego and Weston Solutions 2004, Martin and Gruber 2005, City of San Diego and Weston Solutions 2006, McQuaig et al. 2012, Griffith et al. 2013).

During wet weather, wash-off of bacteria from land is the primary mechanism for transport of bacteria from land into the ocean (Griffith et al. 2010, Imamura et al. 2012). During dry conditions, streams in urban areas may sustain a flow even if no rainfall has occurred. These flows result from land use practices that generate urban runoff, which enters storm drains and creeks and carries bacteria into the receiving water.

The RWQCB in conjunction with other regulatory agencies and local research organizations investigated bacteriological water quality at "reference beaches" with upstream watershed consisting of at least 95% undeveloped lands. Because the reference beach drainage area consists almost entirely of undeveloped land, bacteria washed down to the beach come from natural, non-anthropogenic sources. Measurements during the 2004-2005 winter season showed that at four reference beaches (two in Los Angeles County, one in Orange County, and one in San Diego County) 27% of all samples collected within 24 hours of rainfall exceeded water quality standards for at least one indicator bacteria (i.e., a single sample bacteriological threshold was exceeded 27% of the time) (Schiff et al. 2005). Thus, lack of compliance with bacteriological standards at beaches downstream of watersheds is likely related to natural sources as well as anthropogenic ones.

The only shoreline sampling stations along Point Loma that have had any episodes of non-compliance with water contact bacteriological standards during dry weather not related to a sewage spill (D8-D 11 - Figure H-25) are located over 7 mi from the PLOO in the vicinity of the San Diego River (City of San Diego 2008-2016, 2018, 2020). Results of the long-term, comprehensive City of San Diego bacteriological monitoring program and plume studies indicate that the PLOO wastewater plume never contacts the shoreline (City of San Diego 2008-2016, 2018, 2020, Rogowski 2012, 2013.). Indicator bacteria detected adjacent to the San Diego River are derived from natural and urban sources washed off the land and transported to the area by freshwater flows. Thus, any public health risk along the beach shoreline would be associated with exposure to pathogens transported from land, not from the ocean discharge of wastewater over 7 mi away.

H.4.2 Skim-boarding

A popular activity among the young, skim boarding involves running along the water's edge and jumping onto a short flat board to skim atop a thin layer of wave-washed water over the sand. Newer boards and the growing popularity of "tricks" have more enthusiasts skimming toward breaking waves, launching into the air, and landing in water (up to a few feet deep) just beyond the beach. This activity is limited to gradually sloping sandy beaches, occurring, in the Point Loma area, mainly at Ocean Beach.

H.4.3 Surfing

About a third of all U. S. surfing occurs in California (NOEP 2005). With its warm climate, San Diego is an especially popular California surfing venue. Surfing employs a board of some type to ride waves - boogie board, surfboard, belly board, knee board, or standup paddle board. Sandy bottom beach breaks in the vicinity of Point Loma, Ocean Beach pier, and the San Diego River channel jetty attract surfers year-round. Farther south along Point Loma, the Sunset Cliffs reefs provide good surfing for experienced surfers. Because waves break in water depths approximately equal to their height, the majority of surfing at Point Loma takes place over depths considerably less that 15-20 feet, and well inside of the shoreward boundary of the kelp bed (½ mile offshore). When low spring tides coincide with large swells, surfers may wait for waves as far out as the inner edge of the Point Loma kelp bed.

A relatively new type of surfing, tow-in surfing, employs a PWC to pull surfers into larger waves peaking offshore well before they become steep enough to break. Once the surfer feels the push of the wave, the tow line is released, the PWC veers off, and the surfer rides the wave like a paddle-in surfer. This type of surfing is rarely observed in the vicinity of Point Loma.

Standup paddle board surfing brings yet another variation to surfing in California (Guisado and Klaas 2013). Participants use longer boards, usually in the 9-12 feet range, and a specialized, extended paddle. Unlike regular surfing in which a surfer lies prone while paddling and jumps up to ride, standup boarders paddle out to the break standing on their board. Waves are also caught standing and the paddle is used for balance and to assist in turning the board. This type of surfing is relatively uncommon off Point Loma.

H.4.4 Sailboarding and Kiteboarding

Sailboarding, sometimes called windsurfing, is a surface water sport that combines elements of surfing and sailing. It uses a board usually 7-10 foot-long powered by wind on a sail. Kiteboarding use a chute or kite on a long set of control lines rather than a sail to harness the wind. Like sailboarders, kite boarders use a board, more like a ski-board or snowboard rather than a surf or sailboard, to carve and skim along the water's surface and get airborne launching off the face of waves. Sailboarders and kite surfers prefer many of the same beaches popular with surfers, although they tend to be on the water when the weather is less ideal for surfers (i.e., windy). The sport was founded over three decades ago in France. Interest in the sport in the U.

S. accelerated about 15 years ago with improvements in equipment and the advent of articles and magazines dedicated to the sport. Classes are offered at various San Diego locations including the Mission Bay Aquatic center. Both sports can be pursued in bays and large enclosed bodies of water, but the ultimate thrill comes with ocean boarding involving wave riding and jumping. Like sail boarding, kite boarding requires easy access to the shore. The steep stairs and cliffs along Point Loma are not conducive to the sports and participants generally prefer long sandy beaches and relatively kelp-free waters so high speeds can be attained. Sail and kite boards can be deployed from boats, but this is infrequent. Therefore, sailboarding and kiteboarding are not well represented in the immediate vicinity of Point Loma.

H.4.5 Kayaking, Surf Ski and Outrigger Canoeing

Ocean kayaking is rarely observed in the vicinity of the Point Loma. The steep bluffs eliminate the possibility of beach launching, so kayakers must reach the area by larger pleasure boats or by paddling from Ocean Beach, San Diego Bay or Mission Bay harbor. Though uncommon, some sport fishing from kayaks does take place at the northern and southern ends of the Point Loma kelp bed, and the occasional surf kayaker is observed riding waves in the surf zone.

Kayakers participate in the Bay-to-Bay ocean race mentioned in the outrigger canoe section below. The route taken varies depending upon ocean swell conditions and race strategy; some participants remain shoreward of the kelp bed while others take a route beyond the kelp bed.

Surf skis are similar to kayaks, however, the vehicle used is a cross between a surfboard and a kayak. The rider sits in an indentation on the board rather than within its confines. Most surf skiers ride waves like surfers, but many simply paddle for enjoyment and in competition. Competitions usually involve other classes of craft, such as canoes and kayaks. They may take place in offshore ocean waters over routes covering many miles.

With approximately 24 clubs in southern California, outrigger canoeing is a popular aquatic team sport in California. There are four outrigger canoe clubs in Mission Bay with several hundred male and female active members. One to 6 person Polynesian-style canoes are used with an “ama” or outrigger on the left side. Clubs have divisions for ages 12 and under all the way up through men and women’s Senior Masters (45 and older). They practice several times a week and participate in local, regional and, international races. Most practice sessions and local races are within the confines of the bay, but some practices and races venture into the ocean from Mission Bay harbor, and may go out as much as 3 mi offshore.

In San Diego, the longest local ocean race is the annual Bay to Bay Race. Running from Mission Bay to San Diego Bay and held in mid-to-late summer, the Bay-to-Bay Race draws between 100 to 200 participants and every kind of paddling class including kayaks. The actual race routes depend on prevailing weather and swell conditions. When ocean swells are large, paddlers opt for the outside the kelp bed route, when calm conditions prevail most competitors take a more direct, inshore of the kelp bed, route. Other events exit Mission Bay, head to sea in the direction of Crystal pier in Pacific Beach, and then return to finish inside Mission Bay.

Outside of organized competitions, kayaking and canoeing are only infrequently observed off Point Loma. However, some fishing from kayaks, surf skis and canoes is seen at times in and around the kelp bed during summer.

H.4.6 Paddleboarding

Paddleboards are specialized large surfboards (usually about 14 feet) used for paddle races. Some organized races are open water ocean courses of 16 mi or more. Most popular in the waters off Hawaii, paddle races do occur in California waters, notably, the Catalina Island and the San Onofre races and some long-distance races between various San Diego piers, and between San Diego and Mission Bays. Some practice paddling takes place in the vicinity of the Point Loma kelp bed. During summer, paddle boarders may fish near shore or in and around the kelp bed; but, this activity is infrequent.

H.4.7 Water Skiing and Wake Boarding

Although water skiing and wake boarding are popular activities in San Diego as a whole, they are not often seen in the vicinity of Point Loma. Both activities usually remain within the confines of either Mission Bay or San Diego Bay. The ocean waters only rarely offer the smooth surface preferred by skiers, and as the name implies, wake boarders perform their maneuvers on the wake of the towing vessel, or the wake caused by another vessel. In the past the tow vessel was always a boat. Today, with larger more powerful PWC (discussed below) wake boarders can venture into the ocean and make use of ocean swells in the surf zone in a manner similar to tow-in surfers.

H.4.8 SCUBA, Snorkeling, and Free-diving

The abundant and diverse marine life, an array of dive charter boats, and year-round temperate weather make southern California one of the world’s great diving destinations. Recreational divers of all types frequent both natural habitats such as reefs, seamounts and kelp beds such as those off Point Loma, and artificial habitats.

Readily accessible by boat from San Diego Bay and Mission Bay, the Point Loma kelp bed and reef is one of the premier dive spots in southern California (Wolfson and Glinski 1986, Krival 2001, Sheckler and Sheckler 2008). Underwater photography is increasingly popular, and has far surpassed hunting for game species. Some divers spearfish for sheephead, rockfish, bass, flatfish, wrasses, bonitos, amberjacks, barracudas, and sculpins. Harvesting of lobsters, sea urchins, rock scallops and other invertebrates is permitted in some areas, such as the Point Loma kelp forest, and prohibited in others, such as the La Jolla Cove Marine Preserve.

Artificial marine habitats off southern California are also popular, particularly among SCUBA and free divers (Reed et al. 2006). These habitats include shipwrecks, artificial reefs composed of concrete rubble, Navy towers, oil and gas platforms, and even airplane wrecks. Underwater substrates quickly become encrusted with marine life and attract a wide assortment of marine species including predatory migratory species (Broughton 2012, McKinney 2013).

Wreck Alley (described in the artificial reef section) is one of the most popular diving destinations off San Diego. Located just offshore of Mission Bay, Wreck Alley showcases the remains of several vessels that were scuttled in order to benefit divers and serve as artificial reefs, including the *Ruby E*, *Yukon*, *Shooter’s Fantasy*, and *El Rey*.

Also located offshore of Mission Bay is the Naval Ocean Systems Center Tower, a Naval research station that collapsed in a storm in 1988. At an average depth of 30 feet (9 m), this site is suitable for divers of all skill levels including snorkelers. Off San Diego Bay are two additional shipwrecks, the ex-USS *Hogan* (a destroyer) and *S-37* (a submarine), which were used as Naval bombing targets during WWII.

The popularity of SCUBA diving in San Diego is affected by economic and meteorological conditions. During good economic times and mild weather, the number of people learning to dive and the frequency of diving by certified divers increases. When rough, low light or cold conditions prevail, SCUBA activity subsides. The usual maximum range of recreational SCUBA divers is about 100 feet, but most dives are made in 40-70 feet depths.

Snorkeling generally takes place much closer to shore in shallow waters, usually 8-15 feet deep, and perhaps out to 20-30 feet depths in the vicinity of Point Loma. Some limited snorkeling does occur within the Point Loma kelp bed, however, this activity has declined greatly since the ban on abalone harvesting from all waters south of San Francisco went into effect.

Pendleton and Rooke (2006) estimated at that time that SCUBA diving in California generated on the order of $138 million to $276 million in annual gross revenues, and the potential magnitude of expenditures associated with snorkeling is similar. They estimate the non-market use value for California divers at between $21 million and $69 million annually and a range of $19 million to $115 million for snorkeling.

Freediving, breath hold deep-diving, is similar to snorkeling but involves greater depths and frequently, hunting for game. Just after WWII, a close-knit group of skin divers in San Diego known as the “Bottom Scratchers” began skin diving in the La Jolla-Point Loma area. They made their own gear and, initially, their primary goal was seeking game. Freediving has since evolved into a unique sport with specialized but minimal gear. Freedivers hunt game, particularly large fish, in deep and sometimes open blue water. It is a hardy pursuit for a small group of well-conditioned individuals. There are numerous freedive clubs around the nation, with one in San Diego. They have meets and competitions for their members and with other freedive clubs from outside the area. Experienced freedivers dive in excess of 40 feet to spear game. Some freediving takes place in and around the Point Loma kelp bed.

Wolfson and Glinski (1986) estimated about 5,000 SCUBA dives occurred annually in and around the Point Loma kelp bed. Other types of diving in the area are limited.

H.4.9 Jet Skiing/Personal Watercraft

Jet skiing, or PWC boats, developed over the past two decades. Jet skiing is a generic term for all forms of personal, motorized watercraft including the traditional Jet Ski with a single rider, now replaced by larger more powerful PWC capable of carrying more than one rider. PWCs have gasoline-powered engines and use water jets for propulsion.

PWC are infrequently seen off Point Loma. Access limitations and use restrictions tend to confine PWC activity to areas of San Diego and Mission Bay and their harbor entrances. PWC are prohibited in the nearshore zone off Cabrillo National Monument and anywhere near bathers, swimmers, or surfers. Since beach access is not feasible, PWC must come from San Diego or

Mission Bay. Rarely, PWC are launched from large pleasure boats anchored offshore. PWC use is not common off Point Loma.

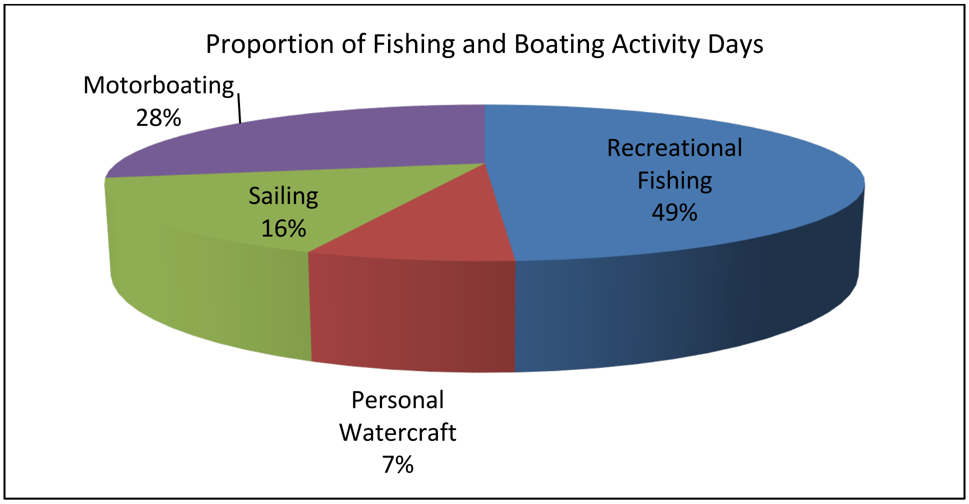
H.4.10 Tidepooling

Tidepooling is a popular recreational activity at Point Loma. The Mia J. Tegner State Marine Conservation Area (SMCA), at the southern tip of Point Loma at Cabrillo National Monument, is the focal point of tidepooling in the area. It is estimated that about one hundred thousand people per year visit the Cabrillo National Monuments' tide pools (Engle and Largier 2006). Another "easy access" point to the rocky shoreline is the stairs at the foot of Ladera Street and Sunset Cliffs Boulevard. From there, the level of tidepooling activity diminishes rapidly both north and south with increasing distance from the stairs.

H.4.11 Boating and Sailing

Boating and sailing are popular throughout coastal California. In 2000, more than 2.7 million fishers participated in more than 20.3 million recreational fishing activity days along the California coast, while more than 4 million people participated in marine boating related activities. California had the largest number of marine fishers and sailors, while it was ranked second, behind Florida, in motor boating in the U. S. The proportions of different boating and fishing related activities are depicted in Figure H-27 (NOEP 2005).

Figure H-27:
Boating Related Activity in California



The waters in and around San Diego Bay are an internationally recognized venue for competitive yachting. In 1995, the America's Cup regatta was held in waters offshore of San Diego Bay. Competitive sailors from a number of different countries frequently practice along the offshore racing course. Inside the bay, a regatta course is located in open waters to the west of Naval Station San Diego. Within San Diego Bay there are 23 public marinas, seven private yacht clubs, four free boat launch ramps, six boatyards, and thousands of docks and anchorages (Recreational Research 2021, San Diego Waterfront 2021). Recreational boat berthing areas are found mainly at Shelter Island, Harbor Island, The Embarcadero, Glorietta Bay, Coronado Cays, and Chula Vista. In addition, Mission Bay has 4 public launch ramps, nine public marinas, a yacht club and over a thousand boat slips.

Most ocean boating near San Diego and Mission Bays takes place in and around the Point Loma kelp bed (fishing and diving), and sail and power boats traverse the area 1-1.5 mi offshore just beyond the outer edges of the kelp bed while traveling between San Diego and Mission Bays.

H.4.12 Whale Watching

Gray whales (*Eschrichtius robustus*) migrate through San Diego's coastal waters twice yearly on their way between summer feeding grounds off Alaska and calving areas in the coastal lagoons of Baja California. The major migration route through southern California is between the mainland and the offshore islands. The whales tend to swim closer to the shore during February and March on their northward migration when calves are present, than on the southward migration during December and January. At Point Loma they traverse the offshore waters from the outer edge of the kelp bed, about 1 nm offshore, out to the horizon.

Private boats and commercial passenger vessels venture out from San Diego Bay and Mission Bay to watch the whales. As any as 12 charter companies run whale watching tours (using a wide variety of sail, paddle, and powerboats) (San Diego Convention Center and Visitors Bureau 2021). Kayakers also venture out from shores to observe whales.

During warm, calm, winter and spring weekends, dozens of boats may be seen off Point Loma observing whales. The NMFS, the agency responsible for protecting gray whales under the Marine Mammal Protection Act (MMPA), has issued guidelines for safe, non-disruptive whale watching (NMFS 2011a). Vessels are to go no faster than a whale or group of whales while paralleling them within 100 yards and do nothing to cause a whale to change direction. The guidelines also state that a whale's normal behavior should not be interrupted and that doing so constitutes illegal harassment. In season, whale watching vessels regularly ply the waters off Point Loma.

H.4.13 Cruising

Another increasingly popular form of ocean adventure is a voyage on a cruise ship. San Diego's cruise ship season runs September through May. Exotic destinations include Hawaii, Tahiti/French Polynesia, the Caribbean, Australia/New Zealand, the Panama Canal, South America, Central America and Mexico. San Diego Bay is considered the "Gateway to the Mexican Riviera" with numerous 3-11 day cruises to popular ports of call like Ensenada, Cabo San Lucas, Mazatlán, Acapulco, Ixtapa and Puerto Vallarta. Operating out of two terminals in San Diego Bay cruises are designed to please people of all ages (San Diego Convention and Visitors Bureau 2021).

H.5 OTHER BENEFICIAL USES

H.5.1 Marine Protected Areas

MPAs are discrete geographic marine or estuarine areas seaward of the mean high tide line or the mouth of a coastal river, including any area of intertidal or subtidal terrain, together with its overlying water and associated flora and fauna, that have been designated by law or administrative action to protect or conserve marine life and habitat (CFGC 2010, CDFW 2013b). There are two types of state MPAs in southern California: State Marine Reserves (SMRs) and SMCAs (CDFW 2021d).

California also has dedicated ASBS that the California State Legislature has defined as having biological communities of such extraordinary value that no risk of change in their environment can be entertained (SWRCB 2014). The California Ocean Plan prohibits discharge of waste into an ASBS and requires that outfalls be located at a sufficient distance away from an ASBS to assure the maintenance of natural water quality conditions (Raimondi et al. 2012, SWRCB 2012).

In addition, California State Water Quality Protection Areas (SWQPAs) are designated to protect marine species or biological communities from an undesirable alteration in natural water quality (SWRCB 2012). All ASBS that were previously designated by the State Water Board are now also classified as a subset of SWQPAs and require special protections afforded by the California Ocean Plan.

Six ocean MPAs are within 15 mi (13 nm) of Point Loma:

The Tijuana River Mouth State Marine Conservation Area extends along the shoreline from Imperial Beach 2.3 mi (3.7 km) south to the Mexican Border and offshore to a depth of 55 feet (17 m). It is geographically connected with Tijuana River National Estuarine Research Reserve and the Tijuana Slough National Wildlife Refuge creating the most intact contiguous estuarine/marine complex in southern California. The Tijuana River Mouth SMCA includes a river mouth delta, soft sediment sea floor, a large cobble reef, and a flourishing kelp bed. Taking all living marine resources is prohibited, except recreational take of coastal pelagic species (except market squid, by hand-held dip net only) and commercial take of coastal pelagic species (except market squid, by round haul net only).

The Cabrillo State Marine Reserve extends 1.3 mi (2 km) along the southern Point Loma shore and out to a depth of 30 feet (6 m). It incorporates the previously established Mia J. Tegner Point Loma SMCA. The Cabrillo SMR includes a nearshore portion of the Point Loma kelp bed, along with rocky, sandy beach and intertidal habitat, surf grass, and shallow rock reef habitat. It is adjacent to and contiguous with the Cabrillo National Monument. Take of all living marine resources is prohibited. The seaward boundary of the Cabrillo SMR is approximately 4.2 mi (6.8 km) inshore from the Point Loma outfall.

South La Jolla State Marine Conservation Area lies adjacent to and west of the South La Jolla SMR and extends to the limit of state jurisdiction (3 nm (5.6 km) offshore) in depths from 176 to 274 feet (54 to 84 m). The South La Jolla SMCA has a shared northern and southern boundary with the South La Jolla SMR: from Palomar Avenue in La Jolla to Diamond Street in Pacific Beach, encompassing 2 mi (3.2 km) of shoreline. The recreational take of pelagic finfish, including

Pacific bonito, by hook and line is allowed within the SMCA.

South La Jolla State Marine Reserve is adjacent to and east of the South La Jolla SMCA with a shared northern and southern boundary: from Palomar Avenue in La Jolla to Diamond Street in Pacific Beach. It ranges in depth from 0 to 176 feet (0 to 54 m). The recreational take of pelagic finfish, including Pacific bonito, by hook and line is allowed within the SMR.

Matlahuayl State Marine Reserve is just north of Point La Jolla. It has an alongshore span of 1.2 mi (1.9 km) with depths ranging from 0 to 331 feet (101 m). Approximately 13.8 mi (12 nm) north of the PLOO, the Matlahuayl SMR protects near-shore habitat that supports research activities of the SIO. It encompasses the San Diego-La Jolla Ecological Reserve Area of Special Biological Significance. This is the closest ASBS/SWQPA to the PLOO. The other ASBS/SWQPA in San Diego County is part of the San Diego-Scripps Coastal SMCA to the north. The Matlahuayl SMR is part of the 5,977-acre (9.3 mi^2) San Diego-La Jolla Underwater Park which was dedicated by the San Diego City Council in 1970 to protect the natural ecology and environment. The Park extends from Alligator Point in La Jolla north to Del Mar and out to a distance of 8,000 feet (2,438 m) from shore. All take of living marine resources is prohibited.

San Diego-Scripps Coastal State Marine Conservation Area is adjacent to and north of the Matlahuayl SMR. It spans 1.1 mi (1.8 km) of shoreline and extends across depths of 10-366 feet (3-112 m). It incorporates the San Diego Marine Life Refuge adjacent to SIO. In 1929, the California State Legislature granted the University of California "sole possession, occupation, and use" of the intertidal zone and subtidal zone to 1,000 feet offshore along the 2,600-feet oceanfront of the SIO. This area was designated as the San Diego Marine Life Refuge in 1957 and was included in the University of California's Natural Reserve System in 1965. It is also part of the San Diego-La Jolla Underwater Park and incorporates the San Diego-Scripps ASBS/SWQPA. Take of all living marine resources in the San Diego-Scripps Coastal SMCA is prohibited except for the recreational take of coastal pelagic species and market squid, by hook-and-line. Officers, employees, and students of the University of California and may take, for scientific purposes, invertebrates, fish, or specimens of marine plant or algae under the conditions prescribed in a scientific collecting permit issued by the CDFW.

H.5.2 Research and Education

Underwater research has been conducted in the Point Loma kelp bed since the mid 1950's when Wheeler North of the California Institute of Technology and his associates at SIO began long-term investigations of kelp bed ecology (Neushul 1959, North 1964, North and Hubbs 1968). Professors Paul Dayton and associates at SIO have done ecological surveys at fixed locations in the Point Loma kelp bed since 1971 (e.g., Dayton and Tegner 1984, 1990, Dayton et al. 1992, 2003, Tegner et al. 1995, 1996, 1997, Tegner and Dayton 1987, 1991, Steneck et al. 2002, Graham 2000, 2004, Hewitt et al. 2007, Parnell and Riser 2012, Parnell et al. 2005, 2008, 2010, 2019). Their descriptive and experimental studies have established a database unique in the world. They have demonstrated that large-scale, low-frequency episodic changes in oceanographic climate ultimately control kelp forest community structure. Local biological processes, like recruitment, growth, survivorship, and, reproduction, may be driven by small-scale ecological patterns. But, decade-long shifts in climate (between cold water, nutrient-rich La Niñas and warm water, nutrient-stressed El Niños) and rare but catastrophic storms have been the principal forces governing the diversity and productivity of the kelp forest community at Point Loma.

The Point Loma kelp bed also serves as a site for SIO and San Diego State University graduate student research (e.g., Neushul 1959, Gerodette 1971, Deysher 1984, Graham 2000, Mai and Hovel 2007), and for ongoing unpublished research on CA spiny lobster movements in the Point Loma kelp bed by Hovel, Lowe, Loflen, and Palaoro.

Cabrillo National Monument's intertidal community has been studied since the 1970s and investigations continue today (Becker 2006, Engle and Largier 2006, Fenberg and Roy 2012). Diver surveys and fish collections have also been conducted in the Monument's 128-acre administrative waters which extend out to 900 feet from shore and encompass the Mia J. Tegner SMCA (Craig and Pondella 2005). Within the Monument's administrative waters 100 species of macroalgae (Miller 2005), 247 species of marine invertebrates (National Park Service (NPS) 2006), and 48 species of fish have been recorded (Craig and Pondella 2005). The fish assemblage is typical of the southern California rocky mainland coast, and the overall richness is comparable to similar habitats in the San Diego region (NPS 2006). The Cabrillo National Monument Intertidal Monitoring Program began in 1990 and continues twice/year coinciding with extreme low tides during spring and fall. Thirteen key taxa are monitored near shore and in the kelp, and, birds and visitors are also counted. Students from schools throughout San Diego County make field trips to the Cabrillo National Monuments' tide pool areas. An estimated one hundred thousand people visit the Cabrillo National Monuments' tide pools annually (NPS 2014).

The PLOO Monitoring Program provides an extensive database on marine water quality and marine biology beginning with pre-design studies in 1958-1959. The monitoring program at Point Loma was not intended to be a research program, but, instead, was established to determine compliance with local, state, and federal environmental regulations. Even so, the monitoring program has generated data with considerable utility for scientific inquiry. For example, Conversi and McGowan (1992) analyzed 15 years of water transparency data at 7 monitoring stations to evaluate the influence of anthropogenic influences (sewage discharge) and natural oceanographic events. They concluded that anthropogenic activities had not affected transparency, while natural factors such as seasonality and distance from the coast had.

The La Jolla ocean area to the north of Point Loma is a major focus of research and education in San Diego. The SIO, one of the nation's premier oceanographic training institutions, studies physical, chemical, and biological aspects of the marine environment; research aimed at understanding how two-thirds of the planet functions (SIO 2014). The longest continuous measurements of oceanographic parameters (salinity, temperature, biomass, nutrients, etc.) anywhere in the world have been taken in this area. La Jolla waters are used to calibrate and test ocean instruments developed for deployment throughout the world.

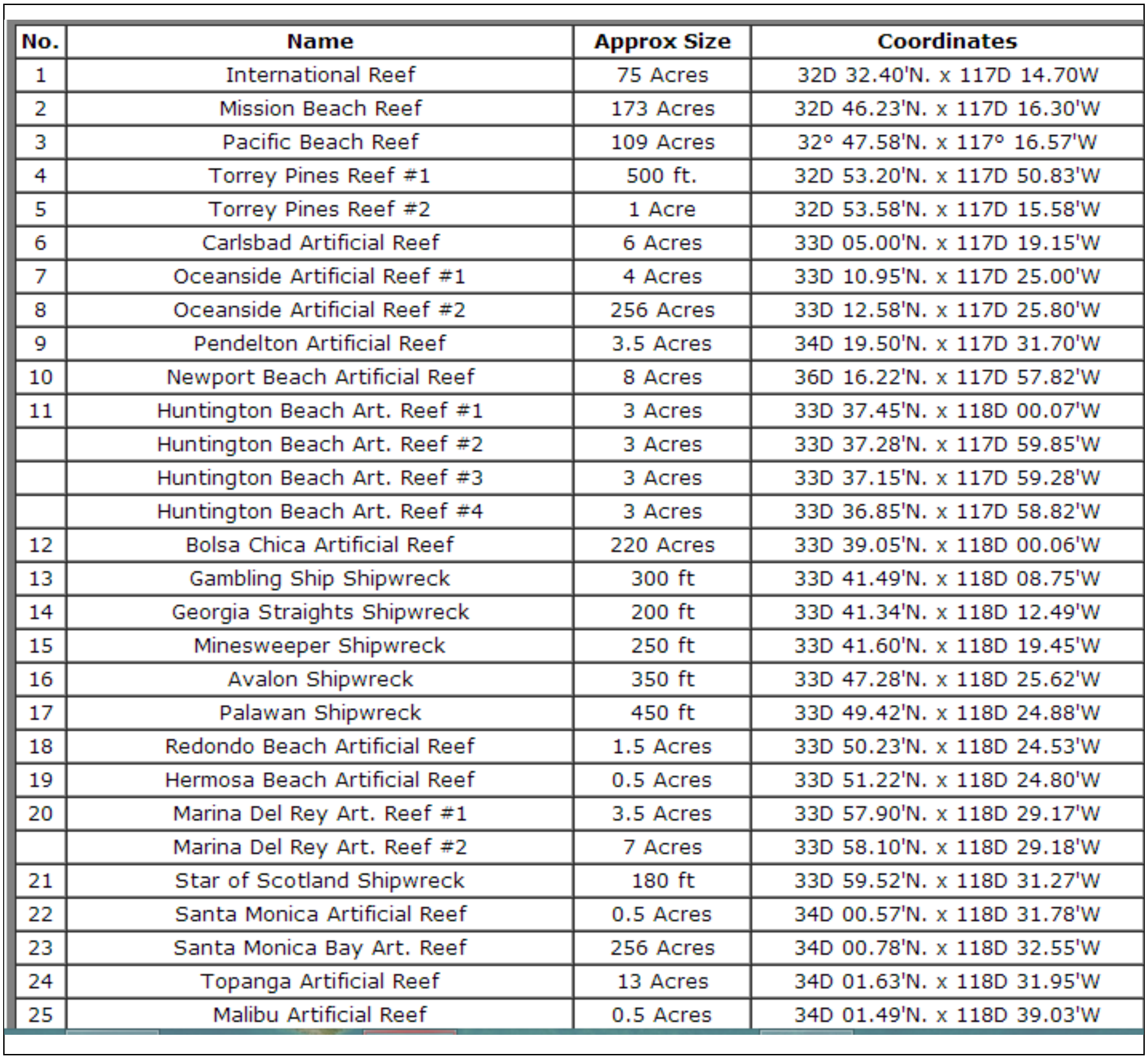
The NMFS has a major marine center in La Jolla. San Diego State University, the University of San Diego, and the Hubbs/Sea World Research Institute all have ocean studies programs in the San Diego area. The Environmental Science Division of the Naval Command, Control and Ocean Surveillance Center, San Diego, conducts ecological research in San Diego Bay and occasionally off Point Loma.

The Marine Mammal Systems Division of the U.S. Navy Space and Naval Warfare System Center on Point Loma conducts a wide variety of research on marine mammal biology, some involving training and field trials in San Diego ocean waters. Navy research has focused on dolphins because of their exceptional sonar capability for detecting objects in the water and on the bottom (superior to any sonar developed by man) and on sea lions because of their acute underwater hearing and low light level vision. Both are also capable, unlike human divers, of making repeated deep dives without experiencing "the bends" (decompression sickness). Working with dolphins and sea lions, Navy scientists have developed Marine Mammal Systems (MMS) for operational fleet deployment. Each "System" has 4 to 8 marine mammals, an Officer-in-Charge, and, several enlisted personnel. All MMSs can be deployed by aircraft, helicopter, and, land vehicles with the equipment necessary to sustain an operational deployment. Four types of MMSs have been based at Navy facilities in San Diego Bay: Mk 4 – using dolphins to detect and mark mines moored off the bottom, Mk 5 – using sea lions to detect and recover mines (at depths up to 1,000 feet), Mk 6 - using dolphins to detect and intercept swimmers and divers, and, Mk 7 - using dolphins to detect and mark mines on the bottom. Training exercises for these systems and others currently under development may be conducted in the open ocean off Point Loma.

H.5.3 Artificial Reefs

Designed to enhance sportfishing, 25 artificial reefs have been built along the southern California coast since 1958 (CDFG 2001, CDFW 2014j). Nine of these are in San Diego County. Five artificial reefs are within 20 mi (32 km) of Point Loma (Table H-19, from Spira 2014).

Table H-19:
Artificial Reefs in Southern California



No.	Name	Approx Size	Coordinates
1	International Reef	75 Acres	32D 32.40'N. x 117D 14.70W
2	Mission Beach Reef	173 Acres	32D 46.23'N. x 117D 16.30'W
3	Pacific Beach Reef	109 Acres	32° 47.58'N. x 117° 16.57'W
4	Torrey Pines Reef #1	500 ft.	32D 53.20'N. x 117D 50.83'W
5	Torrey Pines Reef #2	1 Acre	32D 53.58'N. x 117D 15.58'W
6	Carlsbad Artificial Reef	6 Acres	33D 05.00'N. x 117D 19.15'W
7	Oceanside Artificial Reef #1	4 Acres	33D 10.95'N. x 117D 25.00'W
8	Oceanside Artificial Reef #2	256 Acres	33D 12.58'N. x 117D 25.80'W
9	Pendelton Artificial Reef	3.5 Acres	34D 19.50'N. x 117D 31.70'W
10	Newport Beach Artificial Reef	8 Acres	36D 16.22'N. x 117D 57.82'W
11	Huntington Beach Art. Reef #1	3 Acres	33D 37.45'N. x 118D 00.07'W
	Huntington Beach Art. Reef #2	3 Acres	33D 37.28'N. x 117D 59.85'W
	Huntington Beach Art. Reef #3	3 Acres	33D 37.15'N. x 117D 59.28'W
	Huntington Beach Art. Reef #4	3 Acres	33D 36.85'N. x 117D 58.82'W
12	Bolsa Chica Artificial Reef	220 Acres	33D 39.05'N. x 118D 00.06'W
13	Gambling Ship Shipwreck	300 ft	33D 41.49'N. x 118D 08.75'W
14	Georgia Straights Shipwreck	200 ft	33D 41.34'N. x 118D 12.49'W
15	Minesweeper Shipwreck	250 ft	33D 41.60'N. x 118D 19.45'W
16	Avalon Shipwreck	350 ft	33D 47.28'N. x 118D 25.62'W
17	Palawan Shipwreck	450 ft	33D 49.42'N. x 118D 24.88'W
18	Redondo Beach Artificial Reef	1.5 Acres	33D 50.23'N. x 118D 24.53'W
19	Hermosa Beach Artificial Reef	0.5 Acres	33D 51.22'N. x 118D 24.80'W
20	Marina Del Rey Art. Reef #1	3.5 Acres	33D 57.90'N. x 118D 29.17'W
	Marina Del Rey Art. Reef #2	7 Acres	33D 58.10'N. x 118D 29.18'W
21	Star of Scotland Shipwreck	180 ft	33D 59.52'N. x 118D 31.27'W
22	Santa Monica Artificial Reef	0.5 Acres	34D 00.57'N. x 118D 31.78'W
23	Santa Monica Bay Art. Reef	256 Acres	34D 00.78'N. x 118D 32.55'W
24	Topanga Artificial Reef	13 Acres	34D 01.63'N. x 118D 31.95'W
25	Malibu Artificial Reef	0.5 Acres	34D 01.49'N. x 118D 39.03'W

**Figure H-28:
Artificial Reefs**

Torrey Pines Artificial Reefs (Numbers 4 and 5 above) are 16 mi (26 km) to the north and the International Artificial Reef (Number 1) is 18 mi (29 km) south of the Point Loma Treatment Facility. Mission Beach Artificial Reef and Pacific Beach Artificial Reef (Numbers 2 and 3) are about 9 mi (14 km) north of the tip of Point Loma are the closest artificial reefs to the PLOO.

The Mission Beach Artificial Reef, located at 32 o 46.23’ N X 117o 16.30’ W at depths of 80-90 feet (24-27 m) is closest to the PLOO. It was established in 1987 as a 173-acre site. The original reef consisted of three sunken vessels. Concrete rubble has been added periodically. Most notable was the 1991-1993 addition of 9,000 tons of concrete roadway rubble which was scattered over 11 acres at 60 feet (18 m) depths. Shortly after the material was placed kelp began growing, and this artificial reef has supported the kelp since then. It became a focus of research prior to the construction of the Southern California Edison mitigation kelp reef off San Clemente, since the Mission Beach Kelp Reef represents the first time kelp has been sustained for more than a couple of years on an artificial reef in the United States. This artificial reef also includes a “Wreck Alley” of ships deliberately placed on the bottom to provide high-relief habitat for fish and invertebrates. “Wreck alley” is a popular dive spot only 1 nm from the entrance to Mission Bay (about 7 mi (6 nm) from the PLOO) at a magnetic heading of 324 o. The site includes the decommissioned 366-feet Canadian destroyer, HMCS Yukon, which was deliberately sunk on July 14, 2000 and is a popular dive destination for experienced divers.

The Pacific Beach Artificial Reef is located 3 mi (2.5 nm) from the Mission Bay entrance channel, also on a heading of 3240 magnetic. It encompasses about 109 seafloor acres with depths ranging from 42-72 feet (13-22 m). Composed of 10,000 tons of quarry rock, it quickly became a kelp habitat complete with kelp bass and sand bass and is a seasonal destination for divers seeking lobster. Artificial reefs are increasingly popular destinations for fishing and sport diving (Reed et al. 2006, Love and Nishimoto 2012, McKinney 2013).

H.5.4 Navigation and Shipping

Coastal shipping lanes are over 10 mi from shore, but commercial vessels come closer off Point Loma where they funnel into San Diego Bay. Arriving ships make landfall at Buoy-1, 3 mi due west of the harbor entrance, where they pick up a pilot to guide them into their berth.

The Port of San Diego is located in San Diego Bay and extends across five adjacent cities including Imperial Beach, National City, Chula Vista, San Diego and Coronado. It is the fourth largest of California's 11 public ports and has jurisdiction over approximately 5,500 acres of land and water in and around San Diego Bay. Within this area, the Port operates two deep-water cargo terminals and two cruise ship terminals. The two cargo terminals, the Tenth Avenue Marine Terminal and the National City Marine Terminal, are located in the region's working waterfront area, at the center of industrial activity occurring in San Diego Bay. Port maritime industrial businesses are located between the two terminals including shipbuilding and repair, auto processing, transportation of goods, and manufacturing. These businesses, which are linked to the Port's maritime operations, are port tenants that provide goods and services supporting the region's maritime activity. The cruise ship terminals are located in the North Embarcadero area of downtown San Diego. The port also has a large volume of military vessel traffic, as it contains various naval air stations, a naval amphibious base, and training centers.

In May and June of 2012, the San Diego-based ERISS Corporation conducted a study of the Maritime Economy of San Diego involving quantitative economic analysis, in-person and telephone interviews, and an online survey (ERISS Corporation 2012). In total, the analysis indicated that an estimated 46,000 employees work in San Diego's Maritime Industry. The Port of San Diego was the largest sector in San Diego's maritime economy, with other sectors also providing significant numbers of jobs and revenue, including aquaculture and fishing, marine recreation, ocean energy and minerals, biomedicine, and ocean science.

H.5.5 Military and Industrial Use

San Diego has 18 different Naval and Marine bases. The Naval Base San Diego is the largest on the west coast and the principal homeport of the Pacific Fleet with 54 ships and 13 piers that stretch over 977 acres of land and 326 acres of water (NBSD 2021). The total on-base population is 35,000 military personnel and civilian employees. As many as 100 Navy ships may be in port at one time including aircraft carriers, destroyers, cruisers, frigates, submarines, amphibious ships, and service (auxiliary) vessels (NBSD 2021).

In 2014 the San Diego Economic development Corporation estimated that active-duty military account for more than 114,000 jobs in San Diego with an additional 25,000 full-time civilian workers also employed by the U. S. Department of Defense. In 2012, defense spending generated

$32 billion in economic activity for San Diego. In 2020 the San Diego Military Advisory Council issued a report that just Naval Base San Diego in San Diego Bay accounts for over 5.8% of all San Diego County employment (SDMAC 2020).

Navy ships enter and exit San Diego Bay virtually every day. The offshore area is used extensively for military operations including surface and submarine fleet maneuvers, and for antisubmarine warfare training. Most of this activity takes place well seaward of the PLOO discharge area.

Three facilities in the City of San Diego utilize significant volumes of sea water: Sea World in Mission Bay, the SIO, and the Western Salt Company at the southern end of San Diego Bay, which has been in operation for more than 100 years producing solar evaporated salt from ponds. All operate under permits from the EPA and the RWQCB.

Located in San Diego Bay, General Dynamics NASSCO has been designing and building ships since 1960 and is the only full-service shipyard on the west coast of the United States. NASSCO specializes in auxiliary and support ships for the U.S. Navy and oil tankers and dry cargo carriers for commercial markets. The largest heavy industrial manufacturer in San Diego, NASSCO employs 3,600 people. Because of its location, expertise and full-service capabilities, the Navy relies on NASSCO as a repair facility for its Pacific Fleet ships (NASSCO 2021). General Dynamics NASSCO also performs maintenance and repairs for commercial operators.

H.5.6 Environmental Monitoring

The Environmental Monitoring and Technical Services Division of the City of San Diego's Public Utilities Department (PUD) monitors the ocean in the vicinity of the PLOO. The primary objectives of ocean monitoring for the Point Loma outfall region are to measure compliance with NPDES permit requirements and California Ocean Plan water-contact standards, elucidate changes in ocean conditions over space and time, and assess any impacts of wastewater discharge or other man-made or natural influences on the local marine environment, including effects on water quality, sediment conditions, and marine life (City of San Diego 2008-2016, 2018, 2020). The monitoring area centers on the discharge site 4.5 mi (7.2 km) off Point Loma at a depth of 320 feet (98 m) (Figure H-25).

Shoreline monitoring extends from Mission Beach southward to the tip of Point Loma while offshore monitoring occurs seaward to a depth of about 380 feet (116 m), encompassing an area of approximately 70 mi^2 (182 km^2).

There are six components to the core monitoring program: coastal oceanographic conditions, water quality compliance and plume dispersion, sediment conditions, macrobenthic communities, demersal fishes and megabenthic invertebrates, and bioaccumulation of contaminants in fish tissues. In addition to core monitoring, a broader geographic survey of benthic conditions is conducted each year at randomly selected sites that range from the USA/Mexico border region to northern San Diego County and that extend further offshore to waters as deep as 1,640 feet (500 m).

Region-wide surveys off the coast of San Diego are also conducted as part of larger, multi-agency surveys of the entire Southern California Bight (e.g., Allen et al. 2011, Schiff et al. 2011, Ranasinghe et al. 2012, SCCWRP 2021a). Such large-scale surveys are useful for characterizing the ecological health of diverse coastal areas and in distinguishing reference sites from those impacted by wastewater or stormwater discharges, urban runoff, or other sources of contamination (SCCWRP 2021a).

The Point Loma monitoring program also includes provisions for adaptive or special strategic process studies. Examples of these studies include a comprehensive review of the Point Loma ocean monitoring program conducted by a team of scientists from the SIO and several other institutions (SIO 2004). This was followed by an ongoing sediment mapping study of the Point Loma and South Bay coastal regions that covers deeper continental slope benthic habitats (Stebbins et al. 2012). A special study designed to determine the characteristic fates of the PLOO wastewater plume in the coastal waters off Point Loma was completed in 2012 (Rogowski et al. 2012, 2013).

In addition, the City of San Diego provides staffing or funding support for several other projects assessing ocean quality in the region. One such project involves remote sensing (satellite imaging) of the San Diego/Tijuana coastal region (Svejkovsky 2014, 2003-2018, Hess 2019). The City also helps fund a long-term study of the Point Loma and La Jolla kelp forests being conducted by scientists at the SIO (e.g., Parnell and Riser 2012, Parnell et al 2020), and participates as a member of the Region Nine Kelp Survey Consortium to support aerial surveys of all the major kelp beds in San Diego and Orange Counties (e.g., MBC Applied Environmental Sciences 2012).

H.6 PUBLIC HEALTH

H.6.1 Introduction

This section covers aspects of the PLOO monitoring program that relate to public health and recreation.

Use of Fecal Indicator Bacteria for Assessing Potential Health Implications

Water quality standards to protect human health in recreational waters are customarily assessed by measuring the concentration of fecal indicator bacteria (FIB) to infer the presence of fecal matter and associated fecal pathogens. FIB live in the intestines of warm-blooded animals. FIB may not cause illness themselves, but have been linked to the presence of harmful pathogens.[3] The presence of FIB in a receiving water is an indicator of the potential presence of harmful pathogens that can cause illness in recreational water users.[4]

FIB parameters are used as a surrogate for human pathogens because they are easier and less costly to measure than the pathogens themselves. The most commonly used FIB parameters are total coliform, fecal coliform, *Escherichia Coli* (E. Coli), and enterococcus. State and federal water quality standards are established using these indicator parameters in order to protect recreational users from water quality-related health effects.

---

[3] References: Arnold et al. (2013); EPA (2012b).

[4] References: Boehm and Soller (2013); Harwood et al. (2013); EPA (2012b).

California Ocean Plan REC-1 Standards. Receiving water quality standards for state-regulated waters[5] of the Pacific Ocean are established by the SWRCB in the *Water Quality Control Plan, Ocean Waters of California, California Ocean Plan* (Ocean Plan).[6] Table H-20 summarizes current Ocean Plan receiving water bacteriological standards to protect body contact recreational uses (REC-1). The current version of the Ocean Plan establishes FIB standards for fecal coliform and enterococcus to protect REC-1 use.[7]

For comparison, Table H-20 also presents Ocean Plan REC-1 standards that were in effect at the time the current PLOO NPDES permit (Order No. R9-2017-0007, NPDES CA0107409) was adopted.[8] The 2015 version of the Ocean Plan (on which standards within Order No. R9-2017-0007 were based) established REC-1 standards for total coliform, fecal coliform and enterococcus.

As shown in Table H-20, the current version of the Ocean Plan no longer establishes REC-1 standards for total coliform. Fecal coliform REC-1 standards within the current (2019) version of the Ocean Plan, however, remain unchanged from the prior version. Compared to the 2015 version of the Ocean Plan, the current 2019 Ocean Plan version implements subtle differences in the way enterococcus standards are expressed. A Statistical Threshold Value[9] (STV) is now used in lieu of the former single sample maximum enterococcus limit of 104 CFU/100 milliliters (mL). Additionally, the current 2019 Ocean Plan establishes an enterococcus geometric mean standard on the basis of a 6-week geometric mean instead of the 30-day geometric mean standard established in the prior 2015 version of the Ocean Plan.

Prior to 2005, the Ocean Plan REC-1 bacteriological standards applied to ocean waters with a high potential for recreational use, including waters within:

- 1,000 feet of the shore
- the 30-foot depth contour
- designated kelp beds

---

[5] The State of California regulates waters of the Pacific Ocean that are within 3 nm of the shore.

[6] The current 2019 version of the Ocean Plan was adopted by the SWRCB on August 7, 2018 (SWRCB Resolution No. 2018-0038) and became effective on February 4, 2019.

[7] Ocean Plan receiving water quality objectives have been approved by EPA as representing water quality standards enforceable under the Clean Water Act. Since water quality objectives established in the Ocean Plan and approved by EPA represent water quality standards as defined in the CWA, the term "Ocean Plan standards" used herein is synonymous with "Ocean Plan water quality objectives approved by EPA."

[8] The 2015 version of the Ocean Plan (which included amendments addressing desalination facility intakes and brine discharges) was adopted by the SWRCB on May 6, 2015 (SWRCB Resolution No. 2015-0033) and became effective on January 28, 2016.

[9] The STV is not to be exceeded in more than 10% of the samples in a given month. The STV standard of 110 CFU/100 mL is thus essentially a 90th percentile value as opposed to a single sample maximum value.

Table H-20:
California Ocean Plan Bacteriological Standards to Protect Body-Contact

Recreation (REC-1)[A]						
Parameter	**Standards Implemented within Order No. R9-2017-0007[B] CFU/100 mL**		**Current Ocean Plan (2019 Version) Standards[C] CFU/100 mL**			
	Single Sample Maximum	**30-Day Geometric Mean**	**Single Sample Maximum**	**30-Day Geometric Mean[D]**	**Statistical Threshold Value[E]**	**6-Week Rolling Geometric Mean[F]**
Total coliform	1,000 or 10,000[G]	1,000	NA	NA	NA	NA
Fecal coliform	400	200	400	200[4]	NA	NA
Enterococcus	104	35	NA	NA	110[5]	30[6]

Table H-20 Notes:

A *California Ocean Plan* (Ocean Plan) recreational body-contact (REC-1) bacteriological limits apply to State-regulated receiving waters that are within 1,000 feet of the shore, within the 30-foot depth contour, in designated kelp beds, or in other state-regulated ocean waters designated by Regional Boards as being subject to REC-1 (body contact recreation) use. The above receiving water standards do not apply within designated ocean outfall zones of initial dilution. State-regulated ocean waters extend from the coastline 3 nm offshore.

B Ocean Plan REC-1 standards in effect (2015 version of the Ocean Plan) at the time Order No. R9-2017-0007 was adopted. These standards were established as receiving water limitations within Order No. R9-2017-0007. The Ocean Plan established these standards in terms of "density per 100 milliliters", while Order No. R9-2017-0007 expressed the standards in terms of colony forming units (CFU) per 100 mL (CFU/100 mL).

C Updated Ocean Plan REC-1 standards implemented in the 2019 version of the Ocean Plan. The 2019 version of the Ocean Plan expressed the standards in terms of CFU/100 mL.

D Calculated on the basis of the five most recent samples from each site.

E The STV is defined by the 2019 version of the Ocean Plan as the value not to be exceeded by more than 10% of the samples in any month.

F Six-week rolling geometric mean to be calculated on a weekly basis.

G The single sample maximum for total coliform is 1,000 organisms per 100 mL when the fecal coliform to total coliform ratio exceeds 10%. The single sample maximum for total coliform is 10,000 organisms per 100 mL when the fecal to total coliform ratio is not in excess of 10%.

In 2005, the Ocean Plan was revised to also apply body-contact standards to any other waters designated by the RWQCB as being subject to REC-1 use (body contact recreation).[10] The San Diego RWQCB establishes designated beneficial uses for San Diego Region waters within the *Water Quality Control Plan for the San Diego Region* (Basin Plan).[11] While the original version of the Basin Plan that was adopted in 1975 identified specific San Diego Region beaches and ocean waters that were subject to the REC-1 designation, the current version of the Basin Plan only generically assigns the REC-1 designation to the Pacific Ocean and does not distinguish between

---

[10] The 2005 version of the Ocean Plan (which include a minor change to also apply REC-1 standards to any water so designated by a RWQCB) was adopted by the SWRCB on April 21, 2005 (SWRCB Resolution No. 2005-0035) and became effective on October 12, 2005.

[11] Reference: RWQCB (2019).

beneficial uses at recreational beaches or beneficial uses in deep waters far offshore.[12] Because of this lack of specificity, EPA has interpreted the San Diego Basin Plan as designating all state-regulated ocean waters as being subject to REC-1 use within the San Diego Region. Order No. R9-2017-0007 (NPDES CA0107409) implements this EPA interpretation, and the Order applies Ocean Plan REC-1 bacteriological receiving water standards (presented in Table H-20) throughout the entire depth of the water column within the 3-nm state-regulated limit.

Clean Water Act Section 304(a) Criteria for Primary Contact Recreation. Federal water quality criteria to protect recreational uses are established pursuant to Section 304(a) of the Clean Water Act. In 2012, the EPA issued updated ambient water quality criteria[13] for recreational waters for *Escherichia coli* (E. Coli) and enterococcus. The 2012 criteria are designed to protect primary contact recreational uses including swimming, bathing, surfing, water skiing, tubing, water play by children, and similar water contact activities where a high degree of bodily contact with the water, immersion and ingestion are likely. Table H-21 presents the 2012 federal water quality criteria to protect recreational use for "primary contact recreation." The federal 304(a) water quality criteria[14] were implemented by the State of California within the 2019 update to the Ocean Plan. The 2019 Ocean Plan (see Table H-20) establishes enterococcus standards on the basis of the more conservative illness rate of 32 per 100 primary recreational users.

Order No. R9-2017-0007 implements the federal receiving water criteria presented in Table H-21 and applies the criteria as standards in all areas beyond the state-regulated 3-nm limit where "primary contact recreation" occurs, except within the PLOO ZID, which is exempted.[15] While the 2012 EPA water quality criteria (see Table H-21) addressed "primary contact recreation," prior EPA water quality criteria from 2004 established enterococcus criteria for a range of lesser recreational water contact uses, including:

- 150 per 100 mL for moderate recreational use
- 276 per 100 mL for light use
- 501 per 100 mL for infrequent use[16]

---

[12] The 1994 version of the Basin Plan (adopted by the RWQCB on September 8, 1994 and approved by the State of California Office of Administrative Law on April 26, 1995) was the first Basin Plan version that omitted inclusion of a list of specific beaches and recreational areas designated as REC-1 and omitted reference to the 1000-foot distance offshore or 30-foot-depth contour as parameters defining REC-1 use.

[13] EPA (2012b).

[14] *Ibid.*

[15] See Receiving Water Limitation V.A.2 of Order No. R9-2017-0007 (NPDES CA0107409).

[16] Source: EPA (2004). Such criteria for lesser degrees of public contact were addressed within the prior PLOO NPDES permit (Order No. R9-2009-0001), but the present NPDES permit (Order No. R9-2017-0007) addresses only criteria for primary contact recreation.

Table H-21:
Clean Water Act Section 304(a) Ambient Water Quality Criteria for Bacteria in Federal Waters where Primary Recreation Occurs[A]

Estimated Illness Rate per 1000 Primary Users[B]	EPA Enterococcus Criteria for the Protection of Primary Recreational Use	
	30-day Geometric Mean (Density/100 mL)	Statistical Threshold Value (STV) (Not to Be Exceeded More than 10% of the Time)
36 per 1000	35	130
32 per 1000	30	110

Table H-21 Notes:

A Primary contact recreation is defined as recreation where the potential exists for ingestion of water or immersion in water. Activities include swimming, water skiing, skin-diving, surfing, or other activities likely to result in immersion.

B EPA (2012b) recommends that states establish water quality standards to protect recreational use using one of these two estimated illness rates. In 2019, California revised the Ocean Plan to implement enterococcus standards that are based on the more restrictive illness rate of 32 per 1000 primary users.

As part of the required monitoring and reporting program, Order No. R9-2017-0007 requires the City to make visual observations at a series of offshore monitoring stations, which include describing “the nature and extent of primary contact recreation in federal waters.” City of San Diego ocean monitoring vessels are active at Point Loma ocean monitoring stations approximately 200 days each year. As previously documented within this appendix, visual observations conducted as part of the PLOO monitoring program during 2017-2020 did not identify any federally-defined primary contact recreation activities beyond the 3-nm state-regulated limit. Offshore visual observations conducted during 2017-2020 are in keeping with historic recreational use studies and observations conducted offshore from Point Loma which have not documented any federally-defined primary contact recreational activities outside the state-regulated 3-nm limit.

PLWTP Disinfection. As noted, the PLOO discharges treated effluent from the PLWTP to the ocean at a depth of approximately 310 feet approximately 4.5 statute miles (3.9 nm) offshore. The PLOO discharge occurs outside the state-regulated limit and ocean currents (see Appendix P) are predominantly downcoast and upcoast. These upcoast/downcoast currents, along with the distance offshore and depth of the PLOO discharge, result in the PLOO discharge plume (see Appendix D) predominantly being maintained offshore outside the 3-nm state-regulated limit. As documented within Appendix D, however, periodic (albeit short-term) onshore currents can carry the PLOO discharge plume toward and into state-regulated waters.

The City (see Appendix A) employs hypochlorite disinfection at the PLWTP to reduce effluent concentrations of pathogens and indicator organisms. With this effluent disinfection, the City is compliant with Ocean Plan REC-1 body contact standards in the event the PLOO discharge plume is transported within the state-regulated 3-nm limit. While no federally-defined primary contact use occurs outside the 3-nm limit, the PLWTP disinfection is useful for reducing receiving water pathogen concentrations both within and beyond the 3-nm boundary.

Table H-22 summarizes concentrations of total coliform, *E. coli* and enterococcus in the PLWTP effluent during 2020. As shown in the table, PLWTP effluent total coliform concentrations are typically on the order of 10^4 organisms per 100 mL, while enterococcus concentrations are approximately half the total coliform concentrations.

Table H-22:
Summary of PLWTP Effluent Bacteriological Monitoring, 2020[A]

Parameter[B]	Number of Effluent Samples During 2020	PLWTP Effluent Concentration (organisms per 100 mL)				
		90th Percentile	75th Percentile	50th Percentile	25th Percentile	10th Percentile
Total Coliform	171	1.52E+05	9.80E+04	5.25E+04	3.63E+04	2.38E+04
E. Coli	171	1.85E+05	1.12E+05	5.17E+04	3.08E+04	1.92E+04
Enterococcus	171	9.21E+04	5.03E+04	2.61E+04	1.49E+04	6.45E+03

Table H-22 Notes:

A Data from monthly monitoring reports submitted by the City of San Diego to the RWQCB for 2020. Effluent samples were collected at Monitoring Station EFF-001 prior to discharge to the PLOO. Calendar year 2020 is the most recent year for which 12-months of data are available.

B Order No. R9-2017-007 establishes receiving water standards for total coliform and enterococcus. The City of San Diego also collects data for E. Coli for purposes of assessing the effectiveness of disinfection.

Order No. R9-2017-0007 assigns a minimum month initial dilution of 204:1 to the PLOO discharge. Initial dilution modeling (see Appendix Q) demonstrates that the PLOO achieves a median initial dilution of 338:1 at the full 240 mgd design flow of the PLWTP. With this initial dilution achieving in excess of a 10^2 reduction, concentrations of total coliform and enterococcus at the edge of the ZID should typically be reduced to approximately 10^2 organisms per 100 mL. Additional dilution, dispersion, and die-off would be expected to occur as the effluent plume is transported from the discharge point.

Water Quality Monitoring Program

Receiving Water Compliance Monitoring Program. To assess compliance with applicable receiving water bacteriological standards, Order No. R9-2017-0007 establishes a comprehensive bacteriological receiving water monitoring program that includes monitoring at:

- eleven offshore "F" monitoring stations along the 98m (326 foot) depth contour (Stations F26 to F36)
- eleven offshore "F" monitoring stations along the 80m (266 foot) depth contour (Stations F15 to F25)
- eleven offshore "F" monitoring stations along the 60m (200 foot) depth contour (Stations F4 to F14)

- eight kelp stations, including three "A" stations along the 18m (60 foot) depth contour (Stations A1, A6 and A7) and five "C" monitoring stations along the 18m (60 foot) and 9m (30 foot) depth contours (Stations C4 to C8)

Figure H-25 presents the location of the monitoring stations. Table H-23 summarizes locations and sampling depths of the PLOO ocean monitoring stations within the state-regulated 3-nm limit. As shown in Table H-23, nine monitoring stations inside of the 60m (200 foot) depth contour are within the state-regulated 3-nm limit (Stations F6 through F14), along with three monitoring stations along the 80m (266-foot) contour (Stations F18, F19, and F20).

Order No. R9-2017-0007 also requires bacteriological monitoring at seven shore stations ("D" stations). While useful for assessing impacts from storm runoff or shore-based contaminant sources, the shore "D" stations are of little benefit in assessing PLOO discharge impacts. Historic outfall receiving water data and plume tracking data (see Appendix D) provide conclusive evidence that the PLOO discharge plume does not impinge on nearshore waters. In addition to the distance of the discharge offshore (and prevailing upcoast/downcoast ocean currents), thermal stratification typically traps the PLOO discharge plume from 40 to 60m below the surface.[17] While the PLOO discharge plume remains offshore, multiple shore-based sources of potential bacterial contamination exist in the PLOO monitoring grid, including:

- bacterial contamination from San Diego Bay and the Tijuana and San Diego Rivers[18]
- storm drain discharges and wet-weather runoff from local watersheds which can flush contaminants seaward[19]
- sewage spills from the wastewater collection system which can sometimes find its way to a local beach
- beach wrack (e.g., kelp, seagrass)
- storm drains impacted by tidal flushing and beach sediments which can act as reservoirs, cultivating bacteria until release into nearshore waters by returning tides, rainfall, and/or other disturbances[20]
- the presence of dogs and birds and their droppings in or near coastal areas[21]

---

[17] City of San Diego (2018, 2021); Rogowski et al. (2012, 2013); Svejkovsky (2003-2018).
[18] Svejkovsky (2003-2018); Hess (2019).
[19] Colford et al. (2007), Sercu et al. (2009), Griffith et al. (2010)
[20] Martin and Gruber (2005), Yamahara et al. (2007), Phillips et al. (2011), Griffith et al. (2013).
[21] Wright et al. (2009); Griffith et al. (2010); Araújo et al. (2014).

Table H-23:
PLOO Offshore Receiving Water Monitoring Stations Within State-Regulated Waters[A]

Category	Station	Total Depth of Station		Monitored Depths at Each Station		Approximate Upcoast/Downcoast Distance from PLOO Centerline[B]	
		Meters[C]	Feet	Meters	Feet	Nautical Miles	Kilometers
Kelp Bed Stations[D]	C4	9	30	1, 3, 9	3.3, 10, 29.5	0.8 s	1.5 s
	C5	9	30	1, 3, 9	3.3, 10, 29.5	0	0
	C6	9	30	1, 3, 9	3.3, 10, 29.5	0.9 n	1.6 n
	C7	18	60	1, 12, 18	3.3, 39.4, 59.1	2.2 n	4.1 n
	C8	18	60	1, 12, 18	3.3, 39.4, 59.1	3.2 n	5.9 n
	A1	18	60	1, 12, 18	3.3, 39.4, 59.1	1.0 s	1.8 s
	A6	18	60	1, 12, 18	3.3, 39.4, 59.1	0.9 n	1.7 n
	A7	18	60	1, 12, 18	3.3, 39.4, 59.1	0	0
Offshore Stations	F1[E]	18	60	1, 12, 18	3.3, 39.4, 59.1	2.1 s	3.8 s
	F2[F]	18	60	1, 12, 18	3.3, 39.4, 59.1	5.1 n	9.4 s
	F3[G]	18	60	1, 12, 18	3.3, 39.4, 59.1	6.6 n	12.1 n
	F6	60	200	1,25,60	3.3, 39.4, 59.1	2.5 s	4.6 s
	F7	60	200	1,25,60	3.3, 82, 197	1.3 s	2.3 s
	F8	60	200	1,25,60	3.3, 82, 197	0	0
	F9	60	200	1,25,60	3.3, 82, 197	0.8 n	1.5 n
	F10	60	200	1,25,60	3.3, 82, 197	2.0 n	3.7 n
	F11	60	200	1,25,60	3.3, 82, 197	3.2 n	5.9 n
	F12	60	200	1,25,60	3.3, 82, 197	4.4 n	8.2 n
	F13	60	200	1,25,60	3.3, 82, 197	5.6 n	10.3 n
	F14	60	200	1,25,60	3.3, 82, 197	6.5 n	12.1 n
	F18	80	266	1,25,60,80	3.3, 82, 197, 262	1.1 s	2.0 s
	F19	80	266	1,25,60,80	3.3, 82, 197, 262	0	0
	F20	80	266	1,25,60,80	3.3, 82, 197, 262	1.0 n	1.9 n

Table H-23 Notes:

A	Monitoring station locations per Monitoring and Reporting Program No. R9-2017-0007. The above stations include all PLOO offshore and kelp bed monitoring stations located within the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.
B	Approximate distance north (n) or south (s) of the PLOO centerline.
C	The 9-m (30-foot) contour is located approximately 0.4 nm (0.5 statute miles) offshore at the outfall centerline. The 18m (60-foot) contour is located approximately 0.8 nm (1.0 statute miles) offshore at the outfall centerline. The 60m (200-foot) contour is located approximately 1.6 nm (1.9 statute miles) offshore at the outfall centerline, and the 80m (266-foot) contour is located approximately 2.7 nm (3.2 statute miles) offshore at the outfall centerline, near the 3-nm limit of state-regulated waters. As shown in Figure H-25, all depth contours remain relatively parallel to the coastline.
D	Includes "C" stations located along the 9m and 18m contours, and three "A" stations along the 18m contour.
E	Station F1 station is located offshore from the mouth of San Diego Bay.
F	Station F2 is located offshore from the San Diego River mouth.
G	Station F3 is located offshore from Pacific Beach.

Storm and urban runoff represent key shore-based sources of contamination for beach and near-coast waters. Historical data demonstrate strong correlation between storm events and bacteriological exceedances at shore stations.22 Since plume tracking results and available data demonstrate that water quality at the "D" stations is not influenced by the PLOO discharge but is reflective of shore-based activities, data from the shore "D" stations are not considered herein for assessing PLOO compliance with Ocean Plan REC-1 receiving water bacteriological standards. Instead, to evaluate potential effects related to outfall performance, analysis is focused on data from ocean monitoring stations along the 98m, 80m, 60m, 18m, and 9m contours.

H.6.2 Compliance with REC-1 Water Quality Standards

The PLOO monitoring program is designed to assess general water quality and determine the level of compliance with regulatory standards in Order No. R9-2017-0007, Ocean Plan standards, and EPA water quality criteria for the protection of recreational beneficial use. Eight receiving water monitoring stations are located in nearshore waters and in the Point Loma kelp bed where REC-1 activities commonly occur.[23] These included stations C4, C5, and C6 located near the inner edge of the kelp bed along the 9m depth contour and stations A1, A6, A7, C7, and C8 located near the outer edge of the kelp bed along the 18m depth contour (Figure H-25). These eight nearshore stations are monitored weekly for total coliform, fecal coliform and enterococcus at three discrete depths.[24]

An additional 36 receiving water monitoring stations are located offshore of the kelp bed stations are sampled to monitor FIB levels in deeper waters. These offshore "F" stations are arranged in a grid surrounding the discharge site along or adjacent to the 18m, 60m, 80m and 98m depth contours (Figure H-25). In contrast to shore and kelp bed stations, offshore stations are monitored on a quarterly basis, and each quarterly survey is conducted over a 3-day period.[25] Bacterial analyses for these offshore stations are limited to enterococcus, and samples are collected at three discrete depths at the 60m offshore stations, four depths at the 80m offshore stations, and five depths at the 98m offshore stations.

Compliance with Total Coliform Standards. While the Ocean Plan no longer contains REC-1 standards for total coliform, Order No. R9-2017-0007 establishes REC-1 receiving water standards for total coliform on the basis of (1) single sample maximums and (2) 30-day geometric means. Table H-24 summarizes PLOO compliance with total coliform standards of Order No. R9-2017-0007 for the period 2017-2020 for kelp bed and nearshore stations. As shown in Table H-24, the PLOO achieved 100% compliance with total coliform 30-day geometric mean limits at all kelp bed and near-shore stations during 2017-2020.

---

[22] RWQCB (2018).

[23] As documented herein, recreational activities in near-shore and kelp bed waters include such activities as SCUBA diving, surfing, swimming, fishing, and kayaking.

[24] Average monitoring frequency is weekly, but monitoring may not necessarily occur every seven days.

[25] Quarterly monitoring typically occurs during February, May, August and November.

Table H-24:
PLOO Compliance with Total Coliform Standards of Order No. R9-2017-0007 Kelp Bed and Nearshore Receiving Water Monitoring Stations, 2017-2020[A]

Station	Sample Depth	Nearshore and Kelp Bed Total Coliform Samples, 2017-2020				
		Number of Samples	Number of Samples Exceeding the REC-1 Single Sample Maximum Limit[B]	Percent of Samples that Complied with the REC-1 Single Sample Maximum Limit	Number of Samples Which Caused the 30-Day Geometric Mean Limit to be Exceeded[C]	Percent of Samples that Complied with the REC-1 30-Day Geometric Mean Limit
C4	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C5	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C6	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C7	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %
C8	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %
A1	1	213	0	100 %	0	100 %
	12	213	1	99.5 %	0	100 %
	18	213	1	99.5 %	0	100 %
A6	1	213	1	99.5 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	1	99.5 %	0	100 %
A7	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	1	99.5 %	0	100 %

Table H-24 Notes:

A Based on total coliform monitoring data from January 2017 through December 2020, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. All above stations are within the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

B Observed total coliform concentration on the listed date. None of the receiving water samples exceeded the total coliform single sample maximum limit of 10,000 per 100 mL, but since the fecal:total coliform ratio on each date exceeded 10%, the single sample maximum limit was 1,000 per mL.

C Order No. R9-2017-0007 establishes a 30-day geometric mean standard for total coliform of 1,000 per 100 mL.

Additionally, the PLOO achieved virtually 100% compliance with the total coliform single sample maximum limits during 2017-2020. Among the more than 5,000 total coliform samples collected at the nearshore and kelp bed stations during 2017-2020, five samples exceeded the total coliform single sample limit of 1000 per 100 mL when the fecal to total coliform ratio exceeds 10%. Table H-25 summarizes these exceptions. As shown in Table H-25, one of these exceedances (September 2018 at Station A6) appears to be a singular event unrelated to PLOO operations.

The remaining four exceedances occurred during storm runoff conditions when recreational opportunities are minimal. Each exceedance occurred below the ocean surface at 12m to 18m depths, but FIB concentrations at the surface at each site were negligible and nearby stations also showed above-normal FIB concentrations. As a result, it is unknown whether these exceedances are related to storm conditions or are related to the PLOO discharge.

Table H-25:
Summary of Exceedances of Total Coliform Standards of Order No. R9-2017-0007 Single Sample Maximum Standards for Total Coliform, 2017-2020[A]

Date	Station	Depth (meters)	Total Coliform Concentration[B] (per 100 mL)	Circumstances of Exceedance
9/17/2018	A6	1	3,000	The exceedance occurred only at the surface at Station A6. Samples at 12m and 18m depths were 4 and 12 per 100 mL, respectively. Samples collected at the surface and at depth at surrounding stations also showed negligible FIB concentrations. Since PLOO thermocline conditions at this time of year provide for maximum trapping depths, it is improbable that this exceedance is related to the PLOO.
1/23/2019	A1	12	4,800	The 1/23/2019 exceedances occurred after multiple days of sustained rainfall, but samples collected at the surface at A1, A6 and A7 showed negligible FIB concentrations. Since samples at the 12m and 18m depths at Stations A1, A6 and A7 showed above-average FIB concentrations, it is unknown whether the exceedances at A1 and A7 are storm-related or are related to the PLOO discharge.
	A1	18	3,000	
	A7	18	1,800	
2/19/2019	A6	18	1,500	The 2/19/2019 exceedance at Station A6 occurred after multiple days of sustained rainfall, but samples collected at the surface at Stations A1, A6 and A7 showed negligible FIB concentrations. Since samples at the 12m and 18m depths at Stations A1, A6 and A7 showed above-average FIB concentrations, it is unknown whether the exceedance at A6 is storm-related or is related to the PLOO discharge.

Table H-25 Notes:

A Based on total coliform monitoring data from January 2017 through December 2020, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. All above stations are within the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

B Observed total coliform concentration on the listed date. None of the receiving water samples exceeded the total coliform single sample maximum limit of 10,000 per 100 mL, but since the fecal:total coliform ratio on each date exceeded 10%, the single sample maximum limit was 1,000 per mL.

Compliance with State-Imposed Fecal Coliform Standards. Table H-26 summarizes compliance during 2017-2020 with fecal coliform standards established in Order No. R9-2017-0007 and the Ocean Plan. As shown in Table H-26, 100% compliance was achieved during 2017-2020 with the 30-day geometric mean limits established in Ocean Plan and Order No. R9-2017-0007 at the nearshore and kelp bed stations.

As shown in Table H-26, 100% compliance was achieved with the fecal coliform 30-day geometric mean standard during 2017-2020 at the nearshore and kelp bed stations.

Table H-26:
PLOO Compliance with Fecal Coliform Standards[A]
Kelp Bed and Nearshore Receiving Water Monitoring Stations, 2017-2020[B]

Station	Sample Depth	Nearshore and Kelp Bed Fecal Coliform Samples, 2017-2020				
		Number of Samples	Number of Samples Exceeding the REC-1 Single Sample Maximum Limit[C]	Percent of Samples that Complied with the REC-1 Single Sample Maximum Limit	Number of Samples Which Caused the 30-Day Geometric Mean Limit to be Exceeded[D]	Percent of Samples that Complied with the REC-1 30-Day Geometric Mean Limit
C4	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C5	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C6	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C7	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %
C8	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %
A1	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %
A6	1	213	1	99.5 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %
A7	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %

Table H-26 Notes:

A Order No. R9-2017-0007 implements Ocean Plan REC-1 standards for fecal coliform, which include a single sample maximum limit of 400 per 100 mL and a 30-day geometric mean limit of 200 per 100 mL.

B Based on fecal coliform monitoring data from January 2017 through December 2020, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. All above stations are within the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

C Order No. R9-2017-0007 and the Ocean Plan establish a single sample maximum for fecal coliform of 400 organisms per 100 mL.

D Order No. R9-2017-0007 and the Ocean Plan establish a 30-day geometric mean standard for fecal coliform of 200 per 100 mL.

Table H-27 summarizes maximum observed fecal coliform 30-day geometric means at the nearshore and kelp bed stations during 2017-2020. As shown in Table H-27, maximum observed 30-day geometric means tended to occur during the period December through May, the time of year when recreational use is lowest and the potential for storm-based shore runoff is highest.

Table H-27:
Maximum Observed Fecal Coliform Geometric Means, 2017-2020 Kelp Bed and Nearshore Stations

Nearshore or Kelp Bed Station[A]	Sample Depth (meters)	Maximum Observed Fecal Coliform 30-Day Geometric Mean[B] (density per 100 mL)	Month/Year where Maximum Fecal Coliform 30-Day Geometric Mean Occurred
A1	1	5.9	Apr 2019
	12	13.8	Feb 2019
	18	24.2	Feb 2019
A6	1	11.8	Sep 2018
	12	6.9	Feb 2019
	18	12.0	Feb 2019
A7	1	4.7	Apr 2019
	12	8.5	Feb 2019
	18	12.1	Feb 2018
C4	1	3.2	Apr 2018
	12	3.1	Apr 2018
	18	4.0	Feb 2019
C5	1	4.4	Apr 2020
	12	3.0	Jan 2019
	18	3.6	Dec 2019
C6	1	3.1	Apr 2020
	12	2.3	Jan 2019
	18	2.5	Jan 2019
C7	1	3.8	Jan 2018
	12	3.5	May 2019
	18	5.0	May 2019
C8	1	3.9	Apr 2020
	12	3.0	Mar 2017
	18	4.4	May 2019
Ocean Plan Standard	---	200	---

Table H-27 Notes:

A Order No. R9-2017-0007 requires that weekly fecal coliform monitoring be conducted at nearshore and kelp bed stations A1, A6, A7, C4, C5, C6, C7 and C8.

B Maximum computed 30-day geometric mean of fecal coliform values at the listed station and listed depths during the period January 2017 through December 2020. Based on samples collected during each calendar month of the four-year period. Order No. R9-2017-0007 and the Ocean Plan require that the 30-day geometric mean be calculated using a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period). For demonstration purposes, the above 30-day geometric means included months where four samples were collected during the month at each station and depth, and months where five samples were collected at each station and depth during the month.

Of the over 5000 fecal coliform samples collected at these stations during 2017-2020, only one sample exceeded the fecal coliform single sample maximum limit. Strong evidence exists that result (from September 2018) is not related to the PLOO discharge, as:

- the exceedance was only observed in a surface sample at Station A6
- samples at 12m and 18m depths at Station A6 showed negligible FIB concentrations
- samples at nearby stations showed negligible FIB concentrations at all depths
- thermocline trapping is near maximum in mid-September, and it is extremely unlikely that the PLOO discharge plume could rise near the surface and be transported laterally toward Station A6 at this time of year

Compliance with State of California Enterococcus Limits. Table H-28 summarizes compliance at the kelp bed and near-shore stations during 2017-2020 with the single sample maximum enterococcus limit of 104 per 100 mL that is established within Order No. R9-2017-0007. As shown in Table H-28, of the more than 5,000 samples collected at the kelp bed and nearshore stations, eight samples showed enterococcus concentrations in excess of 104 per 100 mL.

**Table H-28:
PLOO Compliance with Enterococcus Standard
Kelp Bed and Nearshore Receiving Water Monitoring Stations, 2017-2020[A]**

Station	Sample Depth	Nearshore and Kelp Bed Enterococcus Samples, 2017-2020				
		Number of Samples	Number of Samples Exceeding a Concentration of 104 per 100 mL[B]	Percent of Samples that Complied with 104 per mL Effluent Standard of Order No. R9-2017-0007	Number of Samples Exceeding an Enterococcus Concentration of 110 per 100 mL[C]	Percent of Samples with Values Less than 110 per 100 mL
C4	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C5	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C6	1	213	0	100 %	0	100 %
	3	213	0	100 %	0	100 %
	9	213	0	100 %	0	100 %
C7	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	0	100 %	0	100 %
C8	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	1	99.5 %	0	99.5 %

Station	Sample Depth	Nearshore and Kelp Bed Enterococcus Samples, 2017-2020				
		Number of Samples	**Number of Samples Exceeding a Concentration of 104 per 100 mL** [B]	**Percent of Samples that Complied with 104 per mL Effluent Standard of Order No. R9-2017-0007**	**Number of Samples Exceeding an Enterococcus Concentration of 110 per 100 mL** [C]	**Percent of Samples with Values Less than 110 per 100 mL**
A1	1	213	0	100 %	0	100 %
	12	213	1	99.5 %	1	99.5 %
	18	213	1	99.5 %	1	99.5 %
A6	1	213	1	99.5 %	1	99.5 %
	12	213	0	100 %	0	100 %
	18	213	1	99.5 %	0	100 %
A7	1	213	0	100 %	0	100 %
	12	213	0	100 %	0	100 %
	18	213	1	99.5 %	1	99.5 %

Table H-28 Notes:

A Based on enterococcus monitoring data from January 2017 through December 2020 at the nearshore (A1, A6 and A7) and kelp bed (C4, C5, C6, C7 and C8) monitoring locations, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. All above stations are within the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

B Order No. R9-2017-0007 establishes a single sample maximum for enterococcus of 104 per 100 mL.

C The Ocean Plan establishes a STV for enterococcus of 110 per 100 mL, which is a value that is not to be exceeded by more than 10% of the samples in a calendar month.

Table H-29 summarizes occurrences where the 104 per 100 mL enterococcus receiving water limit was exceeded during 2017-2020. As shown in the table, exceedances occurred on four dates during 2017-2020. As with the total coliform exceedances, most of the enterococcus exceedances occurred on or after sustained storm events. The only non-storm exceedance occurred in September 2018. As previously discussed, available evidence indicates that the September 2018 exceedance is unlikely to be connected to the PLOO discharge. Three of the exceedances were in the kelp bed (Stations C7 and C8 on 1/13/2017 and 11/4/2019), but concurrent fecal coliform samples collected at these locations and depths showed negligible fecal coliform concentrations.

Table H-29:
Summary of Exceedances of Enterococcus Standards of Order No. R9-2017-0007 Single Sample Maximum Standards for Enterococcus, 2017-2020[A]

Date	Station	Depth (meters)	Enterococcus Concentration[B] (per 100 mL)	Total Coliform Concentration[C] (per 100 mL)	Circumstances of Exceedance
1/13/2017	A6	18	110	< 2	The exceedances occurred following a series of consecutive storm days, so the exceedances may be related to storm runoff. Concurrent fecal coliform samples showed low values at each station. An additional sample was collected within 48 hours at the 18m depth of Station A6 which showed an enterococcus concentration of < 2.
	C8	18	12000	6	
9/17/2018	A6	1	180	2400	The exceedance occurred only at the surface at Station A6. Enterococcus samples at 12m and 18m depths were 4 and 12 per 100 mL, respectively. Samples collected at surrounding stations also showed negligible FIB concentrations. Since PLOO thermocline conditions at this time of year provide for maximum trapping depths, it is improbable that this exceedance is related to the PLOO.
1/23/2019	A1	12	160	300	The 1/23/2019 exceedances occurred after multiple days of sustained rainfall, but samples collected at the surface at A1, A6 and A7 showed negligible FIB concentrations. Since samples at the 12m and 18m depths at Stations A1, A6 and A7 showed above-average FIB concentrations, it is unknown whether the exceedances at A1 are storm-related or are related to the PLOO discharge.
		18	280	320	
11/4/2019	C7	1	120	< 2	While enterococcus exceedances occurred at the 1m and 18m depths of Station C7 on 11/4/2019, fecal coliform values at these depths at this time were low. The enterococcus value at the 12m depth at Station C7 on this date was 96 per 100 mL, but all of the surrounding stations and depths showed negligible FIB concentrations on this date. The cause of the exceedance at Station C7 is unknown.
		18	560	2	

Table H-29 Notes:

A Order No. R9-2017-0007 establishes a single sample maximum limit for enterococcus of 104 per 100 mL, which implements the Ocean Plan standard that was in effect at the time the Order was adopted. The above table summarizes exceedances of this limit for the period January 2017 through December 2020, based on enterococcus monitoring data reported in monthly reports submitted by the City of San Diego to the RWQCB. All above stations are within the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

B Observed enterococcus concentration on the listed date.

C For reference, the observed fecal coliform concentration on this date at this sample location and depth is also presented.

In lieu of a single sample maximum, the 2019 Ocean Plan establishes a STV for enterococcus of 110 per 100 mL, which is not to be exceeded more than 10% of the time in any given calendar month. Because fewer than 10 samples are collected at each sample location and depth each month, an insufficient number of samples are available to compute a 90th percentile value on a monthly basis. As shown in Table H-28, however, the incidence of enterococcus values in excess of 110 per 100 mL was negligible. As a result, an extremely high probability exists that compliance is consistently achieved with the Ocean Plan enterococcus STV limit at the nearshore and kelp bed stations.

Order No. R9-2017-0007 (see Table H-20) establishes an enterococcus 30-day geometric mean standard of 35 per 100 mL, while the 2019 Ocean Plan establishes a 6-week geometric mean enterococcus limit of 30 per 100 mL. Weekly bacteriological monitoring at the nearshore stations (A1, A6, and A7) and kelp bed stations (C4, C5, C6, C7 and C8) allow for computation of statistically significant 30-day and 6-week geometric means. Table H-30 presents maximum observed enterococcus geometric means during 2017-2020 at the kelp bed and nearshore stations.

Table H-30:
Maximum Observed Enterococcus Geometric Means, 2017-2020[A]
Kelp Bed and Nearshore Stations

Nearshore or Kelp Bed Station[B]	Sample Depth (meters)	Maximum Observed Enterococcus 30-Day Geometric Mean[C] (density per 100 mL)	Month/Year when Maximum Enterococcus 30-Day Geometric Mean Occurred	Maximum Observed Enterococcus 6-week Geometric Mean[D]
A1	1	4.2	Apr 2020	4.3
	12	5.8	Feb 2019	16.7
	18	7.7	Jan 2017	24.6
A6	1	6.2	Sep 2018	6.5
	12	4.9	Jan 2017	7.2
	18	10.3	Jan 2017	11.3
A7	1	4.2	Jan 2018	2.7
	12	4.1	Dec 2019	10.4
	18	6.8	Mar 2017	17.4
C4	1	3.6	Apr 2020	2.9
	12	3.2	Apr 2020	2.9
	18	3.7	Apr 2020	3.2
C5	1	2.6	Apr 2020	3.8
	12	3.6	Apr 2020	2.8
	18	2.5	Apr 2018	3.3
C6	1	2.9	Jan 2019	2.9
	12	4.0	Jan 2017	2.2
	18	3.7	Jan 2017	2.4

Nearshore or Kelp Bed Station[B]	Sample Depth (meters)	Maximum Observed Enterococcus 30-Day Geometric Mean[C] (density per 100 mL)	Month/Year when Maximum Enterococcus 30-Day Geometric Mean Occurred	Maximum Observed Enterococcus 6-week Geometric Mean[D]
C7	1	5.6	Nov 2019	3.4
	12	9.4	Nov 2019	3.5
	18	8.2	Nov 2019	3.8
C8	1	3.8	Jan 2017	3.5
	12	3.3	Jan 2017	2.8
	18	6.3	Jan 2017	3.5
Ocean Plan REC-1 Receiving Water Quality Objective		---	---	30
Receiving Water Limit Established in Order No. R9-2017-0007		35	---	---

Table H-30 Notes:

A Geometric means computed using enterococcus receiving water monitoring data from January 2017 through December 2020 at the nearshore (A1, A6 and A7) and kelp bed (C4, C5, C6, C7 and C8) monitoring locations, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. All above stations are within the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

B Order No. R9-2017-0007 requires that weekly enterococcus monitoring be conducted at nearshore and kelp bed stations A1, A6, A7, C4, C5, C6, C7 and C8.

C Maximum computed 30-day geometric means of enterococcus values at the listed station and listed depths during the period January 2017 through December 2020. Based on samples collected during each calendar month of the four-year period. Order No. R9-2017-0007 and the Ocean Plan require that the 30-day geometric mean be calculated using a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period). For demonstration purposes, the above 30-day geometric means included geometric means within calendar months where four samples were collected during the month at each station and depth, and geometric means within calendar months where five samples were collected at each station and depth during the month. The above geometric means are computed for calendar months and do not represent "rolling" geometric means.

D For purposes of demonstrating differences in FIB concentrations at different depths, the listed 6-week geometric means represent "rolling" means. The above-listed geometric means assess data only at a given station and at a given depth and do combine values collected at differing depths at a given station. Values are computed as a geometric mean of the prior 6 weekly enterococcus samples collected at the listed sample location and listed depth. Sample intervals are approximately weekly, but intervals between weekly samples may not necessarily be 7 days.

As shown in Table H-30, the PLOO discharge during 2017-2020 complied with the 30-day enterococcus geometric mean standard established in Order No. R9-2017-0007 and the 6-week geometric mean standard established in the Ocean Plan. The maximum observed 30-day geometric mean at the nearshore and kelp bed stations was 10.3 per 100 mL during 2017-2020, which occurred at Station A6 at an 18-m depth. The maximum observed enterococcus 6-week geometric mean of 24.6 per 100 mL occurred at Station A1 at an 18m depth. As also shown in Table H-30, most of the observed maximum values for 30-day and 6-week geometric means occurred during winter months when recreational use is lowest *and the potential for shore-based stormwater contamination is highest.*

Order No. R9-2017-0007 requires quarterly enterococcus monitoring at the offshore monitoring stations along the 60m, 80m and 98m contours. As a result, only one sample per quarter at these stations is available for assessing compliance. Table H-31 summarizes the results of enterococcus samples collected within state-regulated waters at the offshore stations during 2017-2020. As shown in the table, enterococcus values are consistently < 2 per 100 mL throughout near-surface waters and the portion of the water column that is within reach of recreational divers. Occasional enterococcus exceedances occur at depths of 60m (200 feet) or more which are likely related to PLOO plume incursion, but such occurrences where the Ocean Plan STV limit are exceeded are relatively rare.

Conformance with Federal 304(a) Enterococcus Criteria. As noted, Order No. R9-2017-0007 implements federal 304(a) enterococcus criteria which apply to all waters outside the state-regulated 3-nm limit where primary contact occurs.[26] As documented within this appendix, recreational use that occurs off the coast of Point Loma is limited to onshore and kelp bed areas. These REC-1 nearshore and kelp bed activities swimming, surfing, snorkeling, water and jet skiing, kayaking, paddle boarding, recreational fishing and SCUBA diving.

While REC-1 use is significant in nearshore waters and the kelp bed zone, evidence is conclusive that no primary recreational use occurs outside of state-regulated waters off the Point Loma coast. The 3-nm limit occurs approximately at the 80m contour, well beyond recreation SCUBA diving limits. PUD monitoring vessel crews (which are engaged in offshore activities approximately 200 days each year) have not reported a single incident of water contact recreational activities outside the state-regulated 3-nm limit during the more than 35 years of ocean monitoring that has been conducted for the extended PLOO.

Table H-32 presents a percentile breakdown of enterococcus concentrations at PLOO receiving water monitoring stations outside the state-regulated 3-nm limit. As shown in Table H-32, enterococcus concentrations were consistently negligible in near-surface waters outside the 3-nm limit. While no such primary contact recreation occurs outside the 3-nm limit off the coast of Point Loma, all samples in surface near-surface waters were within the federal enterococcus criteria. Additionally, all 90th percentile values for deeper waters (waters of 60m or more in depth) were consistently within the federal enterococcus STV criterion for "primary use" of 110 per 100 mL.

---

[26] Primary contact recreation is defined as recreation where the potential exists for ingestion of water or immersion in water. Activities include swimming, water skiing, skin-diving, surfing, or other activities likely to result in immersion.

Table H-31:
Summary of PLOO Offshore Enterococcus Monitoring in State-Regulated Waters Offshore Stations Along the 18m, 60m and 80m Contours, 2017-2020[A]

Station	Sample Depth	Offshore Stations in State-Regulated Waters at the 18m, 60m and 80m Depth Contours				
		Number of Samples	Number of Samples Exceeding a Concentration of 104 per 100 mL[B]	Percent of Samples that Complied with 104 per mL Effluent Standard of Order No. R9-2017-0007	Enterococcus Concentration Density per 100 mL[C]	
					90th Percentile	75th Percentile
F1	1	16	0	100 %	< 2	< 2
	12	16	0	100 %	< 2	< 2
	18	16	0	100 %	< 2	< 2
F2	1	16	0	100 %	3	< 2
	12	16	0	100 %	< 2	< 2
	18	16	0	100 %	< 2	< 2
F3	1	16	0	100 %	< 2	< 2
	12	16	0	100 %	< 2	< 2
	18	16	0	100 %	< 2	< 2
F6	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	0	100 %	27	14
F7	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	1	99.5 %	37	23
F8	1	16	0	100 %	< 2	< 2
	25	16	1	99.5 %	< 2	< 2
	60	16	1	99.5 %	45	26
F9	1	16	1	99.5 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	1	99.5 %	34	20
F10	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	1	93.8 %	87	28
F11	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	2	87.5 %	67	22
F12	1	16	0	100 %	2	< 2
	15	16	0	100 %	< 2	< 2
	60	16	1	93.8 %	18	11.5
F13	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	2	< 2
	60	16	0	100 %	66	23

Station	Sample Depth	Offshore Stations in State-Regulated Waters at the 18m, 60m and 80m Depth Contours				
		Number of Samples	Number of Samples Exceeding a Concentration of 104 per 100 mL[B]	Percent of Samples that Complied with 104 per mL Effluent Standard of Order No. R9-2017-0007	Enterococcus Concentration Density per 100 mL[C]	
					90th Percentile	75th Percentile
F14	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	0	100 %	20	8.0
F18	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	2	< 2
	60	16	2	87.5 %	200	29
	80	16	2	87.5 %	97	45
F19	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	1	93.8 %	73	14
	80	16	4	75 %	160	84
F20	1	16	0	100 %	< 2	< 2
	25	16	0	100 %	< 2	< 2
	60	16	1	93.8 %	32	6
	80	16	1	93.8 %	87	38

Table H-31 Notes:

A Based on enterococcus monitoring data from January 2017 through December 2020 at the nearshore (A1, A6 and A7) and kelp bed (C4, C5, C6, C7 and C8) monitoring locations, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. All above stations are within the 3-nm limit of state regulation. See Figure H-25.

B Order No. R9-2017-0007 establishes a single sample maximum for enterococcus of 104 per 100 mL.

C Percentile values for each station and each sampling depth are computed using all enterococcus data collected at the given station and depth during 2017-2020.

Table H-32:
Summary of PLOO Offshore Enterococcus Monitoring Outside of State-Regulated Waters Offshore Stations Along the 60m, 80m and 98m Contours, 2017-2020[A]

Station	Depth (m)	Enterococcus Percentile Concentration, 2017-2020[B] Density per 100 mL		
		90th Percentile	75th Percentile	50th Percentile
F4	1	2	2	2
	25	2	2	2
	60	38	6	2
F5	1	2	2	2
	25	2	2	2
	60	12	2	2
F15	1	2	2	2
	25	2	2	2
	60	16	2	2
	80	41	16	4
F16	1	2	2	2
	25	2	2	2
	60	15	3	3
	80	47	14	8
F17	1	2	2	2
	25	2	2	2
	60	20	2	2
	80	53	21	9
F21	1	2	2	2
	25	2	2	2
	60	5	2	2
	80	170	93	32
F22	1	2	2	2
	25	2	2	2
	60	37	2	2
	80	77	65	15
F23	1	2	2	2
	25	2	2	2
	60	2	2	2
	80	2	2	2
F24	1	2	2	2
	25	2	2	2
	60	30	3	3
	80	29	10	2
F25	1	2	2	2
	25	2	2	2
	60	37	2	2
	80	22	8.5	4
F28	1	2	2	2
	25	2	2	2
	60	22	2	2
	80	350	57	8
	98	18	12	4
F29	1	2	2	2
	25	2	2	2
	60	20	2	2
	80	167	43	5
	98	55	21	6
F30	1	2	2	2
	25	2	2	2
	60	460	42	42
	80	560	360	130
	98	160	105	57
F31	1	2	2	2
	25	2	2	2
	60	6	2	2
	80	210	123	44
	98	51	30	7
F32	1	2	2	2
	25	2	2	2
	60	22	2	2
	80	105	47	5
	98	30	14	6
F33	1	2	2	2
	25	2	2	2
	60	6	2	2
	80	83	65	12
	98	24	11	2
F34	1	2	2	2
	25	2	2	2
	60	29	2	2
	80	116	16	2
	98	19	5	2
F35	1	2	2	2
	25	2	2	2
	60	15	2	2

Station	Depth (m)	Enterococcus Percentile Concentration, 2017-2020[B] Density per 100 mL		
		90th Percentile	75th Percentile	50th Percentile
F26	1	2	2	2
	25	3	2	2
	60	84	2	2
	80	28	19	7
	98	13	11	3
F27	1	2	2	2
	25	2	2	2
	60	144	2	2
	80	165	51	11
	98	26	16	7
F35 (Cont.)	80	55	8.5	2
	98	10	4.5	2
F36	1	2	2	2
	25	2	2	2
	60	5	2	2
	80	103	2.5	2
	98	11	5	2

Table H-32 Notes:

A Based on enterococcus monitoring data from January 2017 through December 2020 at Monitoring Stations F4, F5, F15 through F17, and F21 through F36, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-2017-0007. All of the above stations are outside the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

B Percentile values for each station and each sampling depth are computed using all enterococcus data collected at the given station and depth during 2017-2020.

In areas where primary contact recreation occurs, the federal 304(a) 30-day geometric mean standard for enterococcus is 35 per 100 mL. During 2017-2020, only one of 672 enterococcus samples collected at depths of 25 m or less exceeded a concentration of 35 per 100 mL. Thus, even though no primary contact recreation occurs in the waters outside the 3-nm limit of state regulation, PLOO receiving water data collected during 2017-2020 demonstrate compliance with the federal enterococcus criteria for primary contact recreation.

While the current EPA 2012 enterococci criteria address "primary use" where a high degree of water contact occurs and immersion or ingestion is likely, the prior 2004 EPA enterococci criteria addressed lesser levels of potential water contact, including moderate use, light use, and infrequent body contact use.[27] Given that no primary recreational use has been observed outside of state-regulated coastal waters, it is instructive to compare PLOO monitoring results outside the 3-nm state-regulated limit with 2004 EPA "level of contact" enterococci criteria.

---

[27] Use-based (e.g., recreational "degree of contact") criteria for enterococcus were promulgated by EPA in 2004 (EPA, 2004). The 2004 enterococcus recreational criteria for coastal waters included an enterococcus criterion of 276 per 100 ml for light use and 501 per 100 ml for infrequent use. Light and infrequent use are as defined below.

Table H-33 presents a comparison of enterococci monitoring data for 2017-2020 with the 2004 federal water quality criteria for "light use" and "infrequent use". As shown in the table, offshore monitoring data from 2017-2020 indicate an overwhelming probability of compliance with the 2002 single sample enterococcus criteria of:

- 276 per 100 mL for light use
- 501 per 100 mL for infrequent use at all depths[28]

Table H-33:
Compliance of PLOO Offshore Enterococci Concentrations with 2004 Enterococcus Criteria Offshore Stations Outside of State-Regulated Waters[A]

Sample Depth	No. of Samples collected during 2017-2020	No. of Samples Exceeding an Enterococci Concentration of 276 per 100 mL	Percent of Samples Exceeding Enterococci Concentration of 276 per 100 mL	No. of Samples Exceeding an Enterococci Concentration of 501 per 100 mL	Percent of Samples Exceeding Enterococci Concentration of 501 per 100 mL	Enterococcus Concentration[B] Density per 100 mL	
						95th Percentile Value	90th Percentile Value
1	336	0	100%	0	100%	< 2	< 2
25	336	0	100%	0	100%	< 2	< 2
60	336	9	97.3%	2	-105.5%	89	37
80	304	13	95.7%	4	-317.9%	237	117
98	176	3	98%	0	100%	103	54
All samples	1488	25	98.3%	6	-510.3%	86	31

Table H-33 Notes:

A. Based on enterococcus monitoring data from January 2017 through December 2020 at Monitoring Stations F4, F5, F15 through F17, and F21 through F36, as reported in monthly reports submitted by the City of San Diego to the RWQCB per requirements established in Order R9-20170007. All of the above stations are outside the 3-nm limit of state regulation. See Figure H-25 for monitoring station locations.

B. Percentile values computed combining enterococcus data from all offshore stations (F4, F5, F17-F19 and F21-F36) outside the 3-nm limit at the listed sampling depths. These data are presented for purposes of demonstrating general depth-dependent differences in enterococcus concentrations outside of state-regulated waters.

---

[28] Light use is defined as coastal recreation waters that are not designated bathing beach waters but typically during the recreation season are used by less than half of the number of people as at typical designated bathing beach waters within the State. Infrequent use coastal recreation waters are defined as coastal recreation waters that are rarely or occasionally used.

Water Quality Compliance Conclusions. RWQCB and EPA Order No. R9-2017-0007 (NPDES CA0107409) regulates the discharge of treated wastewater from the PLWTP to the Pacific Ocean via the PLOO. Order No. R9-2017-0007 establishes receiving water bacteriological standards to protect REC-1 body contact use in the ocean and applies the REC-1 standards throughout all depths within the 3-nm limit of state-regulated waters.

Subsequent to the adoption of Order R9-20917-0007, the SWRCB implemented minor modifications to Ocean Plan bacteriological REC-1 receiving water quality standards. The PLOO discharge also complies with receiving water bacteriological standards established in the current 2019 version of the Ocean Plan.

The PLOO discharge occurs outside the 3-nm limit, and sodium hypochlorite disinfection is implemented at the PLWTP to achieve partial disinfection. Offshore receiving water data from 2017-2020 collected as part of the City's comprehensive ocean monitoring program demonstrate virtually 100% compliance with receiving water standards established in the Ocean Plan and in Order No. R9-2017-0007 for the protection of body contact recreation.

Order No. R9-2017-0007 also implements receiving water bacteriological standards promulgated by EPA pursuant to Section 304(a) of the Clean Water Act which apply to "primary contact recreation" activities defined by EPA. While no such primary contact recreation activities have been documented in off the Point Loma coast beyond the limit of state-regulated waters, receiving water data from 2017-2020 demonstrate compliance with the Clean Water Act 304(a) enterococcus criteria.

H.6.3 Fish Tissue Compliance

Introduction

Potentially toxic chemicals enter the ocean environment through various sources including rivers and streams, storm drains, industrial discharges, municipal wastewater discharges, dredge and disposal activities, aerial fallout, vessel activities and spills, mineral mining, oil exploration and extraction, and through natural sources such as hydrothermal vents, hydrocarbon and elemental seeps (Setty et al. 2012, Hutchinson 2013). All these sources may impact fish populations and possibly public health, if fish accumulate these constituents and are consumed (Klasing and Brodberg 2008, 2011, Walsh et al. 2008, California OEHHA (OEHHA) 2014a, b). Some of the chemicals entering the ocean remain dissolved and are distributed by ocean currents and eddies. Many are physically or chemically bound to particulate matter and settle to the bottom. Chemical constituents may bioaccumulate - that is, be retained in the tissues of marine organisms and concentrated through food-webs (Newman 2009, Daley et al. 2014). The degree to which bioaccumulation occurs depends on the solubility, particle affinity, oxidation state, volatility, and degradability of the specific chemical (Laws 2013). These differences determine how contaminants are distributed within biological communities and throughout the environment (Bienfang et al. 2013).

Fish exposure may include absorption of dissolved chemicals from seawater (by the gills or epidermis), contact with sediment contaminants, ingestion of sediment particles or suspended particulate matter, and ingestion and assimilation of contaminants from food organisms

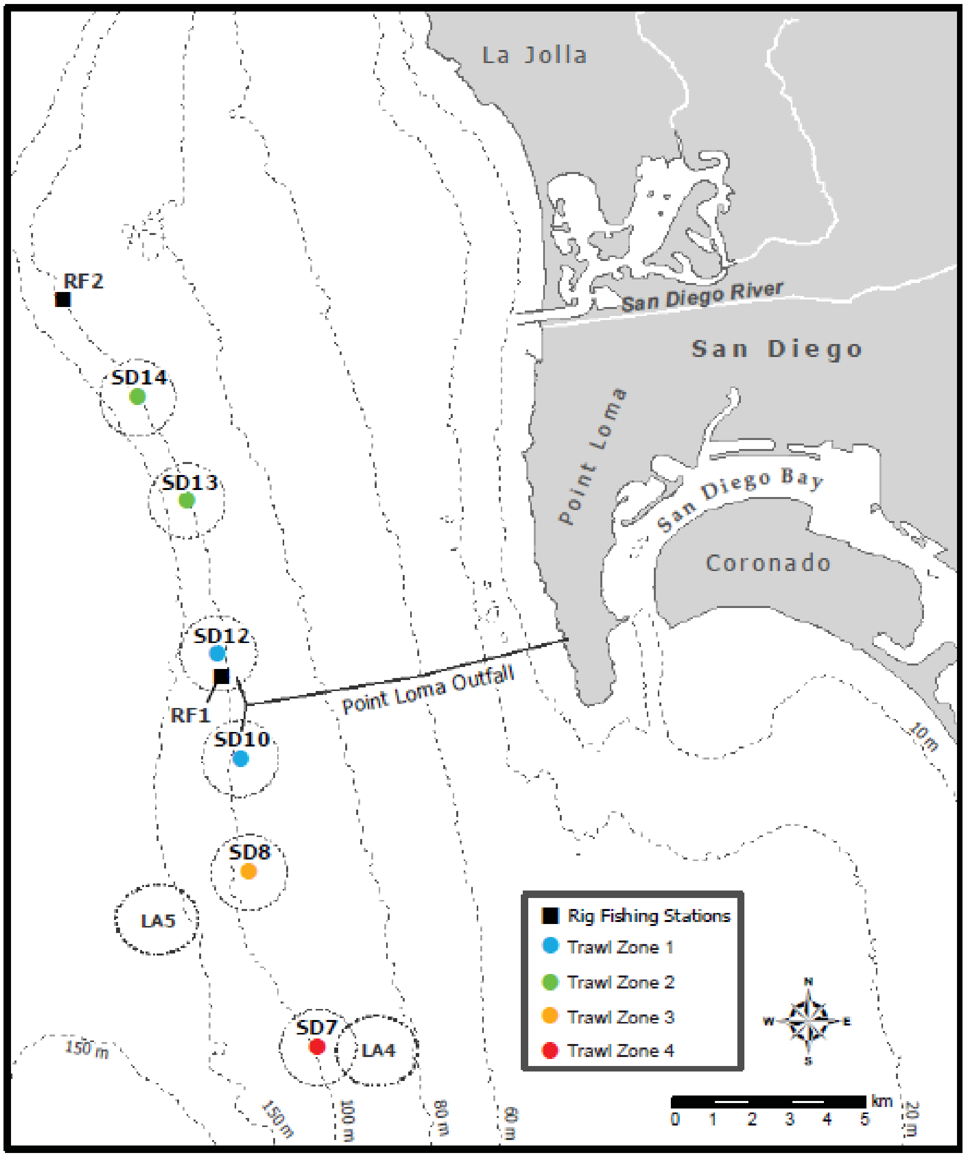
((Newman 2009, Allen et al. 2011, Laws 2013). Demersal (bottom dwelling) fish are useful in biomonitoring programs because of their proximity to bottom sediments, and because most contaminants found in marine organisms are hydrophobic, and accumulate in lipid (fatty) reservoirs of the organism (Schiff and Allen 1997, Allen 2006). The potential impacts of bioaccumulation by marine organisms include comprised immune response and disease resistance, altered behavior, diminished breeding success, developmental abnormalities, population declines via direct mortality, and shifts the composition of communities by affecting top predators and keystone species (Newman 2009, NAVFAC 2013).

The primary goals of the bioaccumulation portion of the City's ocean monitoring program are to: (1) document levels of contaminant loading in local demersal fish, (2) identify whether any contaminant bioaccumulation in fish collected around the PLOO may be due to the outfall discharge, and (3) identify other potential natural and anthropogenic sources of pollutants to the local marine ecosystem. Two types of samples are taken: liver tissues from trawl-caught fish and muscle tissues from fish caught by hook and line (rig fishing). Species collected by trawling are considered representative of the general demersal fish community off San Diego, and specific species are targeted based on their prevalence and ecological significance. The chemical analysis of liver tissues in these trawl-caught fish is important for assessing population effects because this is the organ where contaminants typically bioaccumulate. Species targeted for capture by rig fishing represent fish that are typical of a sport fisher's catch, and are more directly relevant to human health concerns. Muscle samples are analyzed from these fish because this is the tissue most often consumed by humans.

Contaminants in Trawl-Caught Fish

During October 2019, fish were collected from four trawl zones and two rig fishing stations (Figure H-36). Each trawl zone represents an area centered on one or two specific trawl stations. Trawl Zone 1 includes the "nearfield" area within a 1-km radius of stations SD10 and SD12 located just south and north of the PLOO discharge site, respectively. Trawl Zone 2 includes the area within a 1-km radius surrounding northern "farfield" stations SD13 and SD14. Trawl Zone 3 represents the area within a 1-km radius surrounding "farfield" station SD8, which is located south of the outfall near the LA-5 dredged material disposal site. Trawl Zone 4 is the area within a 1-km radius surrounding "farfield" station SD7 located several km south of the outfall near the non-active LA-4 disposal site. Fish collected at the two rig fishing stations were caught within 1 km of the station coordinates using standard rod and reel procedures. Station RF1 is located within 1 km of the outfall and is considered the "nearfield" rig fishing site. In contrast, station RF2 is located about 11 km northwest of the outfall and is considered the "farfield" rig fishing site. The species and sizes collected and details of handling, transport, and laboratory and data analysis are contained in Chapter 8 of the City's Biennial Monitoring Report (City of San Diego 2020).

Figure H-29:
Otter Trawl and Rig Fishing Stations and Zones



Contaminant levels in muscle tissue samples collected in 2019 were compared to the following state, national, and international limits and standards to address seafood safety and public health issues: (1) California OEHHA, which has developed fish contaminant goals for chlordane, DDT, methylmercury, selenium, and PCBs (Klasing and Brodberg 2008); (2) FDS, which has set limits on the amount of mercury, total DDT, and chlordane in seafood to be sold for human consumption (Mearns et al. 1991); (3) international standards for acceptable concentrations of various metals and DDT (Mearns et al. 1991).

A total of 18 trace metals were analyzed in 12 composite fish liver tissue samples. Of these, eight metals were not detected in any sample, 7 were found in all the samples and 3 were found in some of the samples. Table H-34 presents the results of the fish liver tissue trace metal analysis. Most metals occurred at concentrations of less than 5 parts per million (ppm), though higher concentrations up to 32.1 ppm for zinc and 105.0 ppm for iron were recorded. Intra-species comparisons between nearfield and farfield trawl zones reveal no relationship between metal concentrations in terms of proximity to the PLOO discharge site with tissue concentrations of most metals being highly variable across different zones (City of San Diego 2020, Appendix C5).

Table H-34:
Summary of Metals in Liver Tissue, 2019 PLOO Trawls

Species/ Parameter[A]	Concentrations in parts per million (ppm)																	
	Al	**Sb**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Se**	**Ag**	**Tl**	**Sn**	**Zn**
Pacific Sanddab																		
Number Detected	0	0	12	0	0	12	1	4	12	0	12	12	0	11	0	0	12	12
Minimum	nd	nd	4.6	nd	nd	1.64	nd	3.4	45.2	nd	0.7	0.94	nd	nd	nd	nd	1.7	20.8
Maximum	nd	nd	8.5	nd	nd	4.33	0.15	5.6	105	nd	1.4	.280	nd	1.18	nd	nd	2.4	32.1
Mean	nd	nd	6.7	nd	nd	2.56	0.15	4.4	66.0	nd	1.0	.149	nd	.79	nd	nd	2.1	26.8
Number of Samples	12	12	12	12	12	12	12	4	12	12	12	12	12	12	12	12	12	12
Detection Rate (%)	0	0	100	0	0	100	8	100	100	100	100	100	100	92	0	0	100	100

Table H-34:

Notes: "nd' indicates not detected

[A] Summary of metals (ppm) in liver tissues of fishes collected from PLOO trawl zones during 2019 for Pacific Sanddab. Data include the number of samples with detectable concentrations (Number Detected, minimum value, maximum observed value, mean value among detected concentrations, total number of samples and percent of samples where reportable concentrations were detected (Detection Rate %). See City of San Diego (2020) data on individual metals.

Table H-35 presents a summary of detected pesticides, PAHs, and lipids in trawl-caught fish liver tissue at the PLOO trawl zones during 2019. Several chlorinated pesticides were detected in liver tissues during 2019, as were PCBs, PAHs.

Table H-35:
Summary of Pesticides, PCBs, PAHs and Lipids in Fish Liver Tissue, 2019 PLOO Trawls

Species/ Parameter[A]	Concentrations in parts per billion (ppb)									
	tChlor	tDDT	Dieldrin	B-Endo	HCB	tHCH	Mirex	tPCB	tPAH	Lipids
Pacific Sanddab										
Number Detected	12	12	5	1	10	12	7	12	8	12
Minimum	5.8	259.2	nd	nd	8.1	1.67	nd	143.2	nd	40.0
Maximum	13.1	531.9	3.2	4.7	12.3	15.49	1.1	3193.5	80.0	54.7
Mean	9.2	345.3	2.8	4.7	9.9	4.67	0.8	502.3	58.0	46.3
Number of Samples	12	12	12	12	10	12	12	4	12	12
Detection Rate (%)	100	100	42	8	100	100	58	100	66.7	100

Table H-35: Notes:

"nd' indicates not detected

[A] Summary of pesticides (ppb), total PCB (ppb), total PAH (ppb), and lipids (% weight) in liver tissues of fishes collected from PLOO trawl zones during 2019. Data include the number of detectable concentrations (Number Detected), minimum value, maximum observed value, mean value among detected concentrations, total number of samples and percent of samples where reportable concentrations were detected (Detection Rate %). See City of San Diego (2020) for values of individual constituents summed for total chlordane (tChlor), tDDT, tHCH, tPCB, and tPAH.

Based on reportable results a totalof seven chlorinated pesticides were detected in fishliver tissue samples from the PLOO trawl zones in 2019 (Table H-24). Total DDT was detected in all samples at concentrations ≤ 531.9 ppb. Total chlordane was detected in all of the samples at concentrations ≤ 13.1 ppb. Total HCH was detected in all of the PLOO samples and at concentrations ≤ 15.5 ppb. Hexachlorobenzene (HCB) was detected in all of the PLOO samples at concentrations ≤ 12.3 ppb. Mirex was detected in 58% of the PLOO samples at concentrations ≤ 1.1 ppb, while dieldrin was detected in 42% of these samples at concentrations ≤ 3.2 ppb, and beta-endosulfan was detected in 8% of these samples at a concentration of 4.7 ppb. The pesticides (or pesticide constituents) aldrin, alpha-endosulfan, endos ulfan sulfate, endrin, and endrin aldehyde were not detected in any liver samples. As with metals, intra-species comparisons of frequently occurring pesticides at the nearfield and farfield trawl zones did not illustrate any clear relationships with proximity to the PLOO outfall discharge location, with pesticide concentrations being highly variable across all zones (City of San Diego 2020, Appendix C).

Only DDT, HCB, and chlordane have been frequently detected in liver tissues from trawl-zone fishes off San Diego since 1995. Historical detection rates were 99–100% per species (or species group) for DDT, 50–71% for HCB, and 7–66% for total chlordane over these past 25 years. In contrast, long-term detection rates were 3–13% for total HCH, ≤ 7% for mirex and ≤ 2% for aldrin, dieldrin, alpha-endosulfan, beta-endosulfan, endosulfan sulfate, and endrin. Endrin aldehyde has never been detected in any liver tissue samples from the PLOO trawl zones. As with metals, pesticide concentrations have been highly variable over time, with most being detected at levels within ranges reported elsewhere in the Southern California Bight. While relatively high values of various pesticides have been occasionally recorded in liver tissues from nearfield zones, when compared to farfield zones, there were no discernable intra-species patterns that could be associated with proximity to the PLOO outfall (City of San Diego 2020, Appendix C).

Based on reportable results PCBs were detected in all fish liver tissue samples from PLOO trawl zones in 2019, at concentrations ≤ 3193.5 ppb. (Table H-24). Intra-species comparisons between nearfield and farfield trawl zones revealed no clear patterns or relationship in terms of proximity the PLOO discharge site, with tissue concentrations of total PCB varying widely across the different zones. Historically, PCBs have been detected in 89–100% of the liver tissue samples from Sanddabs, Scorpionfish, and Hornyhead Turbot analyzed since 1995, with total PCB concentrations generally within ranges reported elsewhere in the Southern California Bight (City of San Diego 2020, Appendix C). There were no discernable intra-species patterns that could be associated with proximity to the PLOO from the 2019 sampling or over the past 25 years of sampling (City of San Diego 2020, Appendix C). A study by Parnell, et al. in 2008 discriminated sources of PCB contamination in fish on the coastal shelf off San Diego and found the LA-5 dredge disposal site as a likely source, but not the PLOO outfall discharge (Parnell et al 2008).

Based on reportable results PAHs were detected in 67% of PLOO liver tissue samples, at concentrations ≤ 80.0 ppb (Table H-24). Intra-species comparisons between nearfield and farfield trawl zones revealed no clear patterns or relationship in terms of proximity to the PLOO discharge site, with tissue concentrations of total PAH varying widely across the different zones City of San Diego 2020, Appendix C). Historically, PAHs have been detected in ≤ 14% of the liver tissue samples from Sanddabs, Scorpionfish, and Hornyhead Turbot analyzed off the San Diego coast since 1995, with total PAH concentrations generally within ranges reported elsewhere in the Southern California Bight. There were no discernable intra-species patterns that could be associated with proximity to the PLOO outfall during the years that PAH was analyzed (City of San Diego 2020, Appendix C).

Because hydrophobic compounds, including organochlorines like chlorinated pesticides and PCBs, demonstrate high affinity for lipids, differences in the lipid content of tissues between species may be the primary reason for differential organochlorine accumulation (see Groce 2002 and references therein). During 2019, lipid levels in liver tissues of Pacific Sanddabs collected from the PLOO region ranged from 40% to 55% weight. Historically, liver lipid levels ranged from 6% to 70% weight in Longfin and Pacific Sanddabs (also Mixed Sanddabs). The high variability in liver lipid levels likely explains much of the differences within and among species in pesticide and PCB concentrations during the 2019 reporting period as well as over the past 25 years (Groce 2002, City of San Diego 2020, Appendix C).

Contaminants in Fish Collected by Rig Fishing in 2019

Table H-36 summarizes metals detected in fish muscle tissue during 2019 in PLOO rig fishing zones. As shown in Table H-36, ten of the 18 trace metals analyzed were detected in all fish muscle tissue samples from PLOO rig fishing zones during 2019, including: arsenic, beryllium, cadmium, chromium, iron, mercury, nickel, selenium, tin, and zinc. Detection rates for relatively common metals were 83% for copper and 50% for nickel. Beryllium was found in 33% of the muscle tissue samples. Aluminum, antimony, barium, lead, manganese,silver, and thallium were not detected in any of the samples during 2019. Overall, metal concentrations were highly variablethroughout the PLOO outfall region, possibly reflecting differences in weight, length, and/or life history of the different species of fish analyzed (Groce 2002). Of the 12 rockfish muscle tissue samples collected from PLOO rig fishing zones in 2019, 100% exceeded the median international standard for arsenic and selenium. However, all samples were below OEHHA limits and the FDA action limits (Appendix C5).

Table H-36:
Summary of Metals in Fish Muscle Tissue, 2019 PLOO Rig Fishing Zones

Species/ Parameter[A]	Concentration in parts per million (ppm)																	
	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Ag	Tl	Sn	Zn
Vermilion Rockfish																		
Number Detected	0	0	3	0	1	3	3	4	3	0	0	3	1	3	0	0	3	3
Minimum	-	-	4.07	-	nd	.049	.043	3.4	2.30	-	-	.052	nd	.412	-	-	.74	3.89
Maximum	-	-	6.27	-	.002	.072	.082	5.6	3.44	-	-	.071	.050	.439	-	-	.85	4.06
Mean	-	-	5.10	-	.002	.060	.062	4.4	3.04	-	-	.064	.050	.425	-	-	.81	3.98
Greenstriped Rockfish																		
Number Detected	0	0	1	0	1	1	1		1	0	0	1	1	1	0	0	1	1
Value	-	-	4.31	-	.001	.053	.056		3.12	-	-	.184	.028	.451	-	-	.88	3.18
Mixed Rockfish																		
Number Detected	0	0	1	0	1	1	1		1	0	0	1	0	1	0	0	1	1
Value	-	-	2.23	-	-	.030	.068		257	-	-	.094	-	.379	-	-	136	3.83
Starry Rockfish																		
Number Detected	0	0	1	0	0	1	1		1	0	0	1	1	1	0	0	1	1
Value	-	-	1.60	-	-	.020	.114		1.67	-	-	.125	.035	.331	-	-	.82	3.00
Total No. of samples	6	6	6	6	6	6	6	4	6	6	6	6	6	6	6	6	6	6
Detection Rate (%)	0	0	100	0	33	100	100	100	100	0	0	100	50	100	0	0	100	100

Maximum	-	-	6.27	-	.002	.072	.114	5.6	257	-	-	.184	.050	.451	-	-	1.36	4.06
OEHHA[B]	na	na	na	na	na	na	na	na	Na	na	na	0.22	na	7.4	na	na	na	na
FDA[C] Action Limit	na	na	na	na	na	na	na	na	Na	na	na	1	na	na	na	na	na	na
Median IS[D]	na	na	1.4	na	na	1.0	1.0	2.0	Na	2	na	0.50	na	0.3	na	na	175	70

Table H-36 Notes:

“na” indicates that no standards or action limit is established for the listed parameter.

A Summary of metals (ppm) in fish muscle tissue in fishes collected from PLOO trawl zones during 2019 for the listed species. Data include the number of samples with detectable concentrations (Number Detected), minimum value, maximum observed value, mean value among detected concentrations, total number of samples and percent of samples where reportable concentrations were detected (Detection Rate %). See City of San Diego (2020) data on individual metals.

B From California Environmental Protection Agency Office of Environmental Health Hazard Assessment.

C Mearns at al 1991. FDA action limits for mercury and all international standards are for shellfish; but are often applied to fish.

D Is indicates International Standard.

Metal concentrations in muscle tissues of San Diego fishes have been highly variable. Cadmium, copper, lead, tin, and zinc were never found at concentrations above their median international standards. The OEHHA fish contaminant goal for selenium was never exceeded. Since 1995, only 17% of the samples exceeded the OEHHA goal for mercury, and only one sample (0.35%) exceeded the FDA action limit for mercury. While relatively high values of various metals have been occasionally recorded in muscle tissues from fishes collected off San Diego, there were no discernable patterns at the rig fishing zones, which could be associated with proximity to the PLOO discharge site (City of San Diego 2020, Appendix C5).

Table H-37 summarizes chlorinated pesticides, PCBs, PAHs and lipids detected in fish muscle tissue during 2019 in PLOO rig fishing zones. Five chlorinated pesticides were detected in fish muscle tissue samples from PLOO rig fishing zones in 2019. Total DDT was detected in 100% of the samples at concentrations ≤ 34.89 ppb. Total chlordane was detected in 50% of the PLOO samples at concentrations ≤ 0.32 ppb. Total HCH was detected in 33% of the samples and 17% at concentrations ≤ 0.09 ppb. HCB was detected in 100% of the samples at concentrations ≤ 4.79 ppb, while dieldrin was detected in 17% of these samples at concentrations ≤ 0.12 ppb. Additionally, the pesticides (or pesticide constituents) aldrin, alpha-endosulfan, beta-endosulfan, endosulfan sulfate, endrin, endrin aldehyde, and mirex were not detected in any muscle samples. Concentrations of DDT, chlordane, HCB, and HCH in muscle tissue samples were variable, substantially lower than in liver tissues, generally below available thresholds, and demonstrated no discernable patterns with proximity to the PLOO outfall. Values of individual constituents summed for total chlordane and total DDT are available in Appendix C5 or at City of San Diego 2020.

Based on reportable results, PCBs were detected in all muscle tissue samples from PLOO rig fishing zones in 2019, at concentrations ≤ 10.98 ppb. One had PCB levels in exceedance of the OEHHA threshold of 3.6 ppb. This elevate value occurred at RF1. Historically, PCB detection rates were 74–77% per species (or species group) in muscle tissue samples, with highly variable concentrations falling within ranges reported elsewhere in the Southern California Bight (e.g., Allen et al. 2002, Mearns et al. 1991, LACSD 2016, OCSD 2018) and with no discernable patterns that could be associated with proximity to the PLOO discharge (City of San Diego 2020, Appendix C5). Of the 286 muscle tissues samples analyzed for PCBs over the past 25 years off the San Diego coastline, only 23% exceeded the OEHHA fish contaminant goal for total PCB. Values of individual PCB congeners determined is available in Appendix C5 or at City of San Diego (2020).

Based on reportable results PAHs were detected in 17% of the muscle tissue samples from the PLOO rig fishing zones in 2019, at concentrations ≤ 61.4 ppb. The PAH value was recorded in a single sample from RF1. PAH detection rates were 0–7% per species (or species group) in muscle tissue samples, with highly variable concentrations falling within ranges reported elsewhere in the Southern California Bight (e.g., Allen et al. 2002, Mearns et al. 1991, LACSD 2016, OCSD 2018) and with no discernable patterns that could be associated with proximity to the PLOO outfall (City of San Diego 2020, Appendix C5) Values of individual PAHs determined is available in Appendix C5 or at City of San Diego (2020).

Table H-37: Summary of Pesticides, PCBs, PAHs and Lipids in Fish Muscle Tissue, 2019 PLOO Rig Fishing Zones

Species/Parameter[A]	Concentration in parts per billion (ppb)							Lipids (% Weight)
	tChlor	tDDT	Dieldrin	HCB	tHCH	tPCB	tPAH	
Vermilion Rockfish								
Number Detected	3	3	1	1	1	3	1	3
Minimum Value	nd	5.6	nd	nd	nd	3.0	nd	0.4
Maximum Value	0.3	11.9	0.1	4.8	.07	6.6	61.4	1.0
Mean of Detected Values	0.1	7.9	0.1	4.8	.07	4.8	61.4	0.6
Greenstriped Rockfish								
Number Detected	0	1	0	1	0	1	0	1
Value	-	3.1	-	1.3	-	1.7	-	0.3
Mixed Rockfish								
Number Detected	0	1	0	0	0	1	0	1
Value	-	6.1	-	-	-	2.3	-	0.4
Starry Rockfish								
Number Detected	0	1	0	0	1	1	0	1
Value	-	5.5	-	-	.04	2.1	-	0.3
Total samples	6	6	6	2	6	6	6	6
Detection Rate (%)	50	100	17	100	33	100	17	100
Maximum Value	0.3	11.9	0.1	4.8	0.07	6.6	61.4	1.0
OEHHA[B]	5.6	21	na	na	na	3.6	na	-
FDA[C] Action Limit	na	5000	na	300	na	na	na	-
Median IS[D]	100	5000	na	100	na	na	na	-

Table H-37 Notes:

"nd' indicates not detected

A Summary of pesticides (ppb), total PCB (ppb), total PAH (ppb), and lipids (% weight) in muscle tissues of fishes collected from PLOO rig fishing zones during 2019 for the listed species. Data include the number of detectable concentrations (Number Detected), minimum value, maximum observed value, mean value among detected concentrations, total number of samples and percent of samples where reportable concentrations were detected (Detection Rate %). See City of San Diego (2020) for values of individual constituents summed for total chlordane (tChlor), tDDT, tHCH, tPCB, and tPAH.

B From California Environmental Protection Agency Office of Environmental Health Hazard Assessment.

C Mearns at al 1991. FDA action limits for mercury and all international standards are for shellfish; but are often applied to fish.

D IS indicates International Standard.

During 2019, lipid levels in fish muscle tissue samples from PLOO rig fishing zones were generally much lower than levels found in liver tissues, a pattern that is similar to historical results observed since 1995 (City of San Diego 2020). Muscle lipid content was < 1% weight for the current reporting period and ≤ 4.4% weightover the past 25 years for all species (or species groups). These low lipid concentrations indicate that these species do not store fat in their muscle tissues (Groce 2002), which likely explainssome of the generally lower levels of contaminants found in these tissues.

Discussion

Several trace metals, pesticides, PCBs, and PAHs were detected in liver tissues from various fish species collected in the Point Loma monitoring regions in 2019. Many of the same metals, pesticides, PCBs, and PAHs were detected during this reporting period, as have been documented historically in California Scorpionfish and rockfish muscle tissues, albeit generally less frequently and/or in lower concentrations. Although tissue contaminant concentrations varied among different species of fish and across stations, most values were within ranges reported previously for southern California fishes (e.g., Mearns et al. 1991, Allen et al. 1998, 2002, CLA 2015, LACSD 2016, OCSD 2018). Over the past year, arsenic and selenium were found to exceed their median international standards for human consumption in ≥ 83% of the muscle tissue samples from sport fish collected in the PLOO region. In contrast, all muscle tissue samples had concentrations of mercury, total chlordane, and total DDT below FDA action limits.

The frequent occurrence of different trace metals and chlorinated hydrocarbons in the tissues of fish collected from the PLOO region is likely influenced by multiple factors. For example, many metals occur naturally in the environment, although little information is available on background levels in fish tissues. Brown et al (1986) determined that there may be no area in the Southern California Bight sufficiently free of chemical contaminants to be considered a reference site, while Mearns et al. (1991) described the distribution of several contaminants, such as arsenic, mercury, DDT, and PCBs as being ubiquitous. The wide-spread distribution of contaminants in Southern California Bight fishes has been supported by more recent work regarding PCBs and DDT (e.g., Allen et al. 1998, 2002).

Other factors that affect contaminant loading in fish tissues include the physiology and life history of different species (Groce 2002 and references therein). Exposure to contaminants can also vary greatly between different species and among individuals of the same species depending on migration pathways (Otway 1991). Fishes may be exposed to contaminants in a highly polluted area and then move into areas free of contamination. For example, California Scorpionfish tagged in Santa Monica Bay have been recaptured as far south as the Coronado Islands (Hartmann 1987, Love et al. 1987). This is of particular concern for fishes collected in the vicinity of the PLOO, as there are many point and non-point sources that may contribute to local contamination in the region, including the San Diego River, San Diego Bay, Tijuana River, and offshore dredged material disposal sites (see Chapters 2–4 and Parnell et al. 2008). However, assessments of contaminant loading in San Diego offshore sediments have revealed no evidence to indicate that the PLOO is a major source of pollutants in the region (Parnell et al. 2008, City of San Diego 2020).

Overall, there was no evidence of contaminant accumulation in PLOO fishes that could be associated with wastewater discharge from the PLOO. This is consistent with historical findings. Concentrations of most contaminants were generally similar across trawl or rig fishing zones, and no relationships with the PLOO was evident. These results are consistent with findings of other assessments of bioaccumulation in fishes off San Diego (City of San Diego 2020, Parnell et al. 2008, Appendix C5). Finally, there were no other indications of poor fish health in the region, such as the presence of fin rot or other indicators of disease (City of San Diego 2020, Appendix C5).

Summary

Overall, there was no evidence of contaminant bioaccumulation in PLOO fishes that could be associated with wastewater discharge from the outfall. Concentrations of most contaminants were generally similar across zones or stations, and no relationship associated with the PLOO was evident. These results are consistent with findings of other assessments of bioaccumulation in fish off San Diego (Parnell et al. 2008, Appendix C5 – Bioaccumulation Assessment). Finally, there were no other indications of poor fish health in the region, such as the presence of fin rot or other indicators of disease.

The state of California OEHHA, Fish and Water Quality Evaluation Unit (OEHHA 2014 a,b) and the California Department of Public Health (CDPH 2014) provide information on fish contaminants, publish tissue limits for contaminants, and issue fish consumption advisories. OEHHA is the responsible agency for evaluating chemical contaminant human health risk of California marine fish consumed by anglers. Neither OEHHA nor the California Department of Public Health have issued any restrictions on fish consumption or advisories specific to the ocean waters in San Diego County.

H.7 RESTRICTIONS

There are no federal, state, or, local restrictions on recreational activities or other Beneficial Uses in the vicinity of the Point Loma discharge.

H.8 ENDANGERED SPECIES

H.8.1 Regulatory Framework

Endangered Species Act

The ESA of 1973 (16 U.S.C. §§ 1531 et seq.) establishes protection over and conservation of endangered species and the ecosystems on which they depend (USFWS 2014a,b). An endangered species is a species that is in danger of extinction throughout all or a significant portion of its range. The ESA establishes procedures for nominating species for protection and prohibits actions that would jeopardize their continued existence. All federal agencies are required to implement protection programs for endangered species and to use their authority to further the purposes of the ESA.

Marine Mammal Protection Act

The MMPA of 1972 (16 U.S.C. §§ 1361 et seq.) creates the authority to protect marine mammals in waters or on lands under U. S. jurisdiction (NMFS 2014a). It defines federal responsibility for conserving marine mammals (whales, dolphins, porpoises, seals, sea lions, and sea otters). The MMPA prohibits harassing, capturing, disturbing, or, killing marine mammals except under special permit. It creates a Marine Mammal Commission, Regional offices, and Fisheries Science Centers to implement research and protection.

California Endangered Species Act

The California Endangered Species Act (CESA) of 1970, re-amended in 1984, is part of the California Fish and Game Code and is administered by the CDFW (CDFW 2021b). It establishes measures to conserve, protect, restore, and enhance endangered species and their habitats. Certain species that are not recognized as endangered under the federal ESA may be listed as endangered under the CESA. The provisions included in the CESA generally parallel those in the federal ESA, but also apply to species petitioned for listing (i.e., state candidates).

H.8.2 Endangered Species

Twenty-eight endangered species covered under the federal ESA, the federal MMPA, and/or the CESA may occur in the vicinity of Point Loma (Table H-38). Listed species include eight marine mammals, seven birds, five sea turtles, six fish, and two invertebrates. Their population biology, status, distribution, and potential environmental effects of the PLOO on endangered species are discussed in the following paragraphs.

Table H-38:
Endangered and Threatened Species That May Occur in the Vicinity of Point Loma

Marine Mammals	**Species**	**Listing Status**
Blue Whale	Balaenoptera musculus	Endangered
Fin Whale	Balaenoptera physalus	Endangered
Humpback Whale	Meaptera novaeangliae	Endangered
Northern Right Whale	Eubalaena japonica	Endangered
Sei Whale	Balaenoptera borealis	Endangered
Sperm Whale	Physeter macrocephalus	Endangered
Western North Pacific GrayWhale	Eschrichtius robustus	Endangered
Guadalupe Fur Seal	Arctocephalus townsendi	Threatened
Fish	Species	Listing Status
Ocean Whitetip Shark	Carcharhinus longimanus	Threatened
Giant Manta Ray	Manta birostris	Threatened
Chinook Salmon	Oncorhynchus tshawytscha	Threatened
Steelhead Trout	Oncorhynchus mykiss	Endangered
Green Sturgeon	Acipenser medirostris	Threatened
Scalloped Hammerhead Shark	Sphyrna lewini	Endangered
Turtles	Species	Listing Status
Green Sea Turtle	Celonia mydas	Endangered
Loggerhead Sea Turtle	Caretta caretta	Endangered
Leatherback Sea Turtle	Dermochelys coriacea	Endangered
Olive Ridley Sea Turtle	Lepidochelys olivacea	Endangered
Hawksbill Sea Turtle	Eretmochelys imbricata	Endangered
Mollusks	Species	Listing Status
Black Abalone	Haliotis cracherodii	Endangered
White Abalone	Haliotis sorenseni	Endangered

Birds	Species	Listing Status
California Least tern	Sterna antillarum browni	Endangered
Light-footed Clapper Rail	Rallus longirostris levipes	Endangered
Western Snowy Plover	Charadrius alexandrines nivosus	Threatened
Guadalupe Murrelet	Synthliboramphus hypoleucus	Threatened
Marbled Murrelet	Brachyramphus marmaoratus	Threatened
Scripp's Murrelet	Synthlibramphus scrippsi	Threatened
Short-tailed Albatross	Phoebastria albatross	Endangered

References: California Department of Fish and Wildlife (CDFW 2021c); National Marine Fisheries Service (NOAA 2021c); U.S. Fish and Wildlife Service (USFWS 2021c)

Whales

Marine mammals are warm-blooded, have fur or hair, breathe air through lungs, bear live young, and nurse them with milk. They have streamlined bodies and most have an insulating layer of blubber. Two types of marine mammals pass through or inhabit San Diego coastal waters; cetaceans and pinnipeds. Whales are members of the first group that also includes dolphins and porpoises (NMFS 2021b, Perrin et al. 2008). Cetaceans are entirely aquatic, have two front flippers, and tails with horizontal extensions that provide swimming power. The great whales, like blue, gray, and humpback whales, have rows of closely spaced baleen plates that filter out and trap plankton and small fish. Sperm whales, dolphins, and porpoises have teeth for grasping prey.

The second group of marine mammals, pinnipeds (sea lions and seals), regularly haul out on land to rest, breed, and give birth (NMFS 2021d). Sea lions have visible external ears and can walk on all four flippers by rotating their rear flippers forward under their body. Their swimming power comes from large front flippers. Seals have no external ears and can only crawl on land because their front flippers are small and their hind flippers cannot rotate forward. Seals swimming power comes from their large, fan-like rear flippers.

Of the species of great whales that may pass by Point Loma, seven are endangered: the blue whale, the fin whale, the humpback whale, the right whale, the sei whale, the sperm whale and a very occasional visitor may include the western North Pacific Gray whale (Table H-26). The other great whales, the eastern Northern Pacific gray whale and the minke whale, were previously endangered but have now recovered. There are no endangered dolphins or porpoises in the San Diego area.

Gray whales are found mainly in shallow coastal waters in the North Pacific Ocean, although during migration, they do sometimes cross deep waters far from shore. There are two geographic distributions of gray whales in the North Pacific. The eastern North Pacific stock found along the west coast of North America and the western North Pacific stock primarily found along the coast of eastern Asia.

Although western and eastern stocks of gray whales were thought to be relatively isolated from each other, recent satellite tagging data and photo-identification and genetic matches have shown that some western North Pacific gray whales may migrate across the northern Gulf of

Alaska to join the eastern stock along the west coast of British Columbia, the United States, and Mexico.

Eastern North Pacific gray whales spend the summer feeding in the northern Bering and Chukchi seas, but some feed along the Pacific coast during the summer, in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and northern California. Each year in the fall, the gray whales migrate from their summer feeding grounds, heading south along the coast of North America to spend the winter in their wintering and calving areas off the coast of Baja California, Mexico, to return north from mid-February to June. This is the longest migration of any mammal traveling 9,000 – 12,000 round trip miles each year. During the return trip they pass closer to shore and can readily be observed from Point Loma.

The gray whale, Eschrichtius robustus, is the most common whale observed along the San Diego coast and the most easily seen from shore (Jefferson et al. 2011). These large whales can grow to about 50 feet (15 m) long and weigh approximately 80,000 lb (35,000 kg). Gray whales are found only in the north Pacific Ocean – an Atlantic form is extinct (Jones and Swartz 2009).

Hunted practically to extinction, the gray whale has staged a remarkable comeback since it was listed as endangered throughout its range under the ESA (ESA) in 1973. Today, gray whales are protected under the MMPA. The eastern North Pacific stock was once listed as endangered under the ESA but was delisted in 1994 based on evidence that the population had nearly recovered to its estimated original population size and was not in danger of extinction throughout all or a significant portion of its range. Its current population estimate is approximately 20,000 individuals (Carretta et al 2014). In 1999, NOAA Fisheries conducted a review of the status of the eastern North Pacific stock of gray whales and recommended the continuation of its classification as non-threatened based on the continued growth of the population. NOAA continues to monitor the abundance and calf production of the stock, especially in light of recent climatic changes occurring in their arctic feeding grounds.

However, the western North Pacific stock of gray whales has not recovered. It is listed as endangered under the ESA and depleted under the MMPA.

Gray whales usually feed in shallow waters less than 200 feet (60 m) deep (Perrin et al. 2008). They are primarily bottom feeders whose prey includes a wide range of invertebrates living on or near the seafloor. The whales filter amphipods and other crustaceans with their baleen plates. Although generally fasting during the migration and calving season, opportunistic feeding occurs in the shallow coastal waters along the migration path and in the calving lagoons. The gray whale is preyed on by killer whales. Many exhibit attack scars indicating not all attacks are fatal, however fatalities are known (Jones and Swartz 2009).

Gray whales are susceptible to entanglement in fishing gear and ship strikes. No gray whales were observed entangled in California gillnet fisheries between 2007 and 2011 (Carretta and Enriquez 2012), but previous mortality in the swordfish drift gillnet fishery has been observed and there have been recent sightings of free-swimming gray whales entangled in gillnets (Carretta et al. 2014). Although acoustic pingers are known to reduce the entanglement of cetaceans in the California drift gillnet swordfish fishery (Carretta and Barlow 2011), it is unknown whether pingers have any effect on gray whale entanglement. Most data on human-caused mortality and serious injury of gray whales is from strandings. There are few at-sea reports of entangled animals alive or dead. Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2012), who estimated that only 3.9% to 13.0% of gray whales that die in a given year end up stranding and being reported.

For 2007-2011, as reported by NMFS (Carretta et al. 2013), the total mortality of eastern north Pacific gray whales attributed to ship strikes was six deaths. Additional mortality from ship strikes probably goes unreported because the whales either do not strand or have no evident signs of trauma when observed at sea.

As with other great whales that may occur in the Point Loma region, the NMFS has not designated any critical habitat for gray whales (NMFS 2013a).

Minke whales, Balaenoptera acutorostrata, the smallest of the baleen whales, can occur year-round off California (Carretta et al. 2014). These sleek, baleen whales feed on krill and schooling fish such as herring, pollock, and cod (Jefferson et al. 2011). Minke whales are lunge feeders, often plunging through patches of krill or shoaling fish. They frequent shallower water more often than any other whales except gray whales. Minke whales are prey for killer whales. Increasing levels of anthropogenic sound in the world's oceans is considered a habitat concern for whales, particularly for baleen whales that communicate using low-frequency sound (McDonald et al. 2008, Hildebrand 2009, Rolland et al. 2012).

As with other whales, entanglement in commercial gillnets and ship strikes pose a threat to minke whales. Minke whales may occasionally be caught in coastal set gillnets off California and in offshore drift gillnets off California and Oregon (Carretta et al. 2014).

Ship strikes were implicated in the death of one minke whale in 1977, but the reported minke whale mortality due to ship strikes was zero for the period 2004-2008 (Carretta et al. 2014).

Although rare in California (estimated population in the low to mid hundreds (Carretta et al. 2014)), minke whales are relatively abundant elsewhere and are not listed as endangered under the ESA. Like the gray whale, minke whales are protected under the MMPA but are not considered depleted.

The other whales that periodically traverse the area off Point Loma are deeper water species. The most spectacular of these is the blue whale, Balaenoptera musculus. Blue whales, the largest animal that has ever lived, can reach over 100 feet (30 m) in length and weigh as much as 330,000 lbs (150,000 kilograms (kg)) (Perrin et al. 2008). Preying almost exclusively on zooplankton, especially krill, they lunge feed and consume approximately 12,000 lb (5,500 kg) of krill per day.

The blue whale inhabits all oceans and typically occurs near the coast over the continental shelf, though it is also found in oceanic waters (Sears and Perrin 2008). The U. S. west coast is a feeding area for blue whales during summer and fall (Carretta et al. 2014). They are regularly observed in the Southern California Bight most often along the 200-m (656-foot) isobath.

Blue whales have been documented to be preyed on by killer whales (Jefferson et al. 2011). While there is little evidence that killer whales attack this species in the north Atlantic or southern hemisphere, 25% of photo-identified whales in the Gulf of California show rake scars from killer whale attacks (Sears and Perrin 2008).

Blue whales are susceptible to ship strikes and entanglement in fishing gear (Redfern et al. 2013). Between 1988 and 2007, 21 blue whale deaths were reported along the California coast and eight of these whales were confirmed to have died as a result of ship strikes (Berman-Kowalewski et al. 2010). The offshore drift gillnet fishery is the only fishery that is likely to entangle blue whales off southern California, although no fishery mortality or serious injuries have been observed (Carretta et al. 2013). The drift gillnet fisheries for swordfish and sharks along the Pacific coast of Baja California, Mexico may take animals from this population as well. Some gillnet mortality of large whales goes unobserved because whales swim away with a portion of the net; however, fishermen report blue and fin whales usually swim through nets without entangling and with little damage to the nets (Carretta et al. 2014).

Tagged blue whales exposed to simulated mid-frequency military sonar sounds showed significant behavioral responses, including cessation of feeding, increased swimming speeds, and movement away from the simulated sound sources, even though the simulated source levels were orders of magnitude lower than some operational military sonar systems (Goldbogen et al. 2013). This study suggests that sonar sources could disrupt feeding and displace whales from high-quality feeding areas, with negative implications for individual fitness and population health.

The current best available abundance estimate for the Eastern North Pacific stock of blue whales that occur off California, Oregon, and Washington is 1,647 (Carretta et al. 2014.)

As a result of commercial whaling, blue whales were listed as endangered under the Endangered Species Conservation Act of 1969. This protection was transferred to the ESA in 1973. They are still listed as endangered and consequently the Eastern North Pacific stock is automatically considered as depleted under the MMPA.

Fin whales, Balaenoptera physalus, like blue whales, occur mainly in offshore waters (Jefferson et al. 2011). They do, however, venture closer to shore after periodic upwelling that leads to increased krill density. Recent observations show aggregations of this, second largest of the baleen whales, year-round off southern California (Carretta et al. 2014). Fin whales feed on krill, small schooling fishes, squid, and copepods. They are not known to have a significant number of predators, but in areas where killer whales are abundant, some fin whales exhibit attack scars on their flippers, flukes, and flanks.

The organochlorines DDE, DDT, and PCBs have been identified in fin whale blubber, but at lower concentrations than in toothed whales that feed at higher levels in the food chain (Marsili and Focardi 1996). Female fin whales contain lower burdens than males, likely due to mobilization and export of contaminants during pregnancy and lactation (Gauthier et al. 1997).

Fin whales are susceptible to ship strikes and entanglement in fishing gear (Carretta et al. 2014). Ship strikes were implicated in the deaths of seven fin whales during 2007-2011 (Carretta et al. 2013). During 2007-2011, there were an additional four injuries of unidentified large whales attributed to ship strikes. Documented ship strike deaths and serious injuries are derived from actual counts of whale carcasses and are considered minimum values (Carretta et al. 2013).

As with blue whales, the offshore drift gillnet fishery is the only fishery that is likely to pose a threat of entanglement for fin whales. One fin whale death has been observed in over 8,000 sets since 1990 when NMFS began observing the fishery (Carretta et al. 2014).

Moore and Barlow (2011) present evidence of increasing fin whale abundance in the California Current region. They predict continued increases in fin whale numbers over the next decade that may result in fin whale densities reaching "current ecosystem limits." The best available abundance estimate of fin whales in California, Oregon, and Washington waters is 3,051 (Carretta et al. 2014).

Historical whaling drastically reduced fin whale and other whale stocks. Populations began to recover with implementation of the International Whaling Commission, ESA, and the MMPA. Fin whales are listed as endangered under the ESA, and as depleted under the MMPA.

Humpback whales, Meaptera novaeangliae, are distinguished by their long pectoral fins (flippers) and complex, repetitive vocalizations (Jefferson et al. 2011). The migratory population of humpbacks present in California offshore waters during summer and fall ranges from Costa Rica to southern British Columbia (Carretta et al. 2014). Humpback whales feed on schools of fish and krill and reach a length of 60 feet (18 m). In the southern California feeding grounds, humpback whales feed on a wide variety of invertebrates and small schooling fish. Feeding occurs both at the surface and in deeper waters, wherever prey is abundant. Humpback whales are the only species of baleen whale that cooperate when feeding in large groups (Perrin et al. 2008).

This species is known to be attacked by both killer whales and false killer whales as evidenced by toothrake scars on their bodies and fins (Jefferson et al. 2011). Humpback whales observed on the feeding grounds off Washington and California have the highest rate of rake marks of any of their observed feeding grounds.

Entanglement in fishing gear poses a threat to humpback whales throughout the Pacific Ocean. Pot and trap fisheries are the most commonly documented source of mortality and serious injury of humpback whales in U. S. west coast waters (Carretta et al. 2013). Between 2007 and 2011, there were 16 documented humpback whale interactions with pot/trap fisheries. Gillnet and unidentified fisheries accounted for 1 death and 9 serious injuries of humpback whales between 2007 and 2011 (Carretta et al. 2014). An additional number of whales are likely entangled in fishing gear from Mexican fisheries, though quantitative data are not presently available for most of these fisheries.

Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes. Younger whales spend more time at the surface, are less visible, and are found closer to shore, making them more susceptible to collisions (USDON 2013). Eight humpback whales were reported struck by vessels with four resulting deaths between 2007 and 2011 (Carretta et al. 2013). The recorded number of serious injuries and mortality from ship strikes is a fraction of the total because additional mortality from ship strikes goes unreported.

Organochlorines, including PCBs and DDE, have been identified from humpback whale blubber (Gauthier et al. 1997). As with blue whales, these contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to that of their mothers (Elfes et al. 2010). Humpback whales feed higher on the food chain, consuming prey carrying higher contaminant loads than the krill that blue whales feed on.

The Central North Pacific stock of humpback whales is the focus of whale-watching activities in both its feeding grounds (Alaska) and breeding grounds (Hawaii) (NMFS 2021b). Regulations addressing minimum approach distances and vessel operating procedures are in place to help protect the whales; however, there is still concern that whales may abandon preferred habitats if the disturbance is too high (USDON 2013).

In 2011 the estimated abundance of humpback whales in the entire Pacific Basin was about 22,000 with approximately 2,000 in California and Oregon waters (Barlow et al. 2011).

As a result of commercial whaling, humpback whales were listed as endangered under the Endangered Species Conservation Act in 1970, and again under the ESA in 1973. The species is still listed as endangered under the ESA and is considered as depleted under the MMPA. Based on evidence of population recovery in many areas, the species was considered by NMFS for removal or downlisting from the ESA (NMFS 2021d).

Prior to being hunted by man, the right whale, Eubalena japonica, occurred from the Bering Sea to central Baja California (NMFS 2014b). It was targeted early for exploitation because it was slow moving, easy to approach, provided large quantities of meat, oil, and bone, and floated after being killed – thus the common name – the right whale to kill. Right whales are large baleen whales with adults about 50 feet (15 m) length and can weigh up to 14,000 lb (6,350 kg) (Perrin et al. 2008). They consume zooplankton, krill and copepods. Unlike other baleen whales, right whales are skimmers: they feed by removing prey from the water using baleen while moving with their mouth open through a patch of zooplankton. There are no reliable estimates of current abundance or trends for right whales in the North Pacific. They would be rarely sighted in southern California waters and highly unlikely in the Point Loma area.

The North Pacific right whale has been listed as endangered under the ESA since 1973 when it was listed as the "northern right whale." It was listed as a separate, endangered species in April 2008. The species is designated as depleted under the MMPA.

The sei whale, Balaenoptera borealis, is the fastest great whale and can reach speeds well over 20 miles per hour. Sei whales occur rarely in offshore waters in southern California (Carretta et al. 2014). They are present as early as May and June, but primarily are encountered during July to September and leave California waters by mid-October. Sei whales feed on a diversity of prey, including copepods, krill, fish, and cephalopods like squid, cuttlefish, and octopus (Jefferson et al. 2011).

The best current estimate of abundance for the eastern north Pacific stock of sei whales that occur off California, Oregon, and Washington waters out to 300 nm is 126 animals (Carretta et al. 2014). Sei whales, like other large baleen whales, are subject to occasional attacks by killer whales. Based on the statistics for other large whales, it is likely that ship strikes and bycatch also pose a threat to sei whales along the west coast. The sei whale is listed as endangered under the ESA and as depleted under the MMPA.

The only great whale with teeth instead of baleen, the sperm whale, Physeter macrocephalus, is by far the most abundant worldwide. During the past 2 centuries, commercial whalers took about 1,000,000 sperm whales (NMFS 2014b). Its current population is estimated at roughly one million – four times the combined total population of the other five endangered large whale species. Sperm whales attain lengths of 60 feet (18 m) and are distinguished by an extremely large head (Perrin et al. 2008). Feeding primarily on squid and fish, sperm whales can make dives of over ten thousand feet deep lasting an hour and a half. Broadly distributed in the north Pacific, sperm whales are found year-round off California, with peak abundance in summer (Carretta et al. 2014).

Contaminants including organochlorines and several heavy metals have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location with northern hemisphere individuals generally carrying higher burdens (Evans et al. 2004). Unlike other marine mammals, females appear to bioaccumulate toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Wise et al. 2009).

Bycatch of sperm whales in the California swordfish drift gillnet fishery has rarely been documented since the inception of the observer program in 1990 (Carretta et al. 2013). This fishery has been the subject of field study every year since 1990, and through 2012 a total of 8,365 drift gillnet sets have been observed. Ten sperm whales have been recorded entangled during this time. All of the entanglements occurred from October through December in waters deeper than 4,900 feet (1,500 m), in proximity to steep continental shelf bathymetry. One sperm whale died as the result of a ship strike in Oregon in 2007 (Carretta et al. 2014).

Large populations of sperm whales exist in waters several thousand miles west and south of California, but there is no evidence that sperm whale move from there into U. S. west coast waters (Carretta et al. 2014). The most precise, recent estimate of sperm whale abundance for the California to Washington stock is 971 animals. As a result of previous whaling, sperm whales are listed as endangered under the ESA, and the California to Washington stock is considered depleted under the MMPA.

Seals and Sea Lions

The other endangered marine mammal, the Guadalupe fur seal, *Arctocephalus townsendi*, is an occasional; but uncommon visitor to San Diego offshore waters. Severely reduced by hunting in the 1800s, the Guadalupe fur seal was considered extinct by the turn of the century. A small, remnant breeding colony was discovered by Carl Hubbs of the SIO on Guadalupe Island in 1954 and the population has grown since then (Hubbs 1956). Guadalupe fur seals feed on crustaceans, squid and fish (NMFS 2021e). The Guadalupe fur seal breeds mainly on Guadalupe Island about 100 mi (161 km) off the Baja California coast. Guadalupe fur seals may migrate at least 230 mi (600 km) from their rookery sites, based on observations of individuals in the Southern California Bight (Carretta et al. 2014). The Guadalupe fur seal population is now in the process of recovering (Gallo 1994).

Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals in Mexico and the United States. In the United States there have been no reports of mortality or injuries for

Guadalupe fur seals (Carretta et al. 2014). No information is available for human-caused mortality or injuries in Mexico. The Guadalupe seal is listed as threatened under the ESA and depleted under the MMPA.

The Steller sea lion was originally listed under the ESA throughout its range in 1990. However, the eastern Distinct Population Segment (DPS) was recently delisted (NMFS 2013c). It is seldom seen in southern California except near the Channel Islands. It ranges from Baja California to Alaska but prefers the colder temperate to sub-arctic waters of the North Pacific Ocean (NMFS 2021f). Steller sea lions are opportunistic marine predators, feeding on a variety of fish including mackerel, sculpin, rockfish, salmon, squid, and octopus (Perrin et al. 2008). Among pinnipeds, they are only surpassed in size by the walrus and elephant seal. Although the Steller sea lion may be able to avoid being hit by ships, could be subject to entanglement in fishing gear (Carretta et al. 2005).

Birds

Of the seven species of endangered birds in Table H-26, only the California least tern (*Sternula antillarum browni*) would be regularly encountered in marine waters off Point Loma. Once common along the southern California coast, the least tern population diminished to a low of about 600 pairs in the early 1970s as a result of loss of wetland habitat and increasing human disturbance (USFWS 2009). Implementation of mitigation measures following their classification as an endangered species helped the species slowly recover. The California least tern historically nested on beaches, often near estuaries. Now, active management is required to create and maintain safe nesting sites. Fencing, signs, education, and predator control are all employed to protect the species. Least terns are generally present at nesting areas between mid-April and late September, often with two waves of nesting during this time.

California least terns are distributed along the U. S. Pacific Coast from San Francisco to Baja California (USFWS 2021c). Foraging habitats include nearshore ocean waters, bays, and salt marshes. They plunge-dive to capture prey, usually within 1 mi (1.6 km) from shore in waters less than 60 feet (18 m) deep. Prey species include anchovies, smelt, and gobies. Peak foraging behavior typically occurs from the end of May through mid-July after chicks hatch. California least terns eggs, chicks, and adults are preyed upon by gulls, ravens, hawks, crows, rodents, raccoons, and coyotes. The California least tern was federally listed as endangered in 1970 and was listed as endangered by the state of California in 1971.

The 2012 California least tern breeding survey estimated 4,293-6,421 breeding pairs established 6,636 nests and produced 557-628 fledglings at 49 locations (Frost 2013). The estimated number of breeding pairs in 2012 was less than recorded in 2011, which represented the lowest count recorded since 2002. The fledgling to breeding pair ratio in 2012 was approximately half that in 2011. Since 1977, this ratio has been less than 0.50 for only 13 years, which includes the last 11 years. Continuing the upward trend observed in the previous four years, chick mortality in 2012 continued to be a factor at specific sites, possibly due to limited or inappropriate food sources. In addition to avian predators, which were responsible for the highest predation rates over the last several years, coyotes also contributed to the highest predation rates documented in 2012.

The closest California least tern breeding area to the Point Loma outfall is the Naval Base Coronado. The nesting sites there accounted for an estimated 803-1,023 breeding pairs, 1,068 nests, and 17-19 fledglings in 2012 (Frost 2013). As for the rest of California, least tern mortality due to non-predation factors at Naval Base Coronado was greater than mortality due to predation in 2012. State-wide, of non-predation egg mortality events, the highest death rate (55%) was attributed to abandonment prior to the expected hatching date, leading to the loss of 2,038 eggs. Abandonment post-term or failure to hatch was estimated to constitute 26% of non-predation state-wide mortality.

The light-footed clapper rail, *Rallus longirostris levipes*, is a hen-sized bird with long legs and toes. It has a tawny breast, gray-brown back, and gray and white striped flanks (USFWS 2021d). They feed primarily on invertebrates such as snails, crab, insects and worms and are year-round inhabitants of coastal estuaries. Light-footed clapper rails historically ranged from Santa Barbara County to San Quintin, Baja California, Mexico. Loss and degradation of southern California wetlands resulted in the species being listed as federally endangered in 1970 and California state endangered in 1971. In the vicinity of Point Loma, light-footed clapper rails inhabit the Tijuana River Valley, the Sweetwater Marsh National Wildlife Refuge, and the San Diego River Flood Control Channel.

The light-footed clapper rail population fell to its lowest level in 1989 when only 163 pairs were recorded in eight southern California marshes. The population then slowly increased to 325 and 307 pairs censused in 1996 and 1997, respectively in 15 of 16 California coastal wetlands (Zembel et al. 1997). The thirty-fourth annual census of the light-footed clapper rail in California was conducted from 2 March to 21 June 2013 (Zembel et al. 2013). Thirty coastal wetlands were surveyed by assessing call counts from Mugu Lagoon in Ventura County, south to Tijuana Marsh National Wildlife Refuge on the Mexican border. For the second year in a row the California population of the light-footed clapper rail exceeded 500 breeding pairs. A total of 525 pairs exhibited breeding behavior in 22 marshes in 2013. This was the highest count on record, representing an increase of four pairs over the breeding population detected in 2012, and 18.5% larger than the former high count in 2007. The Tijuana Marsh National Wildlife Refuge was at its third highest recorded level with 105 breeding pairs, an increase of 4% over the 2012 breeding season but 26% lower than the record high of 142 pairs in 2007. The Tijuana Marsh National Wildlife Refuge comprised 20% of the breeding population of this rail in California.

The western snowy plover, *Charadrius alexandrinus nivosus*, is a small, pale-colored shorebird with dark patches on its upper breast (USFWS 2021e). It feeds by probing the sand at the beach-surf interface for small crustaceans and marine worms. It breeds on coastal beaches from southern Washington to southern Baja California, Mexico. In southern California, snowy plovers typically nest in association with federally endangered California least terns. The western snowy plover is threatened by habitat loss, human disturbance, and nest/egg destruction by native and introduced predators and domesticated pets. Western snowy plovers nest in San Diego Bay along the Silver Strand and at the south San Diego Bay Saltworks. They are occasional visitors to the Point Loma shoreline. A 2006 breeding season census of western snowy plovers by the USFWS observed 95 adults in San Diego Bay and Tijuana Estuary and a total of 1,723 adults state-wide (USFWS 2007). The Pacific coast population of western snowy plovers was listed as threatened under the ESA in 1993. In 2012, a 0.6 mi (0.96 km) stretch of Coronado City Beach to the south of Point Loma was designated as western snowy plover critical habitat (USFWS 2012).

The last four bird species in Table H-26 – the Guadalupe murrelet, marbled murrelet, Scripps's murrelet, and short-tailed albatross are strictly sea birds, usually found well offshore in southern California waters (USDON 2013). These endangered birds would rarely be seen in the Point Loma area (UCSD 2013).

Sea Turtles

Five species of sea turtles occasionally visit San Diego ocean waters: green, loggerhead, leatherback, olive Ridley, and hawksbill – all are protected under the ESA (Table H-26). The U. S. NMFS and the U. S. Fish and Wildlife Service (USFWS) share Federal jurisdiction for sea turtles, with NMFS having lead responsibility in the marine environment and USFWS having lead responsibility on nesting beaches (NMFS 2021g).

Sea turtles are saltwater reptiles with streamlined bodies built for trans-oceanic navigation (Wyneken et al. 2013). Although they live most of their life in the ocean, females return to land to lay their eggs on nesting beaches. Recovery plans for the U.S. Pacific populations of sea turtles provide a wealth of information on their distribution, diet, growth, reproduction, behavior, and health (NMFS and USFWS 1998a,b,c,d,e). These plans also discuss threats to the continued existence of sea turtles and define procedures and goals for their recovery.

All five species of sea turtles forage along the California coast in the summer and early fall when sea temperatures are warmest (Eckert 1993). There are no known sea turtle nesting sites in the San Diego area or anywhere on the west coast of the United States (USDON 2013).

Most commonly seen in San Diego marine waters, the east Pacific green sea turtle, *Chelonia mydas*, nests on beaches of the Pacific coast of Mexico and ranges throughout the north Pacific Ocean (NMFS 2021h). Adults have three-foot-wide shells with a radiating pattern of brown, black, and cream-colored markings and weigh about 200-300 lb (90-136 kg). The biting edge of their lower jaw is serrated. They eat algae and sea grasses. Green sea turtles are often found from July through September off the coast of California. As for the other endangered sea turtles discussed here, there is no designated green turtle critical habitat in the San Diego region.

In the past, Green sea turtles have aggregated at the southern end of San Diego Bay, attracted to the warm water effluent from a power plant (McDonald et al. 1995, McDonald et al. 2012). A 20-year monitoring program of these turtles indicated an annual abundance of between 16 and 61 turtles (Eguchi et al. 2010). Local researchers have used genetics and satellite telemetry to determine that the turtles are part of the Eastern Pacific nesting populations, and migrate thousands of miles to lay their eggs on beaches off the coast of Mexico. Within San Diego Bay, the turtles can most often be seen surfacing within the South San Diego Bay National Wildlife Refuge, which provides a protected foraging and rest area, as well as a prime study site for turtle biologists. The power plant, which had continuously operated since 1960, ceased operation in December 2010. The closure of the power plant may impact these resident turtles and alter movement patterns but they will still be present in the bay, although their range within the bay may enlarge to other areas where they have not normally been found. (Turner-Tomaszewicz and Seminoff 2012, POSD 2021). The green turtles' greatest threat in San Diego Bay is being hit by boats traveling over the 5-mile per hour speed limit posted throughout the southern portion of the bay. (POSD 2021).

The loggerhead turtle, *Caretta caretta*, is a reddish-brown sea turtle with a large head. Adult loggerheads average about 200-300 lb (91-136 kg) with shells about three-feet (1 m) wide (NMFS 2014i). They take over two decades to mature and in the northern Pacific are only known to nest in southern Japan. Their diet consists of crabs, shrimp, mollusks and jellyfish. Most recorded sightings in California are juveniles (Battey 2014).

The leatherback sea turtle, *Dermochelys coriacea*, is the largest sea turtle, reaching over six-feet in diameter and weighing as much as 1,400 lb (635 kg) (NMFS 2014j). Unlike other species which have solid shells covered with scales, the leatherbacks' shell is a bony matrix covered with a firm, rubbery skin with seven longitudinal ridges or keels (Wyneken et al. 2013). Most sea turtles are cold-blooded and prefer to live in warm waters. Leatherbacks are the exception, and are more likely to be found in colder waters at higher latitudes because of their unique ability to maintain an internal body temperature higher than that of the environment (Dutton 2006). These large sea turtles feed mostly on jellyfish and nest in the tropics and subtropics. Along the western U. S coast, leatherbacks are mostly seen in waters over the continental slope, with greatest densities off central California (NMFS 2013a). The majority of loggerheads observed in the eastern North Pacific Ocean are juveniles, believed to have come from nesting beaches in Japan (USDON 2013).

The olive Ridley turtle, *Lepodochelys olivacea*, is the smallest sea turtle in Pacific waters. Their shell is heart-shaped to round and may be colored grey-brown, black, or, olive. Olive Ridleys' are primarily carnivores and eat a wide variety of food including crab, shrimp, lobster, jellyfish, and tunicates (NMFS 2014k). In San Diego waters, loggerheads, leatherbacks, and olive Ridleys are most often seen well offshore, unlike green sea turtles which tend to hug the shoreline (USDON 2013).

Like other Pacific sea turtles, the hawksbill turtle, *Eretmochelys imbricata*, makes vast oceanic excursions and could occur off the U. S. west coast (NMFS 2021l). Hawksbills were originally considered to be omnivores, but subsequent research revealed they are primarily specialist sponge carnivores, preferring only a few species of sponge (Vicente 1994). There have been few hawksbill sightings north of Baja California Sur and its appearance in San Diego waters would be extremely unlikely (USDON 2013).

Fish

In 1997, the NMFS listed the southern California Evolutionary Significant Unit of West Coast steelhead (*Oncorhynchus mykiss*) as endangered (Federal Register: 18 August 1997 [Volume 62, Number 159, Pages 43937-43954]) (NMFS 1997). In March of 1999, NMFS added nine species of salmon and steelhead to the Endangered Species list and designated critical habitat for them in 2005 (NMFS 2005c). Though most of these are Pacific northwest species, the chinook salmon and steelhead range south to California (NMFS 2021m). Chinook salmon are mostly encountered north of Point Conception.

Steelhead trout are usually dark-olive in color, shading to silvery-white on the underside with a heavily speckled body and a pink to red stripe running along their sides (USFWS 2021f).

Steelhead are born in freshwater streams and later move into the ocean where most of their growth occurs. After 1 to 4 years in the ocean, they return to their home freshwater stream to spawn. Some steelhead, however, spend their entire life in freshwater: these fish are called rainbow trout. Steelhead tend to move immediately offshore on entering the marine environment although, in general, steelhead tend to remain closer to shore than other Pacific salmon species (Beamish et al. 2005).

Steelhead occurred historically in all San Diego County watersheds that drain into the ocean (NMFS 2012). Currently, steelhead in southern California range only as far south as San Mateo Creek in northern San Diego County (USDON 2013). Both steelhead and chinook salmon are occasionally caught in ocean waters off San Diego but do not enter streams in the San Diego Metropolitan area.

One other fish that may be found in the waters off San Diego and that is currently listed as endangered is the Scalloped Hammerhead Shark. It is ESA endangered for the Eastern Pacific DPS. They are moderately large sharks with a global distribution that includes the west coast of the United States. The most distinguishing characteristic is its "hammer-shaped" head. The greatest threats to this shark are overfishing and bycatch (USFWS 2021g).

Three other fish in table 26 are listed as threatened. The Oceanic Whitetip Shark is ESA threatened throughout its range that includes the west coast. They are large, pelagic sharks found in tropical and subtropical oceans. They live offshore in deep water; but spend much of their time near the surface. Oceanic whitetip sharks are long-lived, late maturing and have only moderate productivity. Their main threat is bycatch in commercial fisheries combined with demand for its fins. They are often caught in pelagic longline, purse seine and gillnet fisheries and their fins are highly valued in the international trade for shark products. As a result populations have declined throughout their range. They became listed as threatened in 2018 under provisions of the ESA (NOAA 2021f). The Giant Manta Ray is the world's largest ray with a wingspan of up to 29 feet. They are filter feeders and eat large quantities of zooplankton. They are slow-growing, migratory and exist in small highly fragmented populations that are sparsely distributed across the world. The main threat to manta rays is commercial fishing, both overfishing and bycatch. Target fishing of the species still exists despite prohibitions in a significant portion of the species range. Other threats include marine debris/pollution, vessel strike, entanglement and recreational fishing interactions. In 2018, NOAA Fisheries listed the species as threatened under the ESA (NOAA 2021g). The Green Sturgeon is an anadromous fish, meaning it can live in both fresh and salt water. They have a complex life history that includes spawning and juvenile rearing in rivers followed by migrating to saltwater to feed, grow and mature before returning to freshwater to spawn. They are long-lived, slow growing fish. They are vulnerable to many stressors and threats including blocked access to spawning grounds and habitat degradation caused by dams and culverts. The southern district population is listed as threatened under the ESA. Twenty-seven species of sturgeon can be found in the temperate waters of the Northern Hemisphere. Two of them reside on the west coast of North America. The green sturgeon being one of them. Although Green sturgeons have successfully existed throughout North America for 200 million years, they are thought to have experienced a large decline the last century. Harvest of adults and destruction of spawning and rearing habitat are considered a main reason for the decline. Threats include insufficient water flow rates in spawning areas, contaminants, bycatch, poaching, invasive species, impassable barriers and unfavorable water conditions. In April 2007 the population of North America was listed as threatened under the ESA and critical habitat was designated in 2009. None of the critical habitat exists in the Point Loma area (NOAA 2021h).

Invertebrates

The white abalone, *Haliotis sorenseni*, was historically found from Punta Abreojos, Baja California, Mexico, to Point Conception, California (NMFS 2021n). Inhabiting deeper water than any other abalone species, white abalone in southern California typically occur from 60 to 195 feet (18 to 59 m), with the highest densities between 130 and 165 feet (40 and 50 m) (Butler et al. 2006). They reproduce by broadcast spawning and reach sexual maturity at age 4 to 6 years at a size of 3 to 5 inches. Newly settled individuals feed on benthic diatoms, bacterial films, and single-celled algae found on coralline algal substrates. As they grow larger, white abalone feed on drift and attached algae. Adult white abalone can reach a shell length of up to 9 inches. Except for some isolated survivors, the species is currently distributed only around the Santa Barbara Channel Islands and along various banks far offshore from Point Loma.

Inhabiting deeper water initially provided white abalone a refuge from divers, but a commercial fishery began in the early 1970s and together with increasing recreational take, over-harvesting led to the collapse of the fishery in the 1980s. The state of California suspended all forms of harvesting of the white abalone in 1996 and, in 1997, and imposed an indefinite moratorium on the harvesting of all abalone in central and Southern California (NMFS 2008). The white abalone was federally listed as an endangered species on 29 May 2001 (NMFS 2001). Critical habitat is not designated for white abalone.

The black abalone, *Haliotis cracherodii*, inhabits the intertidal and shallow subtidal zones where it has been easily targeted for exploitation (NMFS 2021o). It has experienced dramatic population declines due to recreational and commercial fishing and withering syndrome disease (VanBlaricom et al. 2009). The state of California imposed a moratorium on black abalone harvesting 1993 and adopted an Abalone Recovery Management Plan 2005 (CDFG 2005). There is concern that the low remaining densities of both black and white abalone may be insufficient for continued reproductive success (VanBlaricom et al. 2009).

The black abalone was proposed as a candidate for listing as an endangered species in 2005 (NMFS 2005d) and listed as endangered under the ESA on 14 January 2009 (NMFS 2009). Critical habitat was designated for black abalone in 2011 (NMFS 2011b). The designated critical habitat extends north of the Palos Verdes Peninsula and in waters surrounding Santa Catalina Island and the Channel Islands, but not in the vicinity of the PLOO discharge.

H.8.3 Environmental Effects

Twenty-eight endangered species; eight marine mammals, seven birds, five sea turtles, six fish, and two invertebrates, may occur in the Point Loma area (Table H-26).

Endangered species in southern California are subject to a variety of natural and human influences (Davidson et al. 2011, Van Der Hoop et al. 2013, NOAA 2014g). Changes in wide-scale oceanographic regimes can alter endangered species foraging success through impacts on prey distributions and locations, which in turn affects reproductive success and survival (O'Shea and Odell 2008, Simmonds and Eliott 2009, Salvadeo et al. 2010, 2013, Fiedler et al. 2013, NMFS 2013a). Climate shifts can transform the type and the intensity of human activities, such as fishing, shipping, oil and gas extraction, and coastal construction, all of which may have an impact on endangered species (Alter et al. 2010, Hoegh-Guldberg and Bruno 2010, Doney et al. 2012, Hazen et al. 2012). Other potential anthropogenic stressors include noise, bioaccumulation of chemicals, overfishing, marine debris, and habitat deterioration or destruction (Crain et al. 2009, Halpern et al. 2009, Jackson et al. 2011, Hilborn and Hilborn 2012, NAVFAC 2013). Incidence of disease, parasitism, and adverse effects from algal blooms may also pose a threat to the health of endangered species (Brodie et al. 2006, Walsh et al. 2008, Bossart et al. 2011). These impacts have the potential to alter the physiology, behavior, growth, and reproduction of individual species, shift patterns of larval dispersal and recruitment, modify the composition of ecological communities, and, change the structure, function, productivity, and resilience of marine ecosystems.

For marine mammals and sea turtles, ship strikes and fisheries bycatch (accidental or incidental catch) are the primary cause of human-related mortality in southern California ocean waters (Harvey et al. 2010, Carretta et al. 2013, Geijer and Read 2013). In addition to these direct effects, marine mammals and sea turtles may also be indirectly affected by noise, bioaccumulation, habitat alteration, and depletion of prey species (Redfern et al. 2013, NMFS 2021g, NOAA 2021e). In 1994, the MMPA was amended to formally address these issues (16 U.S.C. 1361-1407: PL103-238:108 Stat. 532).

The MMPA requires the NMFS to document human-caused mortality and injury of marine mammals as part of assessing marine mammal stocks (Roman et al. 2013, Carretta et al. 2014). An NMFS report summarizes records of human-caused mortality and injury from 2007 to 2011 for U. S. west coast marine mammal populations (Carretta et al. 2013). Among marine mammals, pinnipeds were most commonly injured or killed by anthropogenic activity followed by small cetaceans and large whales. The primary causes of pinniped injury and mortality were recreational hook and line fishery interactions, shootings, and entrainment into power plant water intakes. Vessel strikes and fishery-related entanglements were the most common form of mortality and injury to whales. Net fisheries accounted for most of the injuries and mortalities for small cetaceans. Sea turtles and sea birds are also at risk of entanglement in fishing gear (Carretta and Enriquez 2012). Impacts of commercial fisheries that utilize nets, pots, and traps are likely to be greater than the number of observed incidents because derelict gear can entangle animals for as long as it remains in the environment (EPA 2012a, Reeves et al. 2013).

Habitat deterioration and loss is an issue for almost all coastal marine mammals (Davidson et al. 2011, Roman et al. 2013). Anthropogenic noise is a potential habitat level stressor especially in areas of industrial activity or commercial ship traffic (McDonald et al. 2008, Hildebrand 2009). Noise is a particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals (USDON 2013). It may induce marine mammals to leave a habitat, impair their ability to communicate, or cause stress (Rolland et al. 2012, Erbe et al. 2012). Noise can create behavioral disturbances and mask other sounds including the marine mammals' own vocalizations (Southall et al. 2012). With ecotourism on the rise, marine life viewing activities like whale watching have the potential to impact the behavior and migration of marine mammal populations (NMFS 2013a, NOAA 2021e).

Endangered species are also subject to bioaccumulation of toxic chemicals. Natural and synthetic chemicals enter the ocean through various sources including rivers and streams, storm drains, industrial discharges, municipal wastewater discharges, dredge and disposal activities, aerial fallout, vessel activities and spills, mineral mining, oil exploration and extraction, and through hydrothermal vents and hydrocarbon seeps (Setty et al. 2012, Hutchinson et al. 2013). Some of the chemical constituents entering the ocean remain dissolved and are distributed by ocean currents and eddies. Many are physically or chemically bound to particulate matter and settle to the bottom.

Marine organisms can absorb dissolved chemicals directly from seawater (by the gills or epidermis), and indirectly through contact with sediment, by ingesting sediment particles or suspended particulate matter, and through assimilation from food organisms (Newman 2009, Allen et al. 2011, Laws 2013). Chemical compounds accumulate in an organism's tissue if they cannot be metabolized and eliminated faster than they are absorbed. Tissue concentration can also increase as these chemicals are passed through the food web from lower to higher trophic levels (Bienfang et al. 2013, Daley et al. 2014, Weis 2014). The degree to which bioaccumulation occurs depends on the solubility, particle affinity, oxidation state, volatility, and degradability of the specific chemical (Laws 2013). These differences determine how chemical compounds are distributed within biological communities and throughout the environment (Whitacre 2014). The potential impacts of bioaccumulation by marine organisms include comprised immune response and disease resistance, altered behavior, diminished breeding success, developmental abnormalities, population declines via direct mortality, and shifts in the composition of communities by affecting top predators and keystone species (Newman 2009, NAVFAC 2013).

The species most at risk from bioaccumulation of toxic compounds are those at the highest trophic levels, especially marine mammals (O'Hara and O'Shea 2005, Tornero et al. 2014). Marine mammals are vulnerable to bioaccumulation because they have long life spans and large blubber stores that can serve as repositories for lipophilic chemicals (Moore et al. 2013). Bioaccumulation of anthropogenic contaminants may also increase susceptibility to other stressors including parasitism and disease (O'Hara and O'Shea 2005, Bossart 2011).

The term "contaminants of emerging concern" (CEC) is being used to describe a very wide variety of anthropogenic contaminants that might be a threat to the environment; but many of which have only recently been identified as a possible cause for concern. The number of substances considered as CECs is exceptionally large and includes substances such as pharmaceuticals, veterinary medicines, personal-care-products, antifoulants, biocides, hormones, hormone like substances, flame retardants, and industrial chemicals among others. It is estimated that world-wide over 100, 000 of these constituents are currently on the market, with thousands of new ones being introduced every year (Bellas et al 2020). Urbanization of coastal locations can result in the discharge of CECs into the marine environment. Sources may include industries, non-point source urban runoff, treated wastewater discharges and agriculture runoff (Scott et al 2012). Whereas marine research and monitoring has historically focused on legacy toxic pollutants such as DDT and PCBs etc., marine monitoring programs now see the need to analyze for CECs. This presents a significant challenge since analytical methods do not exist for many CECs and there is a lack of toxicological information on the effects of many CECs to put into context with monitoring results (Scott et al 2012).

There is no definitive information that endangered species are negatively affected by CECs as a result of the discharge through the PLOO.

This is in agreement with the conclusions presented in Appendix C that the ocean environment, including sediments and resident biological life forms, in the vicinity of the PLOO discharge are healthy and representative of reference conditions within the Southern California Bight. Additionally, there is no discernable pattern of impact as a function of distance from the outfall.

Recognizing that CECs are present in treated wastewater discharges and that routine monitoring for them has not historically been a part of past PLOO monitoring programs, it is anticipated that San Diego will work with the regulatory agencies and those involved in CEC research work to identify the potential for including appropriate chemical compounds in future monitoring efforts. This will provide valuable information to assist research efforts by other others, as well as specific data relative to the PLOO discharge.

Marine debris is a potential threat to endangered marine mammals (EPA 2012a, Howell et al. 2012). Marine debris flows into the ocean from rivers, harbors, estuaries, and, though prohibited in U. S. waters, occasionally from vessels at sea (NOAA 2008). Ingestion of debris can have fatal consequences for whales. The stomach contents of two sperm whales that stranded in California included extensive amounts of discarded fishing netting (NMFS 2013a). Another Pacific sperm whale contained nylon netting in its stomach when it washed ashore in 2004 (NMFS 2013a). Seals and sea lions are also subject to entanglement in marine debris (Carreta et al. 2013). A recent study by Oregon State University found Steller sea lions entangled with rubber bands used on crab pots, hard plastic packing bands from cardboard boxes, fishing line and hooks, and other fishing gear (Oregon State University 2011).

Sea turtles are exposed to a wide variety of natural and anthropogenic threats (Santidrián Tomillo et al. 2012, NMFS 2013a, Wyneken et al. 2013). Nesting beaches are threatened by hurricanes and tropical storms. Hatchlings are preyed on by herons, gulls, and sharks. Juveniles and adults are eaten by sharks and other large marine predators. Sea turtles are also killed or injured by fisheries and by vessel strikes (Carretta et al. 2005, Hazel et al. 2007, Wallace et al. 2010, Work et al. 2010). Marine debris can be detriment as well. Floating plastic garbage can be mistakenly ingested by sea turtles. Leatherback sea turtles in particular may mistake floating plastic garbage as jellyfish, an important component of the leatherback diet (Lazar and Gračan 2011). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown all life stages (Mrosovsky et al. 2009).

All the nearshore birds in Table H-26 became endangered because of habitat loss and disturbance. These bay and estuarine species - California least tern, light-footed clapper rail, and western snowy plover - occasionally forage over San Diego coastal water. The primary threat to their well-being in ocean waters would be exposure to bioaccumulated toxic compounds from prey captured in the area (Arnold et al. 2007).

Regional evaluations have shown that virtually all bottom-dwelling fish populations in southern California have detectable levels of DDT and PCBs as a result of past discharge practices, now discontinued (SCCWRP 2012). The highest concentrations are on or near the Palos Verdes shelf off Whites Point in Los Angeles, an area with highly contaminated sediments, the result of historical discharge. Fish tissue burdens of DDT and PCBs decline to the north and south across the Southern California Bight. A study by Parnell et al in 2008 demonstrated that the major source PCB contamination off Point Loma was a result of the disposal of contaminated sediments from San Diego Bay being deposited at an offshore dredge disposal site and not the PLOO. Concentrations of chlorinated hydrocarbons in fish from reference areas are now less than 5% of levels measured two decades ago (Allen et al. 2011). Contaminant burdens in fish tissues at Point Loma are comparable to those at reference sites beyond the influence of the discharge (City of San Diego 2008-2016, 2018, 2020). Endangered birds feeding in the Point Loma area should not be exposed to a higher risk of bioaccumulation from the discharge of treated wastewater.

Of the five species of endangered sea turtles that may pass through the San Diego marine environment (Table H-26), the green sea turtle would be most common and the one found closest to shore. Green turtles are subject to entrainment in coastal power plants, perhaps attracted to the lush growth of algae on the cooling water intake structures (Seminoff 2007). Green turtles have also been struck by boats and entangled in fishing gear in southern California (Carretta et al. 2005). Although capable of deep dives, most sea turtles passing San Diego would be in surface waters. They should not be exposed to the effluent plume which is normally trapped below the thermocline, especially during the summer when turtles would be most prevalent. The potential impact of discharged debris is minimized by effluent screens at the Point Loma wastewater headworks that remove entrained material greater than an 5/8 inch in diameter.

The other endangered species possibly occurring at Point Loma, the steelhead trout, green sturgeon and black abalone should not be jeopardized by the discharge. Steelhead trout and green sturgeon would be transitory, and the black abalone, if present, would be well inshore of the outfall, beyond potential adverse influence.

Operation of the PLOO could affect endangered species by altering physical, chemical or biological conditions including: water quality, biological integrity (e.g., species abundance and diversity), food web dynamics (e.g., availability of prey), habitat suitability, and the health of organisms (e.g., bioaccumulation of toxic substances, disease, and parasitism).

The City of San Diego monitors changes in ocean conditions over space and time, and assesses any impacts of wastewater discharge or other man-made or natural influences on the local marine environment. Monitoring results are contained in Annual Monitoring Reports (City of San Diego 2008-2016, 2018, 2020). The monitoring program has six components along with special studies: coastal oceanographic conditions, water quality and plume dispersion, sediment conditions, macrobenthic communities, demersal fish and megabenthic invertebrates, and contaminants in fish tissues. The overall findings are summarized in the following paragraphs.

There has been no indication of change in any physical or chemical water quality parameter (e.g., dissolved oxygen, pH) attributable to wastewater discharge off Point Loma. Instead, changes in oceanographic parameters have historically been associated with varying climate regimes and with natural events such as storm activity and the presence of plankton blooms.

Benthic conditions off Point Loma show some changes that may be expected near large ocean outfalls, though restricted to a relatively small, localized region near the discharge site. For example, sediment quality data have indicated slight increases over time in sulfide content and biological oxygen demand at sites nearest the discharge, where the physical presence of the outfall structure has caused relatively coarse sediment particles to accumulate. Other measures of environmental impact such as concentrations of sediment contaminants (e.g., trace metals, pesticides) show no patterns related to wastewater discharge (City of San Diego 2020, Appendix C1).

Some descriptors of benthic community structure (e.g., abundance, species diversity) or indicators of environmental disturbance (e.g., brittle star populations) have shown temporal differences between reference areas and sites nearest the outfall. However, results from environmental disturbance indices such as the Benthic Response Index that are used to evaluate the condition of benthic assemblages indicate that benthic invertebrate communities in the Point Loma region remain characteristic of natural conditions (City of San Diego 2020, Appendix C).

Analyses of bottom dwelling fish and trawl-caught invertebrates reveal no spatial or temporal patterns that can be ascribed to effects of wastewater discharge. Instead, historical data (1991-2014) indicates that patterns of change in benthic communities are related to large-scale oceanographic events or specific site conditions (e.g., near dredge material disposal sites) (see Appendix C – Ocean Benthic Conditions). The lack of physical anomalies and other symptoms of disease in local fish, as well as the low level of contaminants in fish tissues, are also indicative of a healthy marine environment.

H.8.4 Cumulative Impacts

Cumulative impacts are defined in the National Environmental Protection Act (NEPA) (42 USC § 4321 *et seq*. and 32 CFR 775 respectively) as: the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7).

In general, the effects of a particular action or group of actions must meet all of the following criteria to be considered cumulative impacts:

- Effects of several actions occur in a common locale or region
- Effects on a particular resource are similar in nature, such that the same specific element of a resource is affected in the same specific way
- Effects are long-term as short-term impacts dissipate over time and cease to contribute to cumulative impacts

The discharge of wastewater from commercial activities, including municipal wastewater treatment plants, power generating stations, industrial plants (e.g., desalination plants), and storm water from drains into open ocean waters, bays, or estuaries can introduce chemical and biological constituents potentially detrimental to estuarine and marine habitats (Perry 2009, Hutchinson et al. 2013). These constituents include pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, and toxic chemical compounds (Crain et al. 2009, Stein and Cadien 2009, Setty et al. 2012). Historically, wastewater discharges have been one of the largest inputs of these constituents into coastal waters. However, wastewater discharges have been regulated under increasingly stringent requirements over the last 40 years and mass emissions of most constituents have been significantly reduced (Lyon and Sutula 2011, SCCWRP 2012, 2014). Nonpoint source/storm water runoff, on the other hand, has not been managed as effectively and continues to be a substantial remaining source of contamination of coastal areas and the ocean (Setty et al. 2012, Howard et al. 2014).

Human activities, such as shipping, oil and gas extraction, and coastal construction have the potential to directly or indirectly affect endangered species (Alter et al. 2010, Hoegh-Guldberg and Bruno 2010, Doney et al. 2012, Hazen et al. 2012). Other possible cumulative threats to endangered species include degradation of water quality, habitat modification, pollution (chemicals, marine debris, etc.), introduction of exotic species, and disease (Field et al. 2003, Horn and Stevens 2006, O'Shea and Odell 2008, Pinnegar and Engelhard 2008, Crain et al. 2009, Halpern et al. 2009, Hoegh-Guldberg and Bruno 2010, Thrush and Dayton 2010, Doney et al. 2012, Hazen et al. 2012, Howell et al. 2012, SCCWRP 2012, NMFS 2013a, Howard et al. 2014, Maruya et al. 2014). Cumulative impacts could alter the physiology, behavior, growth, and reproduction of individual species, shift patterns of larval dispersal and recruitment, modify the composition of ecological communities, and, change the structure, function, productivity, and resilience of marine ecosystems.

Fishing and non-fishing activities, individually or in combination, can adversely affect endangered species (Jackson et al. 2001, 2011, Dayton et al. 2003, Chuenpagdee et al. 2003, Hanson et al. 2003, Jackson 2008, Baum and Worm 2009, Worm et al. 2009, Norse 2010, Hilborn and Hilborn 2012, NMFS 2013b, Laugen et al. 2014). Potential impacts of commercial fishing include over-fishing of targeted species and bycatch (Dieter et al. 2003, PFMC 2004, Hseih et al. 2006, Carretta and Enriquez 2012, PFMC and NMFS 2012). Indirect effects may include removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (continued catch by lost or discarded gear), and generation of marine debris (Reeves et al. 2013). Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats (NMFS 2013b). Recreational fishing also poses a threat because of the large number of participants and the intense, concentrated use of specific habitats (Coleman et al. 2004, Ihde et al. 2011, United Nations Food and Agricultural Organization (UNFAO) 2012, Arlinghaus et al. 2013).

Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal (Davidson et al. 2011, Hutchinson et al. 2013, Moore et al. 2013). Natural stresses include storms and climate-based environmental shifts, such as algal blooms and hypoxia (Kim et al. 2009, SCCWRP 2013).

A number of factors influence water quality and biological conditions in the Point Loma area. Key potential influences on water quality include the Point Loma treated wastewater discharge, regional non-point source discharges, local river outflows, and other local non-point sources such as harbors, marinas, storm drains, and urban runoff (Bartlett et al. 2004, Parnell et al. 2008, Parnell and Riser 2012).

The effects of the Point Loma discharge on water quality and biological conditions are evident only in deep waters within or near the ZID (City of San Diego 2008-2016, 2018, 2020). Organic enrichment of the sediments due to the outfall discharge is not occurring beyond the ZID. Contaminant loading of sediments is not evident in the discharge vicinity. Sediment chemistry is comparable to reference areas along southern California's outer continental shelf. Biological conditions do not indicate any environmentally-significant changes associated with the discharge. A balanced indigenous population of shellfish, fish and wildlife exist immediately beyond the ZID.

While significant natural variations in fish populations are observed (in response to factors such as water temperature), the Point Loma wastewater discharge is not having any significant effect on fish assemblages off Point Loma. Fish populations are healthy and lack physical abnormalities such as fin erosion or tumors. Levels of trace metals, chlorinated hydrocarbons, pesticides, and polyaromatic hydrocarbons are relatively low, with concentrations within the range found throughout the Southern California Bight. Overall, no outfall-related effects are evident from bioaccumulation data. Contaminants in fish tissues in the Point Loma area are similar to those at reference sites beyond the influence of the discharge.

The discharge of treated wastewater at Point Loma would, therefore, make a minimal, insignificant contribution to regional cumulative impacts on endangered species and their critical habitat.

H.8.5 Summary

Operation of the Point outfall could potentially impact endangered species through changes in environmental conditions that affect the species or their habitat. Monitoring data and research show effects of the Point Loma discharge only in deep water near the outfall where minor water and sediment quality alterations have been observed. Marine communities in the Point Loma area remain characteristic of natural conditions with no suggestion of ecologically-significant changes.

There is no indication of adverse impacts from operation of the PLOO on environmental conditions or biological communities that could affect the health and well-being of endangered species or threaten their critical habitat.

The PLOO discharge complies with all federal and state standards including State of California Ocean Plan standards for the water quality, protection of marine aquatic life, protection of human health (noncarcinogens) and protection of human health (carcinogens) (SWRCB 2019).

Future flows and contaminant concentrations from the PLOO would be at or below currently permitted levels. Thus, the proposed, future discharge of treated wastewater from the PLOO is not likely to affect endangered species or threaten their critical habitat.

It should be noted that a significant modification in San Diego's wastewater system will be initiated during the period of the renewed permit which will improve the quality of the discharge and reduce the flow through the PLOO.

San Diego will begin operating new wastewater treatment and water reclamation facilities that will significantly reduce the flow and associated pollutants discharged through the PLOO. By December 31, 2027, Phase 1 of Pure Water is expected to be in full operation, diverting on average up to 52 mgd of wastewater away from the PLWTP to produce 30 mgd of water suitable for potable reuse and up to 12 mgd of reclaimed water for non-potable reuse (e.g., irrigation, industrial and commercial uses). This diversion will result in a nearly 20% reduction in flow discharged through the PLOO. In addition, tests conducted at the Phase 1 Demonstration Facility have shown a significant portion of the pollutants that would have been released at the PLOO discharge will be eliminated through the use of advanced technologies such as ozonation and biological activated carbon filtration. In addition to a reduction in conventional pollutants such as suspended solids and nutrients, many contaminants of emerging concern (CECs), including persistent organic pollutants (POPs), pharmaceutical and personal care products (PCPPs) etc., are completely removed from the system at a greater efficiency than traditional wastewater treatment processes.

H.9 BENEFICIAL USE IMPACTS

Beneficial uses in the vicinity of Point Loma include aesthetic enjoyment, tide-pooling, wading and swimming, surfing, snorkeling, diving, sailing and boating, recreational and commercial fishing, whale watching, research and education, navigation and shipping, military and industrial use, endangered species, and, conservation of marine species and habitats. The PLOO Monitoring Program focuses on key water quality influences and biological conditions that protect and maintain these uses using the types of data indicated in Table H-39.

Table H-39:
Water Quality and Biological Conditions Monitored at Point Loma

Category	Issue or Condition of Concern	Available monitoring data	
Effluent	Physical characteristics	TSS BOD Temperature pH	Floating particulates Settleable solids Grease and oil Turbidity
	Toxic inorganic constituents	Toxic metals Ammonia-nitrogen	cyanide
	Toxic organic constituents	Volatile organic compounds Acid-extractable compounds Base/neutral compounds Chlorinated pesticides and PCBs	Organophosphorus pesticides TCDDs Tribuyltin
	Nutrients	Ammonia-nitrogen	Total phosphorus
	Pathogens	Total coliform Fecal coliform	Enterococcus
	Toxicity	Chronic toxicity (bioassay)	
Receiving Water	Physical characteristics	Light transmittance pH dissolved oxygen	Temperature Salinity Ocean currents
	Pathogens	Fecal coliform	Enterococcus
	Nutrients	Chlorophyll α Satellite imagery	
Sediments	Physical characteristics	Grain size	
	Organic loading	BOD Sulfides Total nitrogen	Sulfides TOC Total volatile solids
	Sediment toxicity	Toxic metals	Chlorinated pesticides and PCBs
Biological Conditions	Macrofaunal benthic community	Species richness Species diversity Species dominance Abundance (populations)	Benthic Response Index (BRI) Sensitive species Nuisance species
	Demersal fish and megabenthics	Species richness Species diversity Biomass Abundance (populations) Sensitive species Multivariate analyses of fish assemblages	Nuisance species Observation for disease Observations for parasites Observation for impairment of reproduction or growth

Category	Issue or Condition of Concern	Available monitoring data	
	Bioaccumulation of toxics	Liver tissue analysis for metals, pesticides and PCBs	Muscle tissue analysis for metals, pesticides and PCBs
	Kelp bed	Annual kelp ecosystem monitoring	
	Migratory patterns	Observation	
	Survival of biota	Observation	
	Endangered species	Observation	

The City of San Diego conducts extensive ocean monitoring to evaluate potential environmental effects from the discharge of treated wastewater to the Pacific Ocean via the PLOO (City of San Diego 2020). The primary objectives of the ocean monitoring program are to measure compliance with NPDES permit requirements and California Ocean Plan (SWRCB 2019) water-contact standards, monitor changes in ocean conditions over space and time, and assess any impacts of wastewater discharge or other man-made or natural influences on the local marine environment. The monitoring program has six components: coastal oceanographic conditions, water quality compliance and plume dispersion, sediment conditions, macrobenthic communities, demersal fish and megabenthic invertebrates, and contaminants in fish tissues. The following bullet points highlight the overall findings in each of these categories.

Coastal Oceanographic Conditions

- Ocean currents flow along a predominantly north-south axis during most of the year.
- The fate of discharged wastewater is determined by outfall diffuser geometry, the rate of effluent flow, and by oceanographic factors that govern water mass movement.
- Ocean conditions off Point Loma are consistent with well documented patterns for southern California and within the range of normal conditions.
- Natural factors such as upwelling and changes due to large-scale climatic events explain most of the temporal and spatial variability in the coastal waters off Point Loma.

Water Quality and Plume Dispersion

- Prevailing water quality conditions in the Point Loma area are excellent. Overall compliance with Ocean Plan water-contact standards is close to 100%.
- There is no indication that discharged wastewater reaches the shore or the Point Loma kelp bed.
- The PLOO plume remains restricted to relatively deep, offshore waters throughout the year.
- With partial chlorination, densities of indicator bacteria in the submerged plume have been reduced at all offshore stations including those nearest the outfall.

Sediment Conditions

- After more than 25 years of wastewater discharge at this site, sediment quality at Point Loma remains comparable to other areas in the San Diego region.
- There is no buildup of fine sediments attributable to wastewater discharge or any change in particle size beyond the outfall area.
- Contaminant loads and organic content in sediments remain typical for San Diego and other coastal areas of southern California.
- The only sustained effects on benthic sediments are restricted to within 1,000 feet (300 m) of the ocean outfall and are due to the physical structure of the outfall.

Macrobenthic Communities

- Macrofaunal assemblages off Point Loma are comparable to natural, balanced indigenous populations elsewhere in the Southern California Bight.
- Macrobenthic species abundance, richness, and diversity in the vicinity of the outfall are characteristic of natural ranges for the San Diego region.
- Minor changes in macrofaunal populations located within 1,000 feet (300 m) of the outfall remain within the range of normal variations in southern California communities.
- There is no evidence that wastewater discharge has caused degradation of the marine benthos at any of the monitoring sites.

Demersal Fish and Megabenthic Invertebrates

- Demersal fish and megabenthic invertebrate communities in the Point Loma region are unaffected by wastewater discharge.
- Although highly variable, patterns in the abundance and distribution of individual species are similar at stations located near the outfall and farther away.
- Community structure analysis does not indicate any environmentally-significant changes associated with the discharge.
- Local fish populations remain healthy, with < 1% of all fish captured in the monitoring program having external parasites or any evidence of disease.

Contaminants in Fish Tissues

- Several metals, pesticides, and PCBs have been detected liver tissues of flatfish and muscle tissues of rockfish but there are no patterns related to wastewater discharge.
- These contaminants occur in fish distributed throughout the region and all contaminants are within ranges reported previously for southern California fish.
- All muscle samples were within federal (FDA) action limits.
- There is no indication that contaminant loads in Point Loma fish are affected by operation of the PLOO.

In summary, there are few changes to local receiving waters, benthic sediments, and marine invertebrate and fish communities that can be attributed to Point Loma wastewater discharge. Coastal water quality conditions and compliance with Ocean Plan standards are excellent, and there is no evidence that the wastewater plume from the outfall surfaces or is transported inshore to recreational waters along the shore and in the Point Loma kelp bed. There are no outfall related patterns in sediment contaminant distributions, or in differences between invertebrate and fish assemblages at the different monitoring sites. The lack of physical anomalies or other symptoms of disease in local fish, as well as the low level of contaminants in fish tissues, is also indicative of a healthy marine environment. Benthic habitats in the Point Loma region remain in good condition and are similar to reference areas in the Southern California Bight.

Water quality and biological conditions associated with the existing PLOO discharge and expected for the proposed, future PLOO discharge are summarized in Tables 41 and 42.

Table H-40:
Water Quality Conditions - Existing and Proposed Outfall Discharge*

Water Quality Conditions	Monitoring Data	Existing Conditions (Current Discharge)	Projected Conditions (Future Discharge)
Chronic Toxicity	Un-ionized-NH_3, Effluent Toxics,	Discharge complies with *Ocean Plan* standards.	No change.
Conductivity/Salinity	Salinity	No measurable impact on salinity.	No change.
Dissolved Oxygen Depression	Dissolved Oxygen (DO)	DO levels within range of natural conditions throughout water column.	No change.
Pathogens	Total and fecal coliforms, enterococcus	Discharge complies with applicable receiving water standards.	No change.
pH	pH	pH within range of natural conditions throughout water column.	No change.
Oil and grease	Oil and grease	No visible surface slicks or floating particles.	No change.
Temperature	Temperature	No measurable impact on temperature.	No change.
Toxics accumulation in marine organisms	Trace metals, other toxics, pesticides	Levels of contaminants within the range of natural variability and regional reference stations.	No change.
Toxics accumulation in water and sediments	Trace metals, other toxics, pesticides	No significant increase in toxics in sediments.	No change.
Water Clarity/Light Penetration	Observation, Turbidity, Transmissivity	No measurable impact on light transmittance.	No change.

Table H-40 Note:

*PLOO discharge and mass emissions of solids are projected to significantly decrease during the upcoming permit period. During this time the City of San Diego will be implementing the first phase of the Pure Water Program. This program will take wastewater that would normally be going to the PLWTP and divert it to water reclamation facilities where advanced treatment processes will produce reclaimed water suitable for potable use. This will result in significantly less flow and pollutants being discharged through the PLOO (See Appendix B).

Table H-41:
Biological Conditions - Existing and Proposed Ocean Outfall Discharge*

Biological Conditions	Monitoring Data	Existing Conditions (Current Discharge)	Proposed Conditions (Future Discharge)
Abundance, Richness, and Diversity	Benthic Infauna, Fish and Macroinvertebrates	Balanced Indigenous Population beyond Zone of Initial Dilution	No change.
Impairment of Reproduction, Growth or Development	DO, Fish observations	No impact.	No change.
Incidence of Disease or Parasitism	Observation	No impact.	No change.
Nuisance Species	Observation, Benthic Infauna, Fish	No impact.	No change.
Endangered Species	Observation	No impact.	No change.
Survival of Biota	Observation, Abundance	No impact.	No change.

Table H-41 Note:

*PLOO discharge and mass emissions of solids are projected to significantly decrease during the upcoming permit period. During this time the City of San Diego will be implementing the first phase of the Pure Water Program. This program will take wastewater that would normally be going to the PLWTP and divert it to water reclamation facilities where advanced treatment processes will produce reclaimed water suitable for potable use. This will result in significantly less flow and pollutants being discharged through the PLOO (See Appendix B).

H.10 CONCLUSIONS

No significant, outfall-related changes in water quality and biological conditions have been detected in long-term research and monitoring of the existing PLWTP discharge. There is no indication of impacts from operation of the PLOO on environmental conditions that protect and maintain beneficial uses of the ocean. The proposed, future PLWTP discharge should, likewise, protect and maintain beneficial uses.

REFERENCES

Allen, M. J. 2006. Pollution. The Ecology of Marine Fishes: California and Adjacent Waters. In: L. G. Allen, D. J. Pondella and M. H. Horn (eds). University of California Press. Berkeley, CA.

Allen, L. G. and J. N. Cross. 2006. Surface Water. Chapter 12. pp. 320-341 in: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press: Berkeley, CA. 670 p.

Allen, M. J., S. L. Moore, K. C. Schiff, D. Diener, S. B. Weisberg, J. K. Stull, A. Groce, E. Zeng, J. Mubarak, C. L. Tang, R. Gartman, and C .I. Haydock 1998. Assessment of Demersal Fish and Megabenthic Invertebrate Assemblages on the Mainland Shelf of Southern California in 1994. Southern California Coastal Water Research Project, Westminster, CA.

Allen, L. G., A. M. Findlay, and C. M. Phalen 2002. Structure and Standing Stock of Fish Assemblages of San Diego Bay, California from 1994 to 1999. Bulletin of Southern California Academy of Science 101(2):49-85. Berkeley, California.

Allen, M.J., A.K. Groce, D. Diener, J. Brown, Steinert, G. Deets, J.A. Noblet, S.L. Moore, D. Diehl, E.T. Jarvis, V. Raco-Rands, Thomas, Y. Ralph, R. Gartman, D. Cadien, Weisberg, and T. Mikel. (2002). Southern California Bight 1998 Regional Monitoring Program: V. Demersal Fishes and Megabenthic

Allen, M. J., R. W. Smith, E. T. Jarvis, V. R. Rands, B. B. Bernstein, and K. T. Herbinson 2005. Temporal Trends in Southern California Coastal Fish Populations Relative to 30-Year Trends in Oceanic Conditions. In: Fish Populations pp. 264-285.

Allen, L. G., D. J. Pondella, II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press, Los Angeles. 670 p.

Allen, M. J., D. Cadien, E. Miller, D. W. Diehl, K. Ritter, S. L. Moore, C. Cash, D. J. Pondella, V. Raco-Rands, C. Thomas, R. Gartman, W. Power, A. K. Latker, J. Williams, J. L. Armstrong, and K. Schiff 2011. Southern California Bight 2008. Regional Monitoring Program: Volume IV. Demersal Fishes and Megabenthic Invertebrates. Southern California Coastal Water Research Project, Costa Mesa, CA.

Allen W. E., (1933) "Red water" in La Jolla Bay in 1933. Science 78: 12– 13.

Araújo, S., I. S. Henriques, S. M. Leandro, A. Alves, A. Pereira, and A. Correia 2014. Gulls Identified As Major Source of Fecal Pollution In Coastal Waters: A Microbial Source Tracking Study. Science of the Total Environment 470–471:84–91.

Arlinghaus, R., S. J. Cooke, and W. Potts 2013. Towards Resilient Recreational Fisheries on a Global Scale through Improved Understanding of Fish and Fisher Behavior. Fisheries Management and Ecology 20:91–98.

Alter, S. E., M. P. Simmonds, and J. R. Brandon 2010. Forecasting the Consequences of Climate-Driven Shifts in Human Behavior on Cetaceans. Marine Policy 34(5), 943-954. doi: 10.1016/j.marpol.2010.01.026.

Arnold, J. M., J. A. Boyce, and R. J. Bellmer 2007. Damage Assessment and Restoration Planning for Marine Birds. NOAA Restoration Center. Silver Springs, MD. 62p.

Arnold, B. F., K. C. Schiff, J. F. Griffith, J. S. Gruber, V. Yau, C. C. Wright, T. J. Wade, S. Burns,. J. M. Hayes, C. McGee, M. Gold, Y. Cao, S. B. Weisberg, and J. M. Colford, Jr. 2013. Swimmer Illness Associated with Marine Water Exposure and Water Quality Indicators: Impact of Widely Used Assumptions. Epidemiology: 24 (6): 845-853.

Auster, P. J. and R. W. Langton 1998. The Effect of Fishing on Fish Habitat. National Undersea Research Center. Univ. of Connecticut. Groton, CT. 51 p.

Barlow, J., J. Calambokidis, E. A. Falcone, C. S. Baker, A. M. Burdin, P. J. Clapham, and J. K. B. Ford 2011. Humpback Whale Abundance in the North Pacific Estimated by Photographic Capture Recapture with Bias Correction from Simulation Studies. Marine Mammal Science 27:793-818.

Barnette, M. C. 2001. A Review of the Fishing Gear Utilized Within the Southeast Region and their Potential Impacts on Essential Fish Habitat. National Marine Fisheries Service. Southeast Regional Office. St. Petersburg, Fl. 68p.

Bartlett, D., P. Dayton, P. Frank, L. Levin, E. Parnell, L. Shaffer, and C. Winant 2004. Point Loma Outfall Project Report. Scripps Institution of Oceanography. September 2004. 60 p.

Battey, T. 2014. A Guide to the Amphibians and Reptiles of California http://www.californiaherps.com/turtles/pages/c.caretta.html

Baum, J. K. and B. Worm 2009. Cascading Top-Down Effects of Changing Oceanic Predator Abundances. Journal of Animal Ecology 2009 doi: 10.1111/j.1365-2656.2009.01531.x. 16 p.

Beamish, R. J., G. A. McFarlane, and J. R. King. 2005. Migratory Patterns of Pelagic Fishes and Possible Linkages Between Open Ocean and Coastal Ecosystems off the Pacific Coast of North America. Deep Sea Research II. 52:739-755.

Becker, B. J. 2006. Status and Trends of Ecological Health and Human Use of the Cabrillo National Monument Rocky Intertidal Zone (1990-2005). Natural Resource Technical Report NPS/PWR/CABR/NRTR—2006/03. National Park Service, Seattle, Washington.

Bell, S. 2009. Hagfish: A Re-emerging Fishery. Marine Management News: May 2009. https://www.dfg.ca.gov/marine/newsletter/0509.asp

Bellas, J, Hylland, K., and Burgeot, T. 2020. New Challenges in Marine Pollution Monitoring. Front. Mar. Sci. 22 January 2020.

Benjamin S. G. and J. A. Carton 1999. Interannual and Decadal Variability in the Tropical and Midlatitude Pacific Ocean. Journal of Climate. Vol.12: Issue 12: 3402-3418.

Bergen, M., D. B. Cadien, A. Dalkey, D. E. Montagne, R. W. Smith, J. K. Stull, R. G. Velarde, and S. B. Weisberg 2000. Assessment of Benthic Infaunal Condition onthe Mainland Shelf of Southern California. Env. Monit. Assmt. 64:421–434.

Bienfang, P. K., H. Trapido-Rosenthal, and E. A. Laws 2103. Bioaccumulation/Biomagnifications in Food Chains. In: Environmental Toxicology. E. A. Laws (ed) 2013. Springer Publications. Print ISBN 978-1-4614-5763-3. Pp. 35-69.

Berman-Kowalewski, M., F. M. D. Gulland, S. Wilkin, J. Calambokidis, B. Mate, J. Cordaro, D. Rotstein, J. St. Leger, P. Collins, K. Fahy, and S. Dover 2010. Association between Blue Whale (Balaenoptera musculus) Mortality and Ship Strikes along the California Coast. Aquatic Mammals 36(1):59-66.

Bjorkstedt, E., Goericke, R., McClatchie, S., Weber, E., Watson, W., Lo, N., Peterson,

W., Brodeur, R., Bograd, S., Auth, T., Fisher, J., Morgan, C., Peterson, J., Durazo, R.,Gaxiola-Castro, G., Lavaniegos, B., Chavez, F., Collins, C. A., Hannah, B., Field, J., Sakuma, K., Satterthwaite, W., O'Farrell, M., Sydeman, W., Thompson, S.A., Warzybok, P. Bradley, R., Jahncke, J., Golightly, R., Schneider, S., Largier, J., Kim, S.Y., Melin, S., DeLong, R., and J. Abell 2013. State of the California Current 2011- 2012: Ecosystems Respond to Local Forcing as La Niña Wavers and Wanes, CalCOFI Reports 53, 41-78.

Boehm, A. B. and J. A. Soller 2013. Recreational Water Risk: Pathogens and Fecal Indicators. Environmental Toxicology 13:441-459.

Bossart, G. D. 2011. Marine Mammals as Sentinel Species for Oceans and Human Health. Veterinary Pathology: 48(3) 676-690.

Brodie, E. C., F. M. D. Gulland, D. J. Greig, M. Hunter, J. Jaakola, J. Leger, T. A. Leighfield, and F. M. Van Dolah 2006. Domoic Acid Causes Reproductive Failure in California Sea Lions (Zalophus Californianus). Marine Mammal Science, 22(3): 700–707.

Broughton, K. 2012. Office of National Marine Sanctuaries Science Review of Artificial Reefs. Marine Sanctuaries Conservation Series ONMS-12-05. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD. 42p.

Brown, D. A., R. W. Gossett, G. P. Hershelman, C. G. Word, A. M. Westcott, and J. N. Cross 1986. Municipal Wastewater Contamination in the Southern California Bight: Part I-Metal and Organic Contaminants in Sediments and Organisms. Mar. Environ. Res., 18:291–310.

Burtenshaw, J. C., E. M. Oleson, J. A. Hildebrand, M. A. McDonald, R. K. Andrew, B. M. Howe, and J. A. Mercer 2004. Acoustic and Satellite Remote Sensing of Blue Whale Seasonality and Habitat in the Northeast Pacific. Deep-sea Research II 51:967-986.

Butler, J., M. Neuman, D. Pinkard, R. Kvitek, and G. Cochrane 2006. The Use of Multibeam Sonar Mapping Techniques to Refine Population Estimates of the Endangered White Abalone (Haliotis sorenseni). Fishery Bulletin, 104(4), 521-532.

Butler, J. L., M. S. Love, and T. E. Laidig 2012. A Guide to the Rockfishes, Thornyheads, and Scorpionfishes of the Northeast Pacific. University of California Press. 185 p.

CalCOFI (California Cooperative Oceanic Fisheries Investigations) 2013. Review of Selected California Fisheries for 2012: Coastal Pelagic Finfish, Market Squid, Pacific Herring, Groundfish, Highly Migratory Species, White Seabass, Pacific Halibut, Red Sea Urchin, and Sea Cucumber. California Department of Fish and Wildlife. Fisheries Review. CalCOFI Rep., Vol. 54, 2013. 25 p.

California Fisheries Fund 2014. The California Fisheries Atlas. June 2014. http://www.californiafisheriesfund.org

Carlsbad Aquafarms 2021. http://www.carlsbadaquafarm.com/

Carretta, J. V. 2013. A Review of Sperm Whale (Physeter macrocephalus) Bycatch in the California Swordfish and Thresher Shark Drift Gillnet Fishery. Marine Mammal and Turtle Division. Southwest Fisheries Science Center. National Marine Fisheries Service, NOAA. 10p.

Carretta, J. V. and J. Barlow 2011. Long-Term Effectiveness, Failure Rates, and "Dinner Bell" Properties of Acoustic Pingers in a Gillnet Fishery. Marine Technology Society Journal 45(5): 7-15.

Carretta, J. V. and L. Enriquez 2012. Marine Mammal and Seabird Bycatch in California Gillnet Fisheries In 2011. NOAA Technical Memorandum NMFS. November 2012. 18p.

Carretta, J. V., T. Price, D. Petersen, and R. Read 2005. Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996–2002. Marine Fisheries Review 66(2): 21-31. http://spo.nmfs.noaa.gov/mfr662/mfr6623.pdf.

Carretta, J. V., S. M. Wilkin, M. M. Muto, and K. Wilkinson 2013. Sources of Human-Related Injury and Mortality for U. S. Pacific West Coast Marine Mammal Stock Assessments, 2007-2011. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-514. 87p.

Carretta, J. V., Oleson, D. W. Weller, A. R. Lang, K. A. Forney, J. Baker, B. Hanson, K. Martien, M. M. Muto, T. Or, H. Huber, M. S. Lowry, J. Barlow, D. Lynch, L. Carswell, R. L. Brownell Jr., and, D. K. Mattila 2014. U.S. Pacific Marine Mammal Stock Assessments: 2013. U. S. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-XXX. xxx p.

Carter, M., C. Hilbern, F. Mazzillo, C. Culver, and G. Langlois 2013. Southern California Perspective on Harmful Algal Blooms. CalCOFI Rep. Vol. 54. 4 p.

CDFG (California Department of Fish and Game) 1968. The Marine Environment Offshore from Point Loma, San Diego County. Marine Resources Operations. Fish Bulletin 140.

CDFG 2001. A Guide to the Artificial Reefs of Southern California. http://www.dfg.ca.gov/marine/artificialreefs.asp

CDFG 2005. Abalone Recovery and Management Plan. Adopted by the California Fish and Game Commission. December 9, 2005. FINAL. 353 p.

CDFG 2006. Update on Nearshore Fishery Management Plan Implementation. California Department of Fish and Game. Marine Region.

CDFW (California Department of Fish and Wildlife) 2013a. Status of the Fisheries Report an Update Through 2011. Report to the California Fish and Game Commission. January 2013. 277 p.

CDFW 2013b. Guide to the Southern California Marine Protected Areas Point Conception to California-Mexico Border. November 2013. 120 p.

CDFW 2014b. California Marine Life Management Act. www.wildlife.ca.gov

CDFW 2014c. California Nearshore Fishery Management Plan. www.wildlife.ca.gov

CDFW 2014d. White Seabass Fishery Management Plan. www.wildlife.ca.gov

CDFW 2014e. Market Squid Fishery Management Plan. www.wildlife.ca.gov

CDFW 2014f. Spiny Lobster Fishery Management Plan. www.wildlife.ca.gov

CDFW 2014g. Coastal Pelagic Species Landings. www.wildlife.ca.gov

CDFW 2014h. Abalone Recovery and Management Plan. www.wildlife.ca.gov

CDFW 2014j. Artificial Reefs. http://www.dfg.ca.gov/marine/artificialreefs.asp

CDFW 2021a. California Department of Fish and Wildlife Web Site. www.wildlife.ca.gov

CDFW 2021b. California Endangered Species Act. www.wildlife.ca.gov/conservation/CESA

CDFW 2021c State and Federal Endangered and Threatened Species List https://wildlife.ca.gov/Conservation/CESA/Summary-Reports#566973249-2021-report

CDFW 2021d. Marine Protected Areas. www.wildlife.ca.gov/Conservation/Marine/MPAs/Network/Southern-California

CDPH (California Department of Public Health) 2014. California Department of Public

Health. Web Page. http://www.cdph.ca.gov/Pages/DEFAULT.aspx

CFGC (California Fish and Game Commission) 2010. South Coast Marine Protected Areas Project Final Environmental Impact Report. December 2010. 457 p. plus Appendices

CFR (Code of Federal Regulations) 2013. 50 CFR 402.14 - Formal Consultation. Title 50: Wildlife and Fisheries. Subpart B: Consultation Procedures. Tuesday, October 1, 2013. http://www.gpo.gov/fdsys/pkg/CFR-2013-title50-vol11/pdf/CFR-2013-title50-vol11-sec402-14.pdf

Chenillat, F., P. Riviere, X. Capet, P. J. S. Franks, and B. Blanke 2013. California Coastal Upwelling Onset Variability: Cross-Shore and Bottom-Up Propagation in the Planktonic Ecosystem. PLoS ONE 8(5):e62281.

Chuenpagdee, R., L. E. Morgan, S. M. Maxwell, E. A. Norse, and D. Pauly 2003. Shifting Gears: Assessing Collateral Impacts of Fishing Methods in US Waters. Front. Ecol. Environ. 1(10): 517–524.

City of San Diego and Weston Solutions 2004. Mission Bay Clean Beaches Initiative Bacterial Source Identification Study. City of San Diego and Weston Solutions, Inc., San Diego California. Prepared for the State Water Resources Control Board, Sacramento, CA.

City of San Diego and Weston Solutions 2006. Final Report: Bacterial Source Tracking for Pacific Beach Point. June 2006. Prepared for the Metropolitan Wastewater Department, City of San Diego. Prepared by Weston Solutions, Inc.

City of San Diego 2000. City of San Diego. (2020). International Wastewater Treatment Plant Final Baseline Ocean Monitoring Report for the South Bay Ocean Outfall (1995–1998). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2008. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2007. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2008a. Mission Bay and La Jolla Watershed Urban Runoff Management Plan. Storm Water Pollution Prevention Division General Services Department. March 2008. http://www.projectcleanwater.org/pdf/wurmp/mb_wurmp_2008.pdf

City of San Diego 2009. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2008. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2010. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2009. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2011. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2010. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2012. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2011. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2013. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2012. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2014. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2013. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2015. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2014. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2016. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2015. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2016. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 20015. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2018. City of San Diego. (2018). Biennial Receiving Waters Monitoring and Assessment Report for the Point Loma and South Bay Ocean Outfalls, 2016–2017 including addendums. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2020. City of San Diego. (2020). Biennial Receiving Waters Monitoring and Assessment Report for the Point Loma and South Bay Ocean Outfalls, 2018–2019 including addendums. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego 2021. Lifeguard Service. http://www.sandiego.gov/lifeguards/beaches/index.shtml

CMLPA (California Marine Life Protection Act) 2009. Regional Profile of the MLPA South Coast Study Region (Point Conception to the California-Mexico Border). Second Edition. June 25, 2009. 193 p.

Coleman, F. C., W. F. Figueira, J. S. Ueland, and L. B. Crowder 2004. The Impact of United States Recreational Fisheries on Marine Fish Populations. Science 305: 1958-1960.

Colford, J. M. Jr., T. J. Wade, K. C. Schiff, C. C. Wright, J. F. Griffith, S. K. Sandhu, S. S. Burns, M. P. Sobsey, G. P. Lovelace, S. B, and Weisberg 2007. Water Quality Indicators and the Risk of Illness at Beaches with Nonpoint Sources of Fecal Contamination. Epidemiology. 18(1):27-35. January 2007.

Conversi, A. and J. A. McGowan 1992. Variability of Water Column Transparency, Volume Flow and Suspended Solids near San Diego Sewage Outfall (California): Fifteen Years of Data. Chemistry and Ecology 6: 133-147.

COPC 2021. California Ocean Protection Council. Overview of ocean Coastal Laws. www.opc.ca.gov

County of San Diego 2021. Beach and Bay Water Quality Monitoring Program. Department of Environmental Health. http://www.sdcounty.ca.gov/deh/water/beach_bay.html

Craig, M. T. and D. J. Pondella II 2005. Checklist of Fishes of the Cabrillo National Monument, San Diego, California. Report Submitted to the U.S. National Park Service, Cabrillo National Monument for Activities Conducted 1 January 2004- 31 December 2004 under permit No. CABR 2003-SCI-0010, May 25, 2005.

Crain, C. M., B. S. Halpern, M.W. Beck, and C. V. Kappel 2009. Understanding and Managing Human Threats to the Coastal Marine Environment. The Year in Ecology and Conservation Biology, 2009: Ann. N.Y. Acad. Sci. 1162:39–62 (2009). doi: 10.1111/j.1749-6632.2009.04496.x __c 2009 New York Academy of Sciences.

Cross, J. N. and L. G. Allen 1993. Fishes. In: Ecology of the Southern California Bight. Dailey, M. D., D. J. Reish, and J. W. Anderson (eds). University of California Press. Berkeley, California. pp. 459-540.

CSULB 2013. (California State University at Long Beach) 2013. Oceanography of the Southern California Bight. Perspectives on the Pacific Ocean Offshore

Dailey, M. D., J. W. Anderson, D. J. Reish, and D. S. Gorsline 1993. The California Bight: Background and Setting. In: Dailey, M. D., D. J. Reish, and J. W. Anderson. (eds). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, CA, pp. 1–18.

Daley, J. M., G. Paterson, and K. G. Drouillard 2014. Bioamplification as a Bioaccumulation Mechanism for Persistent Organic Pollutants (POPs) in Wildlife. In: Whitacre, D. M. (ed) 2014. Reviews of Environmental Contamination and Toxicology. Vol. 227:107-155. Springer. New York. Print: ISBN 978-3-319-01326-8. eBook: ISBN 978-3-319-01327-5. Online: http://www.springer.com/environment/environmental+toxicology/book/978-3-319-01326-8.

Davidson, A. D., A. G. Boyer, H. Kim, S. Pompa-Mansilla, M. J. Hamilton, D. P. Costa, G. Ceballos, and J. H. Brown 2011. Drivers and Hotspots of Extinction Risk in Marine Mammals. Proceedings of the National Academy of Sciences. 6 p. http://www.pnas.org/content/109/9/3395

Dawson, J. K. and R. E. Pieper 1993. Zooplankton. In: M. D. Dailey, D. J. Reish, and J. W. Anderson (eds). Ecology of the Southern California Bight. Berkeley: University of California Press. pp. 266-304.

Dayton, P. K. and M. J. Tegner 1984. Catastrophic Storms, El Niño, and Patch Stability in a Southern California Kelp Forest Community. Science 224: 283-285.

Dayton, P. K. and M. J. Tegner 1990. Bottoms beneath Troubled Waters: Benthic Impacts of the 1982-1984 El Niño in the Temperate Zone. In: P. Glenn (ed) Global Ecological Consequences of the 1982-1984 El Niño-Southern Oscillation. Pages 433-472. Elsevier Oceanography Series No. 52. Amsterdam, the Netherlands.

Dayton, P. K., M. J. Tegner, P. E. Parnell, and P. B. Edwards 1992. Temporal and Spatial Patterns of Disturbance and Recovery in a Kelp Forest Community. Ecological Monographs 62(3): 421-445.

Dayton, P. K., S. Thrush, and S. A. Coleman 2003. Ecological Effects of Fishing in Marine Ecosystems of the United States. Prepared for the Pew Ocean Commission. 52p.

Dayton, P., P. E. Parnell, L. L. Rasmussen, E. J. Terrill, and T. D. Stebbins 2009. Point Loma Ocean Outfall Plume Behavior Study, Scope of Work. Scripps Institution of Oceanography, La Jolla, CA, and City of San Diego, Metropolitan Wastewater Department, San Diego, CA.

Deysher, L. E. 1984. Recruitment Processes in Benthic Marine Algae. Ph.D. Dissertation. University of California, San Diego. 324p.

Diener, D., B. Riley, G. Robertson, D. Mauer, T. Gerlinger, and I. Haydock 1997. An Ocean Outfall as an Artificial Reef: Impacts to the Benthic Environment and a Balanced Indigenous Population. In: Conf. Proc. Calif. and the World Ocean. 1307-1317.

Dieter, B. E., D. A. Wion, and R. A. McConnaughey 2003. Mobile Fishing Gear Effects on Benthic Habitats: A Bibliography. NOAA Tech. Memo. NMFS-AFSC-135, 206 p.

DOALOS (Division for Ocean Affairs and the Law of the Sea). 2014. Maritime Zones and Delimitation. http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm.

Dodder NG, Maruya KA, Lauenstein GG, Ramirez J, Ritter KJ, Schiff KC. (2012) Distribution and sources of polybrominated diphenyl ethers in the Southern California Bight. Environmental Toxicology and Chemistry, Vol 31(10):2239-45.

Dodder N., Schiff K., Latker A., and Tang C. (2016) Southern California Bight 2013 Regional Monitoring Program: Volume IV. Sediment Chemistry. SCCWRP Technical Report 922.

Doney S.C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley 2012. Climate Change Impacts on Marine Ecosystems Ann. Rev. Marine. Sci. 2012.4:11-37.

Doyle, M. J., W. Watson, N. M. Bowlin, and S. B. Sheavly 2011. Plastic Particles in Coastal Pelagic Ecosystems of the Northeast Pacific Ocean. Marine Environmental Research 71(1):41-52.

Dutton, P. H. 2006. Building our Knowledge of the Leatherback Stock Structure. SWoT Report-State of the World's Sea Turtles, I, 10-11. http://seaturtlestatus.org/report/swot-volume-1

Eckert, K. L. 1993. The Biology and Population Status of Marine Turtles in the North Pacific Ocean. NOAA/NMFS Tech. Memo SWFSC 186. 156 p.

Eguchi, T., J. A. Seminoff, R. A. LeRoux, P. H. Dutton, and D. L. Dutton 2010. Abundance and Survival Rates of Green Turtles in an Urban Environment: Coexistence of Humans and an Endangered Species. Mar. Biol. 157(8):1869–1877.

Elfes, C. T., G. R. Vanblaricom, D. Boyd, J. Calambokidis, P. J. Clapham, R. W. Pearce, J. Robbins, J. C. Salinas, J. M. Straley, P. R. Wade, and M. M. Krahn 2010. Geographic Variation of Persistent Organic Pollutant Levels in Humpback Whale (Megaptera novaeangliae) Feeding Areas of the North Pacific and North Atlantic. U. S. Department of Commerce. Paper 166. 14 p.

Engle, D. L. and J. Largier 2006. Assessment of Coastal Water Resources and Watershed Conditions at Cabrillo National Monument. National Park Service. Technical Report NPS/NRWRD/NRTR-2006/335. 235p.

EPA (Environmental Protection Agency) 2000. Guidelines for Assessing Chemical Contaminant Data for Use in Fish Advisories. 3rd edition. Vol 2.

EPA 2001. Water Quality Criteria: Notice of Availability of Water Quality Criterion for the Protection of Human Health: Methyl Mercury; Final Rule. U.S. Environmental Protection Agency, Washington, D.C. Federal Register: January 8, 2001, Vol. 66, No. 5, pp 1344-1359.

EPA 2004. 40 CFR Part 131 Water Quality Standards for Coastal and Great Lakes Recreation Waters; Final Rule. Federal Register Volume 69, No, 220, pages 67281-67243.

EPA 2007. Guidelines for Assessing Chemical Contaminant Data for Use in Fish Advisories. http://www.USEPA.gov/waterscience/fish/.

EPA 2021. Water Quality Assessment. CWA sec. 303(d) Impaired Waters and Total Maximum Daily Loads (TMDL)http://www.epa.gov/waters/tmdl

EPA 2012a. Marine Debris Impacts. http://water.epa.gov/type/oceb/marinedebris/md_impacts.cfm.

EPA 2012b. Recreational Water Quality Criteria. EPA Office of Water Publication 820-F-12-058.

EPA 2014a. Fish Consumption Advisories. https://www.epa.gov/choose-fish-and-shellfish-wisely/fish-and-shellfish-advisories-and-safe-eating-guidelines

EPA 2014b. Microbial Pathogens. http://water.epa.gov/scitech/swguidance/standards/criteria/health/microbial/index.cf

EPA 2014c. Human Health. http://water.epa.gov/scitech/swguidance/standards/criteria/health/

EPA 2014d. Human Health. http://water.epa.gov/scitech/swguidance/standards/criteria/health/

EPA 2017. NPDES No. CA0107409 and RWQCB Order No R9-2017-0007. (2017)

Eppley, R. W. (ed) 1986. Plankton Dynamics of the Southern California Bight. Springer-Verlag. 373 p.

Erbe C., A. MacGillivray, and R. Williams 2012. Mapping Cumulative Noise from Shipping to Inform Marine Spatial Planning. Journal of the Acoustical Society of America 132(5): 423-428.

ERISS (ERISS Corporation) 2012. San Diego Industry Maritime Report 2012. 84 p. http://www.eriss.com/

Eschmeyer, W. N., E. S. Herald, and H. Hammann 1985. A Field Guide to Pacific Coast Fishes of North America. Houghton Mifflin Company. Boston. 336 p.

Evans, K., M. Hindell, and G. Hince 2004. Concentrations of Organochlorines in Sperm Whales (Physeter macrocephalus) from Southern Australian Waters. Marine Pollution Bulletin 48:486-503.

FDA (U. S. Food and Drug Administration) 2014. Seafood Safety. http://www.fda.gov/Food/PopularTopics/ucm341987.htm

Fenberg, P. B. and K. Roy 2012. Anthropogenic Harvesting Pressure and Changes in Life History: Insights from a Rocky Intertidal Limpet. The American Naturalist Vol. 180(2): 200-210.

Fiedler, P. C., R. Mendelssohn, D. M. Palacios, and S. J. Bograd 2013. Pycnocline Variations in the Eastern Tropical and North Pacific, 1958–2008. Journal of Climate 26:583-599.

Field, J. C., D. F. Boesch, D. Scavia, R. Buddemeier, V. R. Burkett, D. Cayan, M. Fogarty, M. Harwell, R. Howarth, C. Mason, L. J. Pietrafesa, D. Reed, T. Roye, A. Sallenger, M. Spranger, and J. G. Titus 2003. Potential Consequences of Climate Variability and Change on Coastal Areas and Marine Resources. In: Climate Change Impacts in the United States. US Global Change Research Program: 461-487. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/foundation.htm.

Fiedler, P. C., R. Mendelssohn, D. M. Palacios, and S. J. Bograd 2013. Pycnocline Variations in the Eastern Tropical and North Pacific, 1958–2008. Journal of Climate 26:583-599.

Foster, M. S., and D. R. Schiel 1985. The Ecology of Giant Kelp Forests in California: A Community Profile. Biological Report 85. Washington, D.C.: U.S. Fish and Wildlife Service. 185p.

Foster, M. S., D. C. Reed, P. K. Dayton, M. H. Carr, D. P. Malone, J. S. Pearse, and L. Rogers-Bennett 2013. Kelp Forests in California. In M. A. Lang, R. L. Marinelli, S. J. Roberts, and P. R. Taylor (eds). Research and Discoveries: The Revolution of Science through Scuba. Smithsonian Contributions to the Marine Sciences, No. 39, Washington, D.C.: Smithsonian Institution Scholarly Press. pp. 115–132.

Froese, R. and D. Pauly. Editors 2013. FishBase. World Wide Web Electronic Publication. www.fishbase.org, Version (10/2013).

Frost, N. 2013. California Least Tern Breeding Survey, 2012 Season. California Department of Fish and Wildlife. Wildlife Branch. Nongame Wildlife Program Report. 2013-01. Sacramento, CA. 78p.

Gallo, J. P. 1994. Factors Affecting the Population Status of Guadalupe Fur Seal, Arctocephalus townsendi (Merriam, 1897), at Isla de Guadalupe, Baja California, Mexico. Ph.D. Thesis, University of California, Santa Cruz. 199 p.

Gauthier, J. M., C. D. Metcalfe, and R. Sears 1997. Chlorinated Organic Contaminants in Blubber Biopsies from Northwestern Atlantic Balaenopterid Whales Summering in the Gulf of St Lawrence. Marine Environmental Research 44(2):201-223.

Geijer, C. K. A. and A. J. Read 2013. Mitigation of Marine Mammal Bycatch in U.S. Fisheries since 1994. Biological Conservation 159:54-60.

General Dynamics NASSCO 2014. General Dynamics NASSCO Web Site. http://www.nassco.com/index.html

Gerodette, T. 1971. Ecological Studies of Two Temperate Solitary Corals. Dissertation. University of California, San Diego.

Goes, J. I., H. D. R. Gomes, A. Limsakul, W. M. Balch, and T. Saino 2001. El Niño Related Interannual Variations in Biological Production in the North Pacific as Evidenced by Satellite and Ship Data. Progress in Oceanography 49:211-225.

Goldbogen, J. A., B. L. Southall, S. L. DeRuiter, J. Calambokidis, A. S. Friedlaender, E. L. Hazen, E. A. Falcone, G. S. Schorr, A. Douglas, D. J. Moretti, C. Kyburg, M. F. McKenna, and P. L. Tyack 2013. Blue Whales Respond to Simulated Mid-Frequency Military Sonar. Proc. R. Soc. B 2013 280, 20130657, published 3 July 2013.

Graham, M. H., 2000. Role of Pre-Settlement Processes in the Population Dynamic of Subtidal Kelp. Ph.D. Thesis. University of California, San Diego.

Graham, M. H. 2004. Effects of Local Deforestation of the Diversity and Structure of Southern California Giant Kelp Forest Food Webs. Ecosystems 7:341-357.

Griffith, J., K. Schiff, G. Lyon, and J. Fuhrman 2010. Microbiological Water Quality at Non-Human Influenced Reference Beaches in Southern California During Wet Weather. Marine Pollution Bulletin 60:500–508.

Griffith, J. F., B. A. Layton, A. B. Boehm, P. A. Holden, J. A. Jay, C. Hagedorn, C. D. McGee, and S. B. Weisberg 2013. The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches. Southern California Coastal Water Research Project. Technical Report 804. December 2013. 88p.

Groce, A. K. 2002. Influence of Life History and Lipids on the Bioaccumulation of Organochlorines in Demersal Fishes. Master's Thesis. San Diego State University. San Diego, CA.

Guisado, R. and J. Klaas 2013. Surfing California: A Guide to the Best Breaks and SUP-Friendly Spots in California. A Falcon Guide. 343 p.

Gulland, E. M., M. Haulena, D. Fauquier, M. E. Lander, T. Zabka, R. Duerr, and G. Langlois 2002. Domoic Acid Toxicity in Californian Sea Lions (Zalophus californianus): Clinical Signs, Treatment and Survival. Veterinary Record 150(15):475-480.

Hackett, D., M. Hansen, and K. King 2009. The Economic Structure of California's Commercial Fisheries. California Department of Fish and Game. 91p.

Haile, R. W., J. S. Witte, M. Gold, R. Cressey, C. McGee, R. C. Millikan, A. Glasser, N. Harawa, C. Ervin, P. Harmon, J. Harper, J. Dermand, J. Alamillo, K. Barrett, M. Nides and G.-Y. Wang 1999. The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff. Epidemiology 10:355-363.

Halpern, B. S. C. V. Kappel, K. A. Selkoe, F. Micheli, C. M. Ebert, C. Kontgis, C. M. Crain, R. G. Martone, C. Shearer, and S. J. Teck 2009. Mapping Cumulative Human Impacts to California Current Marine Ecosystems. Conservation Letters 2:138–148.

Hamilton, Jr., A. N. 2000. Gear Impacts on Essential Fish Habitat in the Southeastern Region. National Marine Fisheries Service. Southeast Fisheries Science Center.

Hanemann, M., L. Pendleton, C. Mohn, J. Hilger, K. Kurisawa, D. Layton, C. Busch, and F. Vasquez 2004. Southern California Beach Valuation Project. Submitted to the U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration (NOAA). 83 p.

Hanson, J., M. Helvey, and R. Strach (eds) 2003. Non-fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures. National Marine Fisheries Service (NOAA Fisheries). Version 1. Southwest Region, Long, Beach, CA.

Hardy, J. T. 1993. Phytoplankton. In: Dailey, M. D., D. J. Reish, and J. W. Anderson (eds). Ecology of the Southern California Bight. Berkeley: University of California Press. pp. 233-265.

Harwood, V. J., C. Staley, B. D. Badgley, K. Borges, and A. Korajkic 2013. Microbial Source Tracking Markers for Detection of Fecal Contamination in Environmental Waters: Relationships between Pathogens and Human Health Outcomes FEMS Microbiol. Rev. 38:1–40.

Harvey, J., Thomas, K., Goldstein, T., Barakos, J., and F. Gulland 2010. Movement, Dive Behavior, and Survival of California Sea Lions (Zalophus californianus) Posttreatment for Domoic Acid Toxidosis. Marine Mammal Science 26(1):36-52.

Hartmann, A.R. 1987. Movement of Scorpionfishes (Scorpaenidae: Sebastes and Scorpaena) in the Southern California Bight. California Fish and Game, 73: 68–79.

Hayward, T. L. 2000. El Niño 1997-98 in the Coastal Waters of Southern California: A Timeline of Events. CalCOFl Reports 41:98-116.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson 2007. Vessel Speed Increases Collision Risk for The Green Sea Turtle Chelonia mydas. Endangered Species Research, 3(2), 105-113. doi: 10.3354/esr003105.

Hazen E. L., I. D. Schroeder, J. Peterson, W. T. Peterson, W. J. Sydeman, S. A. Thompson, B. K. Wells, and S. J. Bograd 2012. Oceanographic and Climatic Drivers and Pressures. CCIEA Phase II Report 2012: Drivers and Pressures – Ocean and Climate. NOAA Fisheries. 60p.

Hazen, E. L., S. Jorgensen, R. R. Rykaczewski, S. J. Bograd, D. G. Foley, I. D. Jonsen, S. A. Shaffer, J. P. Dunne, D. P. Costa, L. B. Crowder, and B. A. Block 2012. Predicted Habitat Shifts of Pacific Top Predators in a Changing Climate. 13 p. Nature Climate Change Letters. 23 SEPTEMBER 2012. www.nature.com/natureclimatechange.

Heal the Bay 2020. The Beach Report Card. Annual Report 2019-2020.Report-2020_web.pdf (healthebay.org)

Hess, M. 2018-2021, Satellite and Aerial Coastal Water Quality Monitoring in the San Diego/Tijuana Region, Annual Summary Reports. Ocean Imaging. www.oceani.com

Hernández de la Torre, B., G. Gaxiola-Castro, and S. Nájera-Martínez 2004. ENSO Effects on Primary Production off Baja California. Ciencias Marinas 30(3):427-441.

Hewitt, J. E., S. F. Thrush, P. K. Dayton, and Erik Bonsdorff 2007. The Effect of Spatial and Temporal Heterogeneity on the Design and Analysis of Empirical Studies of Scale-Dependent Systems. The American Naturalist, volume 169 (2007), pp. 398–408.

Hickey, B. M. 1993. Physical Oceanography. In: M. D. Dailey, D. J. Reish, and J. W. Anderson (eds) 1993. Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press. Berkeley, CA. pp. 19-70.

Hilborn, R. and U. Hilborn 2012. Overfishing: What Everyone Needs to Know. Oxford University Press., New York. 150 p.

Hildebrand, J. A. 2009. Anthropogenic and Natural Sources of Ambient Noise in the Ocean. Marine Ecology Progress Series, vol. 395: 5-20.

Hoegh-Guldberg, O. and J. F. Bruno 2010. The Impact of Climate Change on the World's Marine Ecosystems. Science 328:1523-1528.

Hood, D. W. 1993. Ecosystem Interrelationships. In M. D. Dailey, D. J. Reish, and J. W. Anderson (eds) 1993. Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press. Berkeley, CA. pp. 782-835.

Horn, M. H., and L. G. Allen 1978. A Distributional Analysis of California Coastal Marine Fishes. Journal of Biogeography 5:23-42.

Horn, M. H. and J. S. Stephens, Jr. 2006. Climate Change and Overexploitation. P. 621-660. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters.

Horn, M. H., L. G. Allen, and R. N. Lea. 2006. Biogeography. Chapter 1. pp. 3-25. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds). 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press, Berkeley, California

Horner R.A., Garrison D.L., and Plumley F.G., (1997) Harmful algal blooms and red tide problems on the U.S. west coast. Limnology and Oceanography 42(2).

Howard, M. D. A., G. Robertson, M. Sutula, B. Jones, N. Nezlin, Y. Chao, H. Frenzel, M. Mengel, D.A. Caron, B. Seegers, A. Sengupta, E. Seubert, D. Diehl, and S.B. Weisberg 2012. Southern California Bight 2008 Regional Monitoring Program: Volume VII. Water Quality. Technical Report 710. Southern California Coastal Water Research Project. Costa Mesa, CA

Howard M. D. A., M. Sutula, D. A. Caron, Y. Chao, J. D. Farrara, H. Frenzel, B. Jones, G. Robertson, K. McLaughlin, and A. Sengupta 2014. Anthropogenic Nutrient Sources Rival Natural Sources on Small Scales in the Coastal Waters of the Southern California Bight. Limnol. Oceanogr. 59(1)285-297.

Howell, E. A., S. J. Bograd, C. Morishige, M. P. Seki, and J. J. Polovina 2012. On North Pacific Circulation and Associated Marine Debris Concentration. Marine Pollution Bulletin, 65(1–3):16-22. http://www.sciencedirect.com/science/article/pii/S0025326X11002372

Hsieh, C., C. S. Reiss, J. R. Hunter, J. R. Beddington, R. M. May, and G. Sugihara 2006. Fishing Elevates Variability in the Abundance of Exploited Species. Nature. Vol 443: 859-862.

Hubbs, C. L. 1956. The Guadalupe Fur Seal Still Lives! Zoonooz, S. D. Zool. Soc. 29(12):6-9.

Hubbs-SeaWorld Research Institute 2021. Aquaculture Program. Ocean Resources Enhancement and Hatchery Program (OREHP) | Home (hswri.org)

Hutchinson, T. H., B. P. Lyons, J. E. Thain, and R. J. Law 2013. Evaluating Legacy Contaminants and Emerging Chemicals in Marine Environments Using Adverse Outcome Pathways and Biological Effects-Directed Analysis. Mar. Pollut. Bull. (2013): http://dx.doi.org/10.1016/j.marpolbul.2013.06.012

Ihde J. F., M. J. Wilberg, D. A. Loewensteiner, D. H. Secor, and T. J. Miller 2011. The Increasing Importance of Marine Recreational Fishing in the US: Challenges for Management. Fisheries Research 108, 268–276.

Imamura, G. J., R. S. Thompson, A. B. Boehm, and J. A. Jay 2012. Wrack Promotes the Persistence of Fecal Indicator Bacteria in Marine Sands and Seawater. FEMS Mirobiological Ecology 77:40-49.

IPHC (International Pacific Halibut Commission) 2014. http://www.iphc.washington.edu/

Jackson, J. B. C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H, S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S. Steneck, M. J. Tegner, and R. R. Warner 2001. Historical Overfishing and the Recent Collapse of Coastal Ecosystems. Science: 293 (629-638).

Jackson, J. B. C. 2008. Ecological Extinction and Evolution in the Brave New Ocean. PNAS 105: 11458–11465. www.pnas.org.cgi.doi.10.1073.pnas.0802812105.

Jackson, J. B. C., E. Sala, and K. E. Alexander (eds) 2011. Shifting Baselines: The Past and the Future of Ocean Fisheries. Island Press. Washington, D. C. 283 p.

Jefferson, T. A., M. A. Webber, and R. L. Pitman 2011. Marine Mammals of the World: A Comprehensive Guide to their Identification. London, UK, Elsevier: 573 p.

Johnson, K. A. 2002. A Review of National and International Literature on the Effects of Fishing on Benthic Habitat. NOAA Tech. Memo. NMFS-F/SPO-57.

Jones, M. L. and S. L. Swartz 2009. Gray whale Eschrichtius robustus. In. Encyclopedia of Marine Mammals. W. F. Perrin, B. Wursig and J. G. M. Thewissen (eds). Academic Press: 503-511.

Kahru, M. and B. G. Mitchell. 2000. Influence of the 1997-98 El Niño on the Surface Chlorophyll in the California Current. Geophysical Research Letters 27:2937-2940.

Kim, H. J., A. J. Miller. J. McGowan, and M. L. Carter 2009. Coastal Phytoplankton Blooms in the Southern California Bight. Progress in Oceanography. 82:137-147.

Kahru M., Kudela R.M., Manzano-Sarabia M., and Mitchell B.G. (2012) Trends in the surface chlorophyll of the California Current: Merging data from multiple ocean color satellites. Deep Sea Research Part II: Topical Studies in Oceanography 77: 89–98.

Kim H., Miller A.J., McGowan J., and Carter M.L. (2009) Coastal phytoplankton blooms in the Southern California Bight. Progress in Oceanography 82: 137-147.

Klasing, S. and R. Brodberg 2008. Fish Contaminant Goals and Advisory Tissue Levels for Contaminants in Sport Fish. Pesticide and Environmental Toxicology Branch. Office of Environmental Health Hazard Assessment. California Environmental Protection Agency. June 2008. 122p.

Klasing, S. and R. Brodberg 2011. Fish Contaminant Goals and Advisory Tissue Levels for Contaminants in Sport Fish: PBDEs. Pesticide and Environmental Toxicology Branch. Office of Environmental Health Hazard Assessment. California Environmental Protection Agency. June 2011. 40p.

Koslow, A. J, R. Goericke, and W. Watson 2013. Fish Assemblages in the Southern California Current: Relationships with Climate, 1951–2008. Fisheries Oceanography. 22:207–219.

Krival, D. 2001. Diving & Snorkeling Southern California & the Channel Islands. Melbourne, Australia: Lonely Planet Publications.

Kudela, R. M., and W. P. Cochlan 2000. Nitrogen and Carbon Uptake Kinetics and The Influence of Irradiance for a Red Tide Bloom off Southern California. Aquatic Microbial Ecology 21:31-47.

Kudela, R., W. Cochlan, and A. Roberts 2003. Spatial and Temporal Patterns of Pseudo-nitzschia spp. in Central California Related to Regional Oceanography. In: K. A. Steidinger, J. H. Landsberg, C. R. Tomas, and G. A. Vargo (eds) 2002. Harmful Algae. Florida Wildlife Conservation Commission, Florida Institute of Oceanography, and Intergovernmental Oceanographic Commission of UNESCO.

LACSD 2016. Los Angeles County Sanitation District. (2016). Joint Water Pollution Control Plant. Biennial Receiving Water Monitoring Report 2014-2915. Los Angeles CA.

Laugen, A. T., G. H. Engelhard, R. Whitlock, et al. 2014. Evolutionary Impact Assessment: Accounting for Evolutionary Consequences of Fishing in an Ecosystem Approach to Fisheries Management. Fish and Fisheries. Vol. 15, (1): 65-96. http://dx.doi.org/10.1111/faf.12007.

Lavaniegos, B. E., G. Gaxiola-Castro, L. C. Jimenez-Perez, M. R. Gonzalez-Esparza, T. Baumgartner, and J. Garcia-Cordova 2003. 1997-98 El Niño Effects on the Pelagic Ecosystem of the California Current off Baja California, Mexico. Geofisica Internacional 42:483-494.

Laws, E. A. (ed) 2013. Environmental Toxicology. Springer Verlag. ISBN-13: 9781461457633. 737 p. http://www.springer.com/978-1-4614-5763-3

Lazar, B. and R. Gračan 2011. Ingestion of Marine Debris by Loggerhead Sea Turtles, Caretta caretta, in the Adriatic Sea. Marine Pollution Bulletin 62(1):43-47.

Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson 2001. California's Living Marine Resources: A Status Report. California Department of Fish & Game. 592 p.

Lew, D. K. and D. M. Larson 2005. Valuing Recreation and Amenities at San Diego County Beaches. Coastal Management 33:71–86.

Linden, P., Shaffer, L., Dayton, P., Parnell, E., Rasmussen, L., Bartlett, D., Dohan, K., and R. Gersberg 2007. Point Loma Outfall Review. Final Report. University of California, San Diego. October 1, 2007. 34p.

Lindholm, J., M. Gleason, D. Kline, L. Clary, S. Rienecke, and M. Bell 2011. Trawl Impact and Recovery Study: 2009-2010 Summary Report. California Ocean Protection Council. 39 p.

Lluch-Belda, D., D. B. Lluch-Cota, and S. E. Lluch-Cota 2003. Scales of Interannual Variability in the California Current System: Associated Physical Mechanisms and Likely Ecological Impacts. California Cooperative Oceanic Fisheries Investigations Reports 44:76-85.

Love, M. S. 2006. Subsistence, Recreational and Commercial Fisheries. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds). 2006. Chapter 22. pp. 567-594.

Love, M.S. 2011. Certainly More Than You Want to Know About the Fishes Pacific Coast – A Postmodern Experience. Really Big Press. Santa Barbara, California.

Love, M. S. and M. Nishimoto 2012. Fish Assemblage Surveys around Manmade Structures and Natural Reefs off California. BOEM OCS Study 2012-020 Marine Science Institute, University of California, Santa Barbara, California. BOEM Cooperative Agreement No.: M10AC2001.

Love, M. S., B. Axell, P. Morris, R. Collins, and A. Brooks 1987. Life History and Fishery of the California Scorpionfish, Scorpaena guttata, Within the Southern California Bight. Fisheries Bulletin, 85: 99–116.

Love, M. S., J. E. Caselle, and W. Van Buskirk 1998a. A Severe Decline in the Commercial Passenger Fishing Vessel Rockfish (Sebastes Spp.) Catch in the Southern California Bight, 1980-1996. CalCOFI Rep.39:180–195.

Love, M. S., J. E. Caselle, and K. Herbinson 1998b. Declines in Nearshore Rockfish Recruitment and Populations in the Southern California Bight as Measured by Impingement Rates in Coastal Electrical Power Generating Stations. U. S. Fish. Bull. 96:492–501.

Love, M. S., M. Yoklavich, and L. Thorsteinson 2002. The Rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.

Love, M. S, M. Yoklavich, and D. M. Schroeder 2009. Demersal Fish Assemblages in the Southern California Bight Based on Visual Surveys in Deep Water. Environ. Biol. Fish 84:55–68.

Lovell, S., S. Steinback, and J. Hilger 2013. The Economic Contribution of Marine Angler Expenditures in the United States, 2011. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-134, 188 p.

Lundquist, C. J., L. W. Botsford, L. Morgan, J. M. Diehl, T. Lee, D. R. Lockwood, and E. L. Pearson 2000. Effects of El Niño and La Niña on Local Invertebrate Settlement in Northern California. California Cooperative Oceanic Fisheries Investigations Reports 41:167-176.

Lyon, G. S., and M. A. Sutula 2011. Effluent Discharges to the Southern California Bight from Large Municipal Wastewater Treatment Facilities from 2005 to 2009. In: SCCWRP Annual Report 2011. 14 p.

Mai, T. T. and K. A. Hovel 2007. Influence of Local-Scale and Landscape-Scale Habitat Characteristics on California Spiny Lobster (Panulirus interruptus) Abundance and Survival. Marine and Freshwater Research 58(5) 419–428.

Marine Research Specialists 2014. Rose Canyon Fisheries, Sustainable Aquaculture Project. Final Report. 2014

Marsili, L., and S. Focardi 1996. Organochlorine Levels in Subcutaneous Blubber Biopsies of Fin Whales (Balaenoptera physalus) and Striped Dolphins (Stenella coeruleoalba) from the Mediterranean Sea. Environmental Pollution 91(1):1-9.

Martin, A. and S. Gruber 2005. Amplification of Indicator Bacteria in Organic Debris on Southern California Beaches. Technical Paper 0507. Weston Solutions, Inc. Presented at StormCon 2005. Orlando, FL, USA. July 2005. 7 p.

Maruya, K. A., D. Schlenk, P. D. Anderson, N. D. Denslow, J. E. Drewes, A. W. Olivieri, G. I. Scott, and S. A. Snyder 2014. An Adaptive, Comprehensive Monitoring Strategy for Chemicals of Emerging Concern (CECs) in California's Aquatic Ecosystems. Integrated Environmental Assessment and Management. Volume 10, Issue 1:69–77.

NASSCO 2021. General Dynamics NASSCO website 2021. https://www.NASSCO.com

MBC (Marine Biological Consultants) 2012. Status of the Kelp Beds 2011: San Diego and Orange Counties. Region Nine Kelp Survey Consortium. June 2012. 231 p.

McClatchie, S. 2014. Regional Fisheries Oceanography of the California Current System: The CalCOFI program. Springer. 235 p.

McDonald, D., P. Dutton, D. Mayer, and K. Merkel 1995. Review of The Green Turtles of South San Diego Bay in Relation to The Operations of the SDG&E South Bay Power Plant. Prepared for San Diego Gas & Electric Company. 27 p.

McDonald, M., J. Hildebrand, S. Wiggins, and D. Ross 2008. 50 Year Comparison of Ambient Ocean Noise Near San Clemente Island: A Bathymetrically Complex Coastal Region off Southern California. Journal of the Acoustical Society of America: 1985-1992.

McDonald, B. D., R. L. Lewison, S. V. Madrak, J. A. Seminoff, and T. Eguchi 2012. Home Ranges of East Pacific Green Turtles Chelonia mydas in a Highly Urbanized Temperate Foraging Ground. Marine Ecology Progress Series 461:211-221.

McGowan, J. A. 1984. The California El Niño, 1983. Oceanus 27:48-51.

McGowan, J. A., D. R. Cayan, and L. M. Dorman 1998. Climate-ocean Variability and Ecosystem Response in the Northeast Pacific. Science 281:210-217.

McGowan J.A., Deyle E.R., Ye H., Carter M.L., Perretti C.T., Seger K.D., de Verneil A. and Sugihara G. (2017) Predicting coastal algal blooms in southern California. Ecology 98: 1419-1433.

McKinney, J. 2013. Reef Impact Mitigation: A Policy Framework for California. University of Washington. Masters in Policy Studies. 74 p.

McPeak, R. H. and D. A. Glantz 1984. Harvesting California's Kelp Forests. Oceanus 27(1):19-26.

McQuaig, S. J. Griffith, and V. J. Harwood 2012. Association of Fecal Indicator Bacteria with Human Viruses and Microbial Source Tracking Markers at Coastal Beaches Impacted by Nonpoint Source Pollution. Applied and Environmental Microbiology Volume 78, Number 18: 6423–6432.

Mearns, A. J., M. Matta, G. Shigenaka, D. MacDonald, M. Buchman, H. Harris, J. Golas, and G. Lauenstein 1991. Contaminant Trends in the Southern California Bight: Inventory and Assessment. NOAA Technical Memorandum NOS ORCA 62. Seattle, WA.

Miller, A. J. 1996. Recent Advances in California Current Modeling: Decadal and Interannual Thermocline Variations. In: California Cooperative Fisheries Investigations Reports. 37: 69-79.

Miller, K. A. 2005. Seaweeds of Cabrillo National Monument: an annotated list. University Herbarium, University of California, Berkeley, CA, December 2005.

Miller, E. F. and K. Schiff 2012. Descriptive Trends in Southern California Fishes, 1994-2008. SCCWRP Annual Report 2012: 129-144.

Miller, E. F. and J. A. McGowan 2013. Faunal Shift in Southern California's Coastal Fishes: A New Assemblage and Trophic Structure Takes Hold. Estuarine, Coastal and Shelf Science. Vol. 127:29-36.

Miller A. J., H. Song, and A. C. Subramaniana 2013. The Physical Oceanographic Environment during the CCE Years: Changes in Climate and Concepts. Deep-Sea Research II. Special Issue on the California Current Ecosystem. 27 p.

Mills, C. M. and J. E. Walsh 2013. Seasonal Variation and Spatial Patterns of the Atmospheric Component of the Pacific Decadal Oscillation. J. Climate 26: 1575–1594.

Moore, J. E. and J. Barlow 2011. Bayesian State-Space Model of Fin Whale Abundance Trends From a 1991-2008 Time Series of Line-Transect Surveys in the California Current. Journal of Applied Ecology: 1-11.

Moore, J. E. and J. P. Barlow 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE 8(1):e52770. doi:10.1371/journal.pone.0052770. 12 p.

Moore, M. J., J. van der Hoop, S. G. Barco, A. M. Costidis, F. M. Gulland, P. D. Jepson, K. T. Moore, S. Raverty, and, W. A. McLellan (eds) 2013. Criteria and Case Definitions for Serious Injury and Death of Pinnipeds and Cetaceans Caused by Anthropogenic Trauma. Dis. Aquat. Org. Vol. 103: 229–264.

Morejohn, G. V., J. T. Harvy, and L. T. Krasnow 1978. The Importance of Loligo

Opalescens in the Food Web of Marine Vertebrates in Monterey Bay, California. California Department of Fish and Game Fish Bulletin 169:67-98.

Mrosovsky, N., G. D. Ryan, and M. C. James 2009. Leatherback Turtles: The Menace of Plastic. Marine Pollution Bulletin 58:287-289.

NAVFAC (Naval Facilities Engineering Command) 2013. Ecosystem Technical Report for the Hawaii-Southern California Training and Testing EIS/OEIS. NAVFAC Biological Resource Services. Arlington, VA. 66p.

NBSD 2021. Naval Base Sab Diego web site. 2021. www.cnic.navy.mil

Neilson, D. J. 2011. The California Spiny Lobster Stock Assessment. California Department of Fish and Game. 138 p.

Neushul, M. 1959. Studies on the Growth and Reproduction of the Giant Kelp, Macrocystis. University of California Ph.D. Thesis. 134p.

Nezlin N.P., Sutula M.A., Stumpf R.P., and Sengupta A. (2012) Phytoplankton blooms detected by SeaWiFS along the central and southern California coast. Journal of Geophysical Research 117: C07004.

Nezlin N.P., McLaughlin K., Booth J.A.T., Cash C.L., Diehl D.W., Davis K.A., Feit A., Goericke R., Gully J.R., and Howard M.D. (2018) Spatial and temporal patterns of chlorophyll concentration in the southern California bight. Journal of Geophysical Research: Oceans 123: 231-245.

Newman, M. C. 2009. Fundamentals of Ecotoxicology. CRC Press. Chelsea, Mi. ISBN-13: 978-1420067040. 571 pages

NMFS (National Marine Fisheries Service) 1997. Listing of Several Evolutionary Significant Units (ESUs) of West Coast Steelhead.

NMFS 2001. Endangered and Threatened Species; Endangered Status of White Abalone. Final Rule. Federal Register 66(103): 29046-29055.

NMFS 2002a. The Final Rule for Essential Fish Habitat. Federal Register 67(12):2343-2383.

NMFS 2002b. Considerations for Conducting a Thorough Analysis of Options to Minimize Adverse Effects. NMFS Office of Habitat Conservation. October 2002. 5p.

NMFS 2004a. Preparing Essential Fish Habitat Assessments: A Guide for Federal Action Agencies. National Oceanic and Atmospheric Administration. February 2004.

NMFS 2004b. Essential Fish Habitat Consultation Guidance (Version 1.1). April 2004. Office of Habitat Conservation. Silver Spring, MD.

NMFS 2005a. Final Groundfish Essential Fish Habitat (EFH) Environmental Impact Statement. National Marine Fisheries Northwest Region. December 2005.

NMFS 2005b. Description of Fishing Gears Used on the U.S. West Coast. Pacific Coast Groundfish Fishery Management Plan. Essential Fish Habitat Designation and Minimization of Adverse Impacts. Final Environmental Impact Statement. December 2005. Volume 2 of 4. Appendix 8 of Appendix A.

NMFS 2005c. Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. https://www.fisheries.noaa.gov/search-critical-habitat

NMFS 2005d. Revision of Species of Concern List, Candidate Species Definition, and Candidate Species List. https://www.fisheries.noaa.gov

NMFS 2007. Magnuson-Stevenson Fishery Conservation and Management Act as Amended Through January 12, 2007. National Marine Fisheries Service. National Oceanic and Atmospheric Administration. 178p.

NMFS 2008. White Abalone Recovery Plan (Haliotis sorenseni). Long Beach, CA:National Marine Fisheries Service, Southwest Regional Office.

NMFS 2009. Endangered and Threatened Wildlife and Plants; Endangered Status for Black Abalone. [Final Rule]. Federal Register 74(9):1937-1946.

NMFS 2011a. California Whale Watching Guidelines. NOAA Fisheries Service. Southwest Regional Office. 2 p. www.fisheries.noaa.gov/west-coast/marine-life-viewing-guidelines/share-shore-watch-marine-mammals-responsibly

NMFS 2011b. Endangered and Threatened Wildlife and Plants: Final Rulemaking To Designate Critical Habitat for Black Abalone. Federal Register 76. No. 208.

NMFS 2012. Southern California Steelhead Recovery Plan. Southwest Region, Protected Resources Division, Long Beach, California. Executive Summary and Two Volumes.

NMFS 2013a. National Marine Fisheries Service Endangered Species Act Section 7 Consultation Biological and Conference Opinion. The U.S. Navy's Training Exercises and Testing Activities in the Southern Hawaii-California raining and Testing Study Area from December 2013 through December 2018. Dec. 13, 2013. 457 p.

NMFS 2013b. Groundfish Essential Fish Habitat Synthesis: A Report to the Pacific Fishery Management Council. NOAA NMFS Northwest Fisheries Service Center, Seattle WA. April 2013. 485p.

NMFS 2013c. Endangered and Threatened Species; Delisting of the Eastern Distinct

Population Segment of Steller Sea Lion under the Endangered Species Act; Amendment to Special Protection Measures for Endangered Marine Mammals Federal Register / Vol. 78, No. 213 / Monday, November 4, 2013.

NMFS 2021a. The Marine Mammal Protection Act of 1972. http://www.nmfs.noaa.gov/pr/laws/mmpa/.

NMFS 2021b. Cetaceans: Whales, Dolphins, and Porpoises. NOAA Fisheries. Office of Protected Resources. http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/

NMFS 2021c. Pinnipeds: Seals, Sea Lions, and Walruses. NOAA Fisheries. Office of Protected Resources. http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/

NMFS 2021d. North Pacific Population of the Humpback Whale and Notice of Status Review. https://www.federalregister.gov/articles/2013/08/29/2013-21066/endangered-and-threatened-wildlife-90-day-finding-on-a-petition-to-delist-the-north-pacific

NMFS 2021e. Guadalupe Fur Seal. http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/guadalupefurseal.htm

NMFS 2021f. Steller Sea Lion. http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/stellersealion.htm.

NMFS 2021g. Sea Turtles. NOAA Fisheries. https://www.fisheries.noaa.gov/find-species

NMFS 2021h. Green Turtle. https://www.fisheries.noaa.gov/find-species

NMFS 2021i. Loggerhead Turtle. https://www.fisheries.noaa.gov/find-species

NMFS 2021j. Leatherback Turtle. https://www.fisheries.noaa.gov/find-species

NMFS 2021k. Olive Ridley. https://www.fisheries.noaa.gov/find-species

NMFS 2021l. Hawksbill Turtle. https://www.fisheries.noaa.gov/find-species

NMFS 2014m. Steelhead Trout. https://www.fisheries.noaa.gov/find-species

NMFS 2021n. White Abalone. https://www.fisheries.noaa.gov/find-species

NMFS 2021o. Black Abalone. https://www.fisheries.noaa.gov/find-species

NMFS and USFWS (U. S. National Marine Fisheries Service and U. S. Fish and Wildlife Service) 1998a. Recovery plan for U.S. Pacific Populations of the East Pacific green turtle, (Chelonia mydas). National Marine Fisheries Service. Silver Springs, MD. 61p. https://www.fisheries.noaa.gov/find-species

NMFS and USFWS 1998b. Recovery plan for U.S. Pacific Populations of the loggerhead turtle, (Caretta caretta). National Marine Fisheries Service. Silver Springs, MD. 71p.

NMFS and USFWS 1998c. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle, (Dermochelys coriacea). National Marine Fisheries Service. Silver Springs, MD. 76p.

NMFS and USFWS 1998d. Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle, (Lepidochelys olivacea). National Marine Fisheries Service. Silver Springs, MD. 62p.

NMFS and USFWS 1998e. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle, (Eretmochelys imbricata). National Marine Fisheries Service. Silver Springs, MD. 95p.

NOAA (National Oceanic and Atmospheric Administration) 1998. Ecological Effects of Fishing. Stephen K. Brown, Peter J. Auster, Liz Lauck, and Michael Coyne. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.

NOAA (National Oceanic and Atmospheric Administration) 2007. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT. Public Law 94-265. As amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479). 178p.

NOAA 2008. Interagency Report on Debris Sources, Impacts, Strategies and Recommendations. Silver Spring, MD: National Oceanic and Atmospheric Administration. 62 p.

NOAA 2021. What is an El Niño. NOAA Fisheries Web Site. http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html.

NOAA 2021a. What is a Harmful Algal Bloom. NOAA. http://www.noaa.gov/what-is-harmful-algal-bloom/

NOAA 2021b. NOAA laws and Policies. http://www.fisheries.noaa.gov/topic/laws-policiesl

NOAA 2021c. NOAA Fisheries Web Site. http://www.nmfs.noaa.gov/

NOAA 2021d. Southwest Fisheries Science Center Web Site. http://swfsc.noaa.gov/

NOAA 2021e. Essential Fish Habitat. http://www.westcoast.fisheries.noaa.gov/habitat/fish_habitat/efh_consultations_go.html

NOAA 2021f. Fisheries Economics Program. NOAA Fisheries. Fisheries Statistics Division. https://www.st.nmfs.noaa.gov/

NOAA 2021a. Pacific Bigeye tune. https://www:fisheries.noaa.gov/species/pacific-bigeye-tuna

NOAA 2021b. Opah. https://www:fisheries.noaa.gov/species/opah

NOAA 2021c. Impacts of COVID-19 on U.S. fisheries. https://www.recfin.org

NOAA 2021d. ESA Endangered and Threatened Species Directory 2021. https://www.fisheries.noaa.gov/

NOAA 2021e. Marine Mammals. Human Impacts. NOAA Fisheries. Office of Protected Resources. https://fisheries.noaa.gov/topic/marine-mammal-protection

NOAA 2021f. Oceanic Whitetip Shark. www.fisheries.noaa.gov/species/oceanic-whitetip-shark

NOAA 2021g. Giant Manta Ray. https://www.fisheries.noaa.gov/search?oq=giant=manta=ray

NOAA 2021h. Green Sturgeon. https://www.fisheries.noaa.gov/search?oq=green=sturgeon

Noble, M. A. 2009. Introduction to the Physical Oceanography of the Southern California Bight. Geological Society of America Special Papers. V. 454. 169p.

NOEP (National Ocean Economics Program) 2005. California's Ocean Economy. Report to the Resource Agency, State of California. Prepared by J. Kildow and C. S. Colgan, July 2005. 167p.

NOEP 2009. State of the U.S. Ocean and Coastal Economies. By Judith T. Kildow, Charles S. Colgan, and J. Scorse. 60p. http://www.miis.edu/media/view/8901/original/NOEP_Book_FINAL.pdf

Norse, E. A. 2010. Ecosystem-Based Spatial Planning and Management of Marine Fisheries: Why and How? Bulletin of Marine Science. Volume 86(2)179-195.

North, W. J. (ed) 1964. An Investigation of the Effects of Discharged Wastes on Kelp. Publ. No. 26. The Resources Agency of California. State Water Quality Control Board.

North, W. J. and C. L. Hubbs 1968. Utilization of Kelp Bed Resources in Southern California. California Department of Fish and Game Bulletin No. 139. 264p.

NPS (National Park Service) 2006. Assessment of Coastal Water Resources and Watershed Conditions at Cabrillo National Monument, California: by D. L. Engle and J. Largier. Technical Report NPS/NRWRD/NRTR-2006/355, August 2006.

NPS 2014. Cabrillo National Monument Web Site. http://www.nps.gov/cabr/index.htm

NRC (National Research Council) 1990. Monitoring southern California's Coastal Waters. Washington, D.C.: National Academy Press.

NRC 2002. Effects of Trawling and Dredging on Seafloor Habitats. National Academy Press. 126 p.

Ocean Imaging 2012. Ocean Imaging Corporation Archive of Aerial and Satellite-Derived Images. Rapid Eye Satellite Image of the Point Loma Region Acquired February 10, 2011. Ocean Imaging Corporation. Solana Beach, CA.

OCSD 2018. Orange County Sanitation District. (2018). Ocean Monitoring Annual Report, Year 2016 – 2017. Marine Monitoring, Fountain Valley, CA.

OEHHA 2020. California Office of Environmental Health Hazard Assessment. Water Bodies with Fish Advisories https://www.oehha.ca.gov/fish/advisories

OEHHA California Office of Environmental Health Hazard Assessment 2014a. Fish. California Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/fish/so_cal/index.html

OEHHA 2014b. Water Bodies with Fish Consumption Advisories. http://www.oehha.ca.gov/fish/special_reports/index.html

ORRRC (Outdoor Recreation Resources Review Commission) 2000. National Survey on Recreation and the Environment 2000.

O'Hara, T. M. and T. J. O'Shea. 2005. Assessing Impacts of Environmental Contaminants. In: Reynolds, J.E. III, W.F. Perrin, R.R. Reeves, S. Montgomery, and T.J. Ragen, (eds). Marine Mammal Research: Conservation Beyond Crisis. Baltimore, MD: Johns Hopkins University Press. p. 63-83.

O’Shea, T. J. and K. K. Odell 2008. Large-scale Marine Ecosystem Change and the Conservation of Marine Mammals. J. Mammalogy 89(3):529-533.

Oregon State University 2011. Sea Lion Entanglement in Marine Debris Preventable, Study Finds. Press Release. http://oregonstate.edu/urm/ncs/archives/2011/apr/sea-lion-entanglement-marine-debris-preventable-study-finds

Otway, N. 1991. Bioaccumulation Studies on Fish: Choice of Species, Sampling Designs, Problems and Implications for Environmental Management. In: A.G. Miskiewicz (ed). Proceedings of a Bioaccumulation Workshop: Assessment of the Distribution, Impacts, and Bioaccumulation of Contaminants in Aquatic Environments. Australian Marine Science Association, Inc.

Parnell, E., and K. Riser 2012. Evaluation of Anthropogenic Impacts on the San Diego Coastal Ecosystem. Annual Project Report (2011-2012). Submitted to City of San Diego Public Utilities Department. UCSD Contract OO-19958/H074007. 15 p.

Parnell, P. Ed, P. K. Dayton, C. E. Lennert-Cody, L. L. Rasmussen, and J. J. Leichtera 2005. Marine Reserve Design: Optimal Size, Habitats, Species Affinities, Diversity, and Ocean Microclimate. Ecological Applications: Vol. 16, No. 3, pp. 945–962.

Parnell, P. Ed, A. K. Groce, T. D. Stebbins, and Paul K. Dayton 2008. Discriminating Sources of PCB Contamination in Fish on the Coastal Shelf off San Diego, California (USA). Marine Pollution Bulletin 56 (2008) 1992–2002.

Parnell, P. E., P. K. Dayton, R. A. Fisher, C. C. Loarie, and R. D. Darrow 2010. Spatial Patterns of Fishing Effort off San Diego: Implications for Zonal Management and Ecosystem Function. Ecol. Appl. 20:2203–2222. http://dx.doi.org/10.1890/09-1543.1

Parnell, P. E., E. Miller, C. Lennert-Cody, M. Carter, and T.D. Stebbins 2010. The Response of Giant Kelp (Macrocystis pyrifera) in Southern California to Low Frequency Climate Forcing. Limnology and Oceanography 55: 2686-2702.

Parnell, P. E., P.K. Dayton, K. Riser, B. Bylach 2019. Evaluation of Anthropogenic Impacts on the San Diego County Coastal Kelp Forest Ecosystem (Biennial Project Report). Scripps Institution of Oceanography. 2018-2019.

Pendleton, L., and J. Rooke 2006. "Understanding the Potential Economic Value of Marine Recreational Fishing." Unpublished.

Perrin, W. F., S. Leatherwood and A. Collet 2008. Encyclopedia of Marine Mammals. San Diego, CA. Academic Press. 1316 p.

Perry, B., P. M. DiGiacomo, and B. Holt 2007. Oceanography of the Southern California Bight. http://geology.campus.ad.csulb.edu/people/bperry/scbweb/circulation.htm

Perry, B. 2009. Coastal Systems and Human Impacts. CSU Long Beach Department of Geological Sciences Course Web Book. http://geology.campus.ad.csulb.edu/people/bperry/geology303/geol303text.html

PFMC (Pacific Fishery Management Council) 2004. Appendix 10, Pacific Coast Groundfish Essential Fish Habitat, the Effects of Fishing Gears on Habitat: West Coast Perspective. Pacific States Marine Fisheries Commission, Portland, OR.

PFMC 2005. Description and Identification of Essential Fish Habitat for the Coastal Pelagic Species Fishery Management Plan. Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council.

PFMC 2006. Measures to Prohibit Fishing in the EEZ off the West Coast. CPS FMP Amendment 12. Pacific Fishery Management Council. 143p.

PFMC 2007. Amendment 1 to the Highly Migratory Species Management Plan: Bigeye Tuna. January 2007. http://www.pcouncil.org/hms/hmsfmp.html#amendment.

PFMC 2008 Management of Krill as an Essential Component of the California Current Ecosystem. Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council. 118p.

PFMC 2011e. Cowcod Status Report. 17p. http://www.pcouncil.org/groundfish/stock-assessments/by-species/cowcod/

PFMC 2012. Pacific Coast Groundfish 5-Year Review of Essential Fish Habitat Phase 1: New Information. Final Report to Pacific Fishery Management Council, September 2012. Portland, OR. 416 p.

PFMC 2020a. Pacific Fishery Management Council Web Site. http://www.pcouncil.org

PFMC 2020b. The Pacific Coast Groundfish Fishery Management Plan. National Oceanic and Atmospheric Administration. http://www.pcouncil.org/groundfish/fishery-management-plan/

PFMC 2020c. Coastal Pelagic Species: Fishery Management Plan and Amendments. http://www.pcouncil.org/coastal-pelagic-species/fishery-management-plan-and-amendments/

PFMC 2020d. Highly Migratory Species: Fishery Management Plan and Amendments. http://www.pcouncil.org/highly-migratory-species/fishery-management-plan-and-amendments/

PFMC 2014e. Pacific Salmon Fishery Management Plan and Amendments. http://www.pcouncil.org/salmon/fishery-management-plan/adoptedapproved-amendments/

PFMC 2014f. Habitats and Communities. http://www.pcouncil.org/managed-fishery/habitat/

PFMC (Pacific Fishery Management Council) and NMFS (National Marine Fisheries Service) 2021

Phillips, C. P., H. M. Solo-Gabriele, A. J. Reneiers, J. D. Wang, R. T. Kiger, and N. Abdel-Mottaleb 2011. Pore Water Transport of Enterococci out of Beach Sediments. Marine Pollution Bulletin 62: 2293–2298.

Pierce, S. D., R. L. Smith, P. M. Kosro, J. A. Barth, and C. D. Wilson 2000. Continuity of the Poleward Undercurrent along the Eastern Boundary of the Mid-Latitude North Pacific. Deep-Sea Research II 47:811-829.

Pinnegar, J. K. and G. H. Engelhard 2008. The ‘Shifting Baseline’ Phenomenon: A Global Perspective. Rev. Fish. Biol. Fisheries 18:1–16.

Pondella, D., J. Williams, J. Claisse, R. Schaffner, K. Ritter, and K. Schiff. 2011. Southern California Bight 2008 Regional Monitoring Program: Volume V. Rocky Reefs. Southern California Coastal Water Research Project, Costa Mesa, CA.

POSD (Port of San Diego) 2009. Commercial Fisheries Revitalization Plan. Background and Existing Conditions Report. October 2009. 172p.

POSD 2014a. Cruise Ship Operations. http://www.portofsandiego.org/recreation/cruise.html

POSD 2021. Progress Report: Evaluation of Fine Scale Movements of East Pacific Green Sea Turtles in San Diego Bay. Space and Naval Warfare Systems Center, Pacific Environmental Readiness Division Naval Facilities Engineering Command Southwest September 2016 https://www.portofsandiego.org/search?keyeord=turtles

Posey, M. H. and W. G. Ambrose Jr. 1994. Effects of Proximity to an Offshore Hard-Bottomed Reef on Infaunal Abundances. Mar. Biol. 118: 745-753.

PSMFC (Pacific States Marine Fisheries Commission) 2014. Recreational Fisher¬ies Information Network (RecFIN). http://www.recfin.org/

Punt, A. E. and P. R. Wade 2012. Population Status of the Eastern North Pacific Stock of Gray Whales In 2009. Journal of Cetacean Research and Management 12(1): 15-28.

Raimondi, P., K. Schiff, and D. Gregorio 2012. Characterization of the Rocky Intertidal Ecological Communities Associated with Southern California Areas of Special Biological Significance. Watershed, Ocean, and Wetland Section. Division of Water Quality. California State Water Resources Control Board. 80 p. Ranasinghe, J.A., K.C. Schiff, C.A. Brantley, L.L. Lovell, D.B. Cadien, T.K. Mikel, R.G. Velarde, S. Holt, and S.C. Johnson. 2012. Southern California Bight 2008 Regional Monitoring Program:VI. Benthic Macrofauna. Technical Report No. 65, Southern California Coastal Water Research Project, Costa Mesa, CA.

Ranasinghe, J. A., K. C. Schiff, C. A. Brantley, L .L. Lovell, D .B. Cadien, T. K. Mikel, R. G. Velarde, S. Holt, and S. C. Johnson. 2012. Southern California Bight 2008 Regional Monitoring Program:VI. Benthic Macrofauna. Technical Report No. 65, Southern California Coastal Water Research Project, Costa Mesa, CA.

Recreational Research 2021. California Boat Ramps Locator. Recreational Research Company. http://www.boatrampslocator.com/

Redfern, J. V., M. F. McKenna, T. J. Moore, J. Calambokidis, M. L. DeAngelis, E. A. Becker, J. Barlow, K. A. Forney, P. D. Fiedler, and S. J. Chivers 2013. Assessing the Risk of Ships Striking Large Whales in Marine Spatial Planning. Conservation Biology 27(2):292-302.

Reed, D. C., S. C. Schroeter, D. Huang, T. W. Anderson, and R. F. Ambrose 2006. Quantitative Assessment of Different artificial Reef Designs in Mitigating Losses to Kelp Forest Fishes. Bulletin of Marine Science 13378(1):133–150.

Reed, D. C., A. Rassweiler, M. H. Carr, K. C. Cavanaugh, D. P. Malone, and D. A. Siegel 2011. Wave Disturbance Overwhelms Top-Down and Bottom-Up Control of Primary Production in California Kelp Forests. Ecology 92(11) 2108–2116.

Reeves, R. R., K. McClellan, and T. B. Werner 2013. Marine Mammal Bycatch in Gillnet and Other Entangling Net Fisheries, 1990 To 2011. Endangered Species Research 20: 71–97. doi: 10.3354/esr00481.

Reiley 2020. Washington Post. Commercial Fishing Industry in Free Fall as restaurants close consumers hunker down and vessels tie up. April 8, 2020.

Roemmich, D. and J. McGowan 1995. Climatic Warming and the Decline of Zooplankton in the California Current. Science 267:1324-1326.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, S. Y. Kim, P. E. Parnell, and P. Dayton 2012. Final Report: Point Loma Ocean Outfall Plume Behavior Study. Prepared for City of San Diego Public Utilities Department by Scripps Institution of Oceanography, University of California, San Diego. San Diego, CA.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, and W. Middleton 2013. Ocean Outfall Plume Characterization Using an Autonomous Underwater Vehicle. Water Science &Technology, 67(4): 925–933.

Rolland, R.M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Kraus 2012. Evidence that Ship Noise Increases Stress in Right Whales. Proc. R. Soc. B. Biological Sciences 279:2363-2368.

Roman, J., I. Altman, M. M. Dunphy-Daly, C. Campbell, M. Jasny, and A. J. Read 2013. The Marine Mammal Protection Act at 40: Status, Recovery, and Future of U.S. Marine Mammals. Ann. N.Y. Acad. Sci. 2013:1-21.

Rutgers University 2020. COVID19 Pandemic had a Big Impact on Commercial Fishing in Northeast. Science news. December 2020.

RWQCB 2017. RWQCB Order No R9-2017-0007 (NPDES No. CA0107409)

RWQCB 2021. San Diego Regional Water Quality Control Board Basin Plan as amended. (2021).

SANDAG. San Diego Association of Governments 2021. http://www.sandag.org

San Diego Chamber of Commerce 2014. Economic Impact Reports. http://www.sdchamber.org/

San Diego Convention Center and Visitors Bureau 2014. San Diego Convention Center and Visitors Bureau web site. http://www.sandiego.org/

San Diego Convention Center and Visitors Bureau 2021. San Diego Convention Center and Visitors Bureau web site. http://www.sandiego.org/

San Diego Economic Development Corporation 2014. Key Industries. Defense. http://www.sandiegobusiness.org/industry/defense

SDMAC 2020. San Diego Military Economic Report 2020. http://www.sdmac.org

San Diego Tourism Authority 2012. 2012 Annual Report and Highlights. 26p.

San Diego Waterfront 2021. San Diego Waterfront Web Site. http://www.sdwaterfront.com/clubs.shtml

Salvadeo, C. J., D. Lluch-Belda, A. Gómez-Gallardo, J. Urbán-Ramírez, and C. D. MacLeod 2010. Climate Change and a Poleward Shift in the Distribution of the Pacific White-Sided Dolphin in the Northeastern Pacific. Endangered Species Research 11: 13-19.

Salvadeo, C. J., S. E. Lluch-Cota, M. O. Maravilla-Chávez, S. T. Álvarez-Castañeda, M. Mercuri, and A. Ortega-Rubio 2013. Impact of Climate Change on Sustainable Management of Gray Whale (Eschrichtius robustus) Populations: Whale-Watching and Conservation. Arch. Biol. Sci., Belgrade, 65 (3):997-1005.

Santidrián Tomillo, P., V. S. Saba, G. S. Blanco, C. A. Stock, F. V. Paladino, and J. R. Spotila 2012. Climate Driven Egg and Hatchling Mortality Threatens Survival of Eastern Pacific Leatherback Turtles. PLoS ONE 7(5):e37602.

SCCOOS 2020. Spring Bulletin 2020. http://SCCOOS.org/california-hab-bulletin/red-tide)

SCCWRP (Southern California Coastal Water Research Project) 2012. Southern California Bight 2008 Regional Monitoring Program. January 2012. Coastal Ecology Synthesis Report. Southern California Coastal Water Research Project: Costa Mesa, CA

SCCWRP 2013. Harmful Algal Blooms in Coastal Waters. http://www.sccwrp.org/ResearchAreas/Nutrients/HarmfulAlgalBloomsHABs.aspx

SCCWRP 2021a. Southern California Bight Regional Monitoring. Bight Program Documents - Southern California Coastal Water Research Project (sccwrp.org)

SCCWRP 2021b. http://www.sccwrp.org/about/research-areas/eutrophication/harmful-algal-blooms

Schiff, K. and M. J. Allen 1997. Bioaccumulation of chlorinated hydrocarbons in livers of flatfishes from the Southern California Bight. In: S. B. Weisberg, C. Francisco, and D. Hallock (eds) Southern California Coastal Water Research Project Annual Report 1995–1996. Southern California Coastal Water Research Project, Westminster, CA.

Schiff, K. C., M. J. Allen, E. Y. Zeng, and S. M. Bay 2000. Southern California. Mar. Pollution Bull. 41(1): 76-93.

Schiff, K., J. Griffith, and G. Lyon 2005. Microbial Water Quality at Reference Beaches in Southern California during Wet Weather. Southern California Coastal Water Research Project Technical Report # 448. Southern California Coastal Water Research Project, Westminster, CA.

Schiff, K., R. Gossett, K. Ritter, L. Tiefenthaler, N. Dodder, W. Lao, and K. Maruya 2011. Southern California Bight 2008 Regional Monitoring Program: III. Sediment Chemistry. Southern California Coastal Water Research Project, Costa Mesa, CA.

Scholin, C. A., F. Gulland, G. J. Doucette, S. Benson, M. Busman, F. P. Chavez, J. Cardaro, R. DeLong, A. De Vogelaere, J. Harvey, M. Haulena, K. Lefebvre, T. Lipscomb, S. Loscutoff, L. J. Lowenstine, R. Marin III, P. E. Miller, W. A. McLellan, P. D. R. Moeller, C. L. Powell, T. Rowles, P. Silvagni, M. Silver, T. Spraker, V. Trainer, and F. W. Van Dolah 2000. Mortality of Sea Lions Along the Central California Coast Linked to a Toxic Diatom Bloom. Nature 403:80-84.

Schnetzer, A, B. H. Jones, R. A. Schaffner, I. Cetinic, E. Fitzpatrick, P. E. Miller, E .L. Seubert, and D. A. Caron 2013. Coastal Upwelling Linked to Toxic Pseudo-nitzschia australis Blooms in Los Angeles Coastal Waters, 2005–2007. J Plankton Res. 35:1080–1092.

Schroeder, D. M. and M. Love 2002. Recreational Fishing and Marine Fish Populations. OCS Study MMS 2005-030 and USGS/NBII 2005-001. CalCOFI Rep., Vol. 43:182-190.

Schroeter, S. C., D. C. Reed, D. J. Kushner, J. A. Estes, and D. S. Ono 2011. The Use of Marine Reserves in Evaluating the Dive Fishery for the Warty Sea Cucumber (Parastichopus parvimensis) in California, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences 58(9):1773-1781. http://www.nrcresearchpress.com/doi/abs/10.1139/f01-127#.UuZ4VRDTnIV

Schwing, F. B., C. S. Moore, S. R. Ralston, and K. M. Sakuma 2000. Record Coastal Upwelling in the California Current in 1999. CalCOFI Reports 41:148-160.

Schwing, F. B., T. Murphree, L. deWitt and P. M. Green 2002. The Evolution of Oceanic and Atmospheric Anomalies in the Northeast Pacific during the El Niño and La Niña Events of 1995-2001. Progress in Oceanography 54: 459-491

Scott, G., Filton MH, Weisberg, SB, Maruya KA, Lauenstein G (2012). Contaminants of Concern in the Marine Environment: The Need for New Monitoring and Assessment Strategies. J. Mar. Biol. Oceanogr. Vol1, Issue 1. 2012.

SDMAC 2020. San Diego Military Economic Report. San Diego Military Advisory Council. 2020. https://www.sdmac.org

RWQCB and EPA (San Diego Regional Water Quality Control Board and U. S. Environmental Protection Agency) 2017. Waste Discharge Requirements and National Pollutant Discharge Elimination System Permit for the City of San Diego E.W. Blom Point Loma Metropolitan Wastewater Treatment Plant Discharge to the Pacific Ocean through the Point Loma Ocean Outfall, San Diego County. Order No. R9-2017-0007. NPDES No. CA0107409. http://www.waterboards.ca.gov/sandiego/

RWQCB 2010. Revised Total Maximum Daily Loads for Indicator Bacteria, Project I – Twenty Beaches and Creeks in the San Diego Region (Including Tecolote Creek) Final Technical Report. February 10, 2010. 168p.

RWQCB 2016. Water Quality Control Plan for the San Diego Basin (Basin Plan). Revised 2016. http://www.swrcb.ca.gov/sandiego/water_issues/programs/basin_plan/

RWQCB (San Diego Regional Water Quality Control Board 2018. Assessing Bacteria Levels at San Diego Beaches. Available online at: https://www.waterboards.ca.gov/sandiego/water_issues/programs//key_areas/docs/Status_Sheet_REC1.pdf

Sears, R. and W. F. Perrin 2008. Blue Whale. In: Encyclopedia of Marine Mammals. W.F. Perrin, B. Wursig and J. G. M. Thewissen. San Diego, CA, Academic Press:120-124.

Seminoff, J. 2007. Green Sea Turtle 5-Year Review: Summary and Evaluation. U. S. National Marine Fisheries Service and U. S. Fish and Wildlife Service. August 2007. 105 p.

Sercu, B., L.C. Van de Werfhorst, J. Murray, and P.A. Holden 2009. Storm Drains are Sources of Human Fecal Pollution During Dry Weather in Three Urban Southern California Watersheds. Environmental Science and Technology, 43:293–298.

Setty, K., K. Schiff, and S. Weisberg (eds) 2012. Forty Years after the Clean Water Act: A Retrospective Look at the Southern California Coastal Ocean. Southern California Coastal Water Research Project. Costa Mesa, CA. Technical Report 727. 52p.

Sheckler, D. and K. Sheckler 2008. A Diver's Guide to Southern California's Best Dives, 4th Edition. Saint Brendan Corporation. 156 p.

Simmonds, M. P., and W. J. Eliott 2009. Climate Change and Cetaceans: Concerns and Recent Developments. Journal of the Marine Biological Association of the United Kingdom 89(1):203-210.

SIO (Scripps Institution of Oceanography) 2004. Point Loma Outfall Project, Final Report, September 2004. Scripps Institution of Oceanography, University of California, San Diego, CA.

SIO 2012. Evaluation of Anthropogenic Impacts on the San Diego Coastal Ecosystem. Annual Project Report (2011-2012). Submitted to City of San Diego Public Utilities Department. UCSD Contract OO-19958/H074007. 15 pp.

SIO 2014. Scripps Institution of Oceanography. https://scripps.ucsd.edu/

Smith J., Connell P., Evans R.H., Gellene A.G., Howard M.D.A., Jones B.H., Kaveggia S., Palmer L., Schnetzer A., Seegers B.N., Seubert E.L., Tatters A.O., and Caron D.A. (2018) A decade and a half of Pseudo-nitzschia spp. and domoic acid along the coast of southern California. Harmful Algae 79: 87-104

Southall, B., J. Calambokidis, P. Tyack, D. Moretti, A. Friedlaender, S. DeRuiter, J. Goldbogen, E. Falcone, G. Schorr, A. Douglas, A. Stimpert, J. Hildebrand, C. Kyburg, R. Carlson, T. Yack, and J. Barlow 2012. Biological and Behavioral Response Studies of Marine Mammals in Southern California, 2011. Final Project Report, 8 March 2012.

Spira, J. 2014. Southern California Ocean Fishing. http://www.socaloceanfishing.com/hp__wrec.html

Stebbins, T., D. Olson, K. Schiff, and K. Ritter 2012. Workplan for Phase 2 San Diego Sediment Mapping Study of the Point Loma Ocean Outfall Monitoring Region. City of San Diego, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA, and Southern California Coastal Water Research Project, Westminster, CA.

Stein, D. 2013. The History and Current Status of the California Red Sea Urchin Fishery. California Department of Fish and Wildlife. Power Point Presentation. 21 p. http://www.fgc.ca.gov/meetings/subcommittees/061813mrcurchin.pdf

Stein, E. D. and D. B. Cadien 2009. Ecosystem Response to Regulatory and Management Actions: The Southern California Experience in Long-Term Monitoring. Marine Pollution Bulletin 59 (4-7):91-100.

Steneck, R. S., M. H. Graham, B. J. Bourque, D. Corbett, J. M. Erlandson, J. A. Estes, and M. J. Tegner 2002. Kelp Forest Ecosystems: Biodiversity, Stability, Resilience, and Future. Environmental Conservation 29 (4):436-459.

Sutton R., Chen D., Sun J., Greig D., and Wu Y. (2019) Characterization of brominated, chlorinated, and phosphate flame retardants in San Francisco Bay, an urban estuary. Science of The Total Environment, Vol 652: 212-223.

Sutton R., Sedlak M., Sun J., and Lin, D. (2017) Contaminants of Emerging Concern in Francisco Bay: A Strategy for Future Investigations. 2017 Revision. SFEI Contribution No. 815. San Francisco Estuary Institute: Richmond, CA.

Surfrider 2020. Surfrider Foundation. November 2, 2020. Enhanced Water Testing and Notification in Imperial Beach – Surfrider Foundation

Suntsov, A., J. A. Koslow, and W. Watson 2012. The Spatial Structure of Coastal Ichthyoplankton Assemblages off Central and southern California. California Cooperative Oceanic Fisheries Investigations Reports. 53:153-170.

Svejkovsky, J. 2014. Satellite and Aerial Coastal Water Quality Monitoring in the San Diego/Tijuana Region: Annual Summary Report, 1 January, 2013–31 December, 2013. Ocean Imaging, Solana Beach, CA.

Svejkovsky J. (2003-2018). Satellite and Aerial Coastal Water Quality Monitoring in the San Diego/Tijuana Region. Annual Summary Reports. Ocean Imaging Inc., Littleton, CO.

SWRCB 2012. State Water Quality Protection Areas and State Marine Protected Areas. Final Staff Report and Substitute Environmental Documentation Amendment of the Water Quality Control Plan for Ocean Waters of California. Final SED for Ocean Plan Amendments – October 16, 2012. 55 p.

SWRCB 2014. Areas of Special Biological Significance. http://www.waterboards.ca.gov/water_issues/programs/ocean/asbs.shtml

SWRCB 2018 (California State Water Resources Control Board) 2018. 2014-2018 Integrated Report (Clean Water Act Section 303(d) List/305(b) Report). http://www.waterboards.ca.gov/water_issues/programs/tmdl/

SWRCB 2019 Water Quality Control Plan Ocean Waters of California (Ocean Plan). https://www.waterboards.ca.gov/water_issues/programs/ocean/docs/oceanplan2019.pdf.

SWRCB 2021 California Beach Water Quality Information. http://www.waterboards.ca.gov/water_issues/programs/beaches/beach_water_quality/index.shtml

Sydeman, W. J., J. A. Santora, S. A. Thompson, B. Marinovic, and E. D. Lorenzo 2013. Increasing Variance in North Pacific Climate Relates to Unprecedented Ecosystem Variability off California. Global Change Biology 19:1662-1675.

Tegner, M. J. and P. K. Dayton 1987. El Niño Effects on Southern California Kelp Forest Communities. Adv. Ecol. Res. 17: 243-279.

Tegner, M. J. and P. K. Dayton 1991. Sea urchins, El Niños, and the Long Term Stability of Southern California Kelp Forest Communities. Mar. Ecol. Prog. Ser. 77: 49-63.

Tegner M. J., and P. K. Dayton 2000. Ecosystem Effects of Fishing in Kelp Forest Communities. ICES Journal of Marine Science 57: 579–589.

Tegner, M. J., P. K. Dayton, P. B. Edwards, K. L. Riser, D. B. Chadwick, T. A. Dean, and L. Deysher 1995. Effects of a Large Sewage Spill on a Kelp Forest Community: Catastrophe or Disturbance? Mar. Env. Res. 40(2): 181-224.

Tegner, M. J., P. K. Dayton, P. B. Edwards, and K. L. Riser 1996. Is There Evidence for Long-Term Climatic Change in Southern California Kelp Forests? CalCOFI Reports 37:111-126.

Tegner, M. J., P. K. Dayton, P. B. Edwards, and K. L. Riser 1997. Large-scale, Low-Frequency Oceanographic Effects on Kelp Forest Succession: A Tale of Two Cohorts. Mar. Ecol. Prog. Ser. 146: 117-134.

The Resources Agency of California 1994. California's Ocean Resources: An Agenda for the Future. Chapter 3: Ocean Jurisdiction and Management. http://resources.ca.gov/ocean/html/chapt_3.html

Thrush, S. F. and P. K. Dayton 2010. What Can Ecology Contribute to Ecosystem-Based Management? Annu. Rev. Mar. Sci. 2:419–41.

Topping, D. T., C. G. Lowe, and J. E. Caselle 2006. Site Fidelity and Seasonal Movement Patterns of Adult California Sheephead Semicossyphus pulcher (Labridae): An Acoustic Monitoring Study. Arch. Ecol. Prog. Ser. 326:257–267.

Tornero, V., T. J. Teresa, J. Sylvina, R. S. Wells, and J. Singh 2014. Eco-toxicants: A Growing Global Threat. Primatology Monographs. Primates and Cetaceans. Field Research and Conservation of Complex Mammalian Societies. Pp. 309-332. http://link.springer.com/chapter/10.1007/978-4-431-54523-1_16.

Turner-Tomaszewicz, C. and J. A. Seminoff 2012. Turning off the Heat: Impacts of Power Plant Decommissioning on Green Turtle Research in San Diego Bay. Coastal Management 40:73–87.

Torrey H.B. (1902) An unusual occurrence of dinoflagellata on the California coast. American Naturalist 36: 187– 192.

UCSD (University of California, San Diego) 2013. Draft Environmental Assessment and Initial Study SIO/UCSD Marfac Berthing Wharf and Pier Replacement UCSD Project Number: 963990/4425. April 2013. 167 p.

UNFAO (United Nations Food and Agricultural Organization) 2012. Recreational Fisheries. Technical Guidelines for Responsible Fisheries. No. 13. Rome, Italy. 176 p.

United States Lifesaving Association 2014. Statistics. http://www.usla.org/

USACOE (U. S. Army Corps of Engineers) 2013. Draft Integrated Feasibility Study & Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Encinitas-Solana Beach Coastal Storm Damage Reduction Project, San Diego County, California. 4 Volumes.

USDON (United States Department of the Navy) 2008. Southern California (SOCAL) Range Complex. Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). December 2008. 2 Volumes.
http://www.nmfs.noaa.gov/pr/pdfs/permits/socal_eis_vol1.pdf
http://www.nmfs.noaa.gov/pr/pdfs/permits/socal_eis_vol2.pdf

USDON 2013. Hawaii-Southern California Training and Testing Activities. Final Environmental Impact Statement/ Overseas Environmental Impact Statement. August 2013. 3 Volumes. http://hstteis.com/DocumentsandReferences/HSTTDocuments/FinalEISOEIS.aspx

USDON 2013. Hawaii-Southern California Training and Testing Activities. Final Environmental Impact Statement/Overseas Environmental Impact Statement. August 2013. 3 Volumes. http://hstteis.com/DocumentsandReferences/HSTTDocuments/FinalEISOEIS.aspx

USFWS (United States Fish and Wildlife Service) 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover. Vol. 1. 190 p.

USFWS 2009. Spotlight Species Action Plan (2010-2014) – California Least Tern. Fish and Wildlife Office, Carlsbad, CA. 4p.

USFWS 2012. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Pacific Coast Population of the Western Snowy Plover. Final Rule. Federal Register 06-19-2012. https://www.federalregister.gov/articles/2012/06/19/2012-13886/endangered-and-threatened-wildlife-and-plants-revised-designation-of-critical-habitat-for-the#h-139

USFWS 2021a. Endangered Species Act of 1973. http://www.fws.gov/

USFWS 2021b. Endangered Species. https://www.fws.gov/endangered

USFWS 2021c. California Least Tern. https://ecos.fws.gov/ecp/species/8104

USFWS 2021d. Light-footed Clapper Rail. https://ecos.fws.gov/ecp/species/6035

USFWS 2021e. Western Snowy Plover. www.fws.gov/arcata/es/birds/wsp/plover.html

USFWS 2021f. Steelhead Trout. www.fws.gov/fisheries/freshwater-fish-of-america/steelhead_trout.html

USFWS 2021g. Scalloped Hammerhead Shark. https://ecos.fws.gov/ecp/species/6035

USGS (United States Geological Survey) 1998. Pacific Seafloor Mapping Project. http://geopubs.wr.usgs.gov/dds/dds-55/pacmaps/sd_index.htm.

USGS (United States Geological Survey) 1998. Pacific Seafloor Mapping Project. http://coastalmap.marine.usgs.gov/regional/contusa/westcoast/pacificcoast/Arc_gispubs.html

USHR (U.S. House of Representatives) 2013. Oversight Hearing on "Reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act". U.S. Congress. September 2013.

VanBlaricom, G., J. Butler, A. DeVogelaere, R. Gustafson, C. Mobley, M. Neuman, and D. Richards 2009. Status Review Report for Black Abalone (Haliotis cracherodii Leach, 1814). Long Beach, CA: National Marine Fisheries Service. 135 p.

Van der Hoop, J. M., M. J. Moore, S. G. Barco, T. V. Cole, Pierre-Yves Daoust, A. G. Henry, D. F. McAlpine, W. A. McLellan, T. Wimmer, and A. R. Solow 2013. Assessment of Management to Mitigate Anthropogenic Effects on Large Whales. Conserv. Biol. 27(1): 121–133.

Vicente, V.P. 1994. Spongivory in Caribbean Hawksbill Turtles, Eretmochelys imbricata: Data from Stranded Specimens. Page 185-188 in B.A. Schroeder, and B.E. Witherington (compilers). Proc. of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, Jekyll Island, Georgia. NOAA Tech. Memo. NMFS-SEFSC-341. 281 pp.

Walsh, P. J., S. L. Smith, L. E. Fleming, H. Solo-Gabriele, and W. H. Gerwick (eds) 2008. Oceans and Human Health: Risks and Remedies from the Seas, Academic Press, Amsterdam. 644 p.

Weis, J. S. 2014. Bioaccumulation/Storage/Detoxification. In: Weis, J. S. (ed). 2014. Physiological, Developmental and Behavioral Effects of Marine Pollution. Springer Link. Pp. 355-392. Print: ISBN: 978-94-007-6948-9. Online: http://link.springer.com/chapter/10.1007/978-94-007-6949-6_10.

Weis, J. S. (ed) 2014. Physiological, Developmental and Behavioral Effects of Marine Pollution. Springer Link. 452 p. Print: ISBN: 978-94-007-6948-9. Online: http://www.springer.com/environment/environmental+toxicology/book/978-94-007-6948-9

Whitacre, D. M. (ed) 2014. Reviews of Environmental Contamination and Toxicology. Vol. 227. Springer. New York. 171 p. Print: ISBN 978-3-319-01326-8. eBook: ISBN 978-3-319-01327-5. Online: http://www.springer.com/environment/environmental+toxicology/book/978-3-319-01326-8.

Wise, J. P., Sr., R. Payne, S. S. Wise, C. LaCerte, J. Wise, C. Gianios, Jr.,W. D. Thompson, C. Perkins, T. Zheng, C. Zhu, L. Benedict, and I. A. Kerr 2009. A Global Assessment of Chromium Pollution Using Sperm Whales (Physeter macrocephalus) as an Indicator Species. Chemosphere 75(11):1461-1467.

Wolfson, A. and T. Glinski 1986. Beneficial Uses of the Ocean at Point Loma. In: Report of Ocean Studies off Point Loma. City of San Diego, Department of Water Utilities. 51p.

Wolfson, A. and T. Glinski 2000. Beneficial Uses of the Ocean off Point Loma. City of San Diego. Request for Modification of Secondary Treatment Requirements. Appendix G. 25p.

Work, P. A., A. L. Sapp, D. W. Scott, and M. G. Dodd 2010. Influence of Small Vessel Operation and Propulsion System on Loggerhead Sea Turtle Injuries. Journal of Experimental Marine Biology and Ecology 393(1-2):168-175.

Worm, B., R. Hilborn, J. K. Baum, T. A. Branch, J. S. Collie, C. Costello, M. J. Fogarty, E. A. Fulton, J. A. Hutchings, S. Jennings, O. P. Jensen, H. K. Lotze, P. M. Mace, T. R. McClanahan, C. Minto, S. R. Palumbi, A. M. Parma, D. Ricard, A. A. Rosenberg, R. Watson, and D. Zeller 2009. Rebuilding Global Fisheries. Science 325:578-584.

Woshner, V. M. 2006. Persistent Contaminants in Selected Species of Marine Mammals in US Waters: A Review of the Literature from 1995 through 2005. National Marine Fisheries Service, Office of Protected Resources. 37p.

Wright, M. E., H. M. Solo-Gabrielea, S. Elmira, and L. E. Fleming 2009. Microbial Load from Animal Feces at a Recreational Beach. Marine Pollution Bulletin 58 (11):1649–1656.

Wyneken, J. K., J. Lohmann, and J. A. Musick (eds) 2013. The Biology of Sea Turtles. Vol. III. CRC Press. 458 p.

Yamahara, K. M., B. A. Layton, A. E. Santoro, and A. B. Boehm 2007. Beach Sands along the California Coast are Diffuse Sources of Fecal Bacteria to Coastal Waters. Environmental Science and Technology, 41: 4515–4521.

Zeidberg, L. D., W. M. Hammer, N. P. Nezlin, and A. Henry 2006. The Fishery for California Market Squid, (Loligo opalescens) (Cephalopoda myopsida), from 1981-2003. Fish. Bull. 104:46-59.

Zmarzly, D. L., T. D. Stebbins, D. Pasko, R. M. Duggan, and K. L. Barwick 1994. Spatial Patterns and Temporal Succession in Soft-Bottom Macroinvertebrate Assemblages Surrounding an Ocean Outfall on the Southern San Diego Shelf: Relation to Anthropogenic and Natural Events. Marine Biology 118: 293-307.

Zembal, R., S. M. Hoffman, and J. R. Bradley 1997. Light-footed Clapper Rail Management and Population Assessment. California Department of Fish and Game. 26 p.

Zembal, R., S. M. Hoffman, and J.Konecny 2013. Status and Distribution of the Light-footed Clapper Rail in California, 2013. California Department of Fish and Wildlife, Wildlife Management, Nongame Wildlife Unit Report, 2013-02. Sacramento, CA. 24 p.

APPENDIX I

ENDANGERED SPECIES ASSESSMENT

City of San Diego
Public Utilities Department

March 2022

Table of Contents

Section **Page**

List of Figures

List of Tables

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
ft	foot
m	meter
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEC	contaminant of emerging concern
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CMLPA	California Marine Life Protection Act
COSD	City of San Diego
CSULB	California State University, Long Beach
ENSO	El Niño-Southern Oscillation
EPA	United States Environmental Protection Agency
ESA	Endangered Species Assessment
kg	kilogram
km	kilometer
lb	pound
mgd	million gallons per day
mi	mile
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Protection Act
NMFS	U.S. National Marine Fisheries Service
NOAA	U.S. National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPGO	North Pacific Gyre Oscillation
PBDEs	Polybrominated diphenyl ethers

PDO	Pacific Decadal Oscillation
PLOO	Point Loma Ocean Outfall
PLWTP	Point Loma Wastewater Treatment Plant
POPs	persistent organic pollutants
PPCPs	pharmaceutical and personal care products
RWQCB	California Regional Water Quality Control Board, San Diego
SCCWRP	Southern California Coastal Water Research Project
sDPS	southern Distinct Population Segment
USDON	United States Department of the Navy
USFWS	U.S. Fish and Wildlife Service
ZID	zone of initial dilution

I.1 INTRODUCTION

This assessment is in support of the City of San Diego's (City's or San Diego's) application to the United States Environmental Protection Agency (EPA) and the California Regional Water Quality Control Board, San Diego (RWQCB) requesting renewal of its National Pollutant Discharge Elimination System (NPDES) permit for the discharge of treated wastewater to the Pacific Ocean from the 23,760-foot-long, approximately 310-foot deep Point Loma Ocean Outfall (PLOO). The City's application requests renewal of modified secondary treatment requirements for the PLOO discharge in accordance with the provisions of Section 301(h) and Section 301(j)(5) of the Clean Water Act (RWQCB and EPA 2017). The current five-year modified discharge permit for the Point Loma discharge expires on September 30, 2022 (RWQCB and EPA 2017). The renewal application does not request any increase in currently permitted discharge flows or mass emissions. Treatment and discharge operations at Point Loma have complied with all applicable state and federal standards for the protection water quality, habitat quality, marine organisms, and beneficial uses of the ocean. The proposed discharge will continue to meet or exceed these standards.

During the upcoming renewed permit cycle, estimated to begin by 2024, changes to the City's wastewater system will result in a significant improvement of the discharge quality through the PLOO. By the end of 2027 Phase 1 of the Pure Water San Diego Program (Pure Water) is expected to begin operation. On average, Pure Water will ultimately divert up to 52 million gallons per day (mgd) of wastewater away from the Point Loma Wastewater Treatment Plant (PLWTP) to eventually produce 30 mgd of water suitable for potable reuse, and up to 11.9 mgd of reclaimed water for non-potable reuse (e.g., irrigation, industrial and commercial uses). This diversion will not only augment San Diego's local water supply; but will also reduce the flow and load of pollutants discharged through the PLOO.

The purpose of this Endangered Species Assessment is to provide the appropriate federal regulatory agencies with information that can be used as the basis to initiate actions that may be required to demonstrate compliance with the provisions of the Endangered Species Act (ESA). The ESA assessment is intended to compliment an Essential Fish Habitat assessment (Appendix J) that has also been prepared in order that it may be reviewed in concert with the ESA assessment.

The ESA of 1973 (16 U.S.C. §§ 1531 et seq.) establishes protection over and conservation of endangered species and the ecosystems on which they depend (EPA 2021). The lead agencies for implementing the ESA are the U.S. Fish and Wildlife Service (USFWS) and the U.S. National Oceanic and Atmospheric Administration (NOAA) Fisheries Service (National Marine Fisheries Service: NMFS). An endangered species is a species that is in danger of extinction throughout all or a significant portion of its range. The ESA establishes procedures for nominating species for protection and prohibits actions that would jeopardize their continued existence. All federal agencies are required to implement protection programs for endangered species and to use their authority to further the purposes of the ESA.

The ESA requires agencies to consult with the USFWS and the NMFS whenever a proposed action may affect threatened or endangered species or their designated critical habitat (50 Code of Federal Regulations (CFR) 402.14) The process can begin with informal consultation that includes discussions and correspondence between the USFWS, NMFS, and the agency or the designated agency representative to determining whether formal consultation is required. During informal consultation, the USFWS and NMFS may suggest modifications to the action that could avoid the likelihood of adverse effects to listed species or critical habitat.

If formal consultation is required, the responsible agency submits a written request to initiate formal consultation to the Directors of the USFWS and NMFS that includes:

- a description of the action to be considered
- a description of the specific area that may be affected by the action
- a description of any listed species or critical habitat that may be affected by the action
- a description of the manner in which the action may affect any listed species or critical habitat andan analysis of any cumulative effects
- relevant reports, including any environmental impact statement, environmental assessment, or biological assessment prepared
- any other relevant available information on the action, the affected listed species, or critical habitat

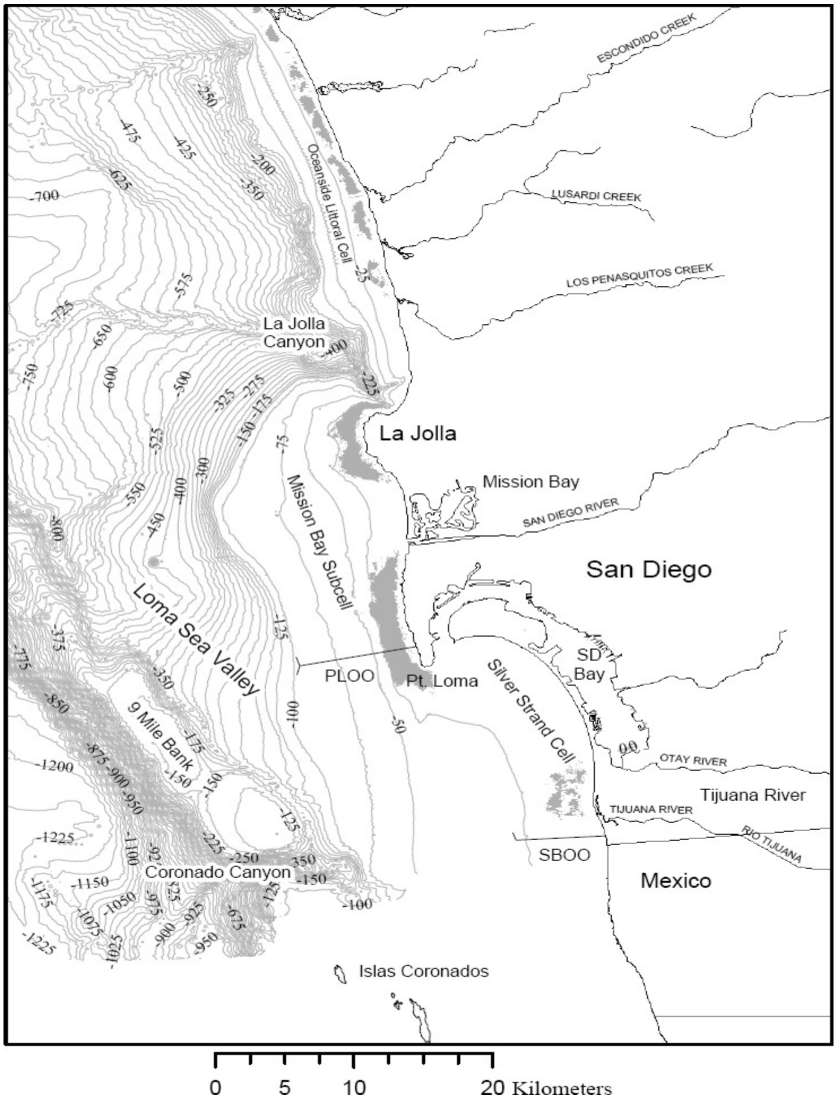
In the following sections, this assessment considers the potential effects of the discharge of treated wastewater from the PLOO on endangered species and their critical habitat. It presents the types of information and analysis detailed above as a basis for initiating actions to determine if the proposed discharge is likely to affect listed species or critical habitat.

At the time of preparation of this NPDES application, consultations between EPA and NOAA Fisheries were ongoing regarding Endangered Species and Essential Fish Habitat effects associated with the PLOO discharge regulated under Order No. R9-2017-0007. Due to the timing of finalizing that review and the completion of this application, information from that review could not be included in this renewal application. If necessary, the information presented herein may be augmented in the future for use in any Endangered Species and Essential Fish Habitat assessment that may be necessary in conjunction with the renewal process for Order No. R9-2017-0007.

I.2 POINT LOMA OCEAN OUTFALL

The PLOO discharges approximately 140 mgd of treated wastewater, generated by more than 2.2 million residents and industries (with source controls) in a 450-square-mile or 1,165-square-kilometer area. The PLWTP has an overall capacity of 240 mgd. Treated wastewater is discharged through the PLOO 4.5 miles (mi) or 7.2 kilometers (km) offshore at a depth of approximately 310 feet (ft) or 95 meters (m) (Figure I-1; note the grey areas off Point Loma and La Jolla represent kelp beds).

**Figure I-1:
Location of the Point Loma Ocean Outfall**



The PLOO is one of the longest and deepest ocean outfalls in the world. It was extended to its present location in 1993 and is buried in a trench from shore through the surf zone out to a distance of about 2,600 ft (792 m) offshore. Over the next 400 ft (123 m) the pipeline gradually emerges from the rock trench. Beyond 3,000 ft (914 m) offshore, the remainder of the 4.5 mi (7.2 km) pipeline rests on a bed of ballast rock on the sea floor. The end of the pipeline connects to a perforated "Y" diffuser section of two legs, each 2,500 ft (762 m) long. Wastewater is discharged through diffuser ports ranging in depth from 306 ft (93 m) to 313 ft (95 m). Mathematical models of outfall operation indicate a median (50th percentile) initial dilution of 338:1 at a discharge flow rate of 240 mgd (the maximum design flow). The minimum month initial dilution (the initial dilution as determined assuming zero ocean currents and using the worst case density conditions from over 13,000 density data profiles) is computed at 202:1.

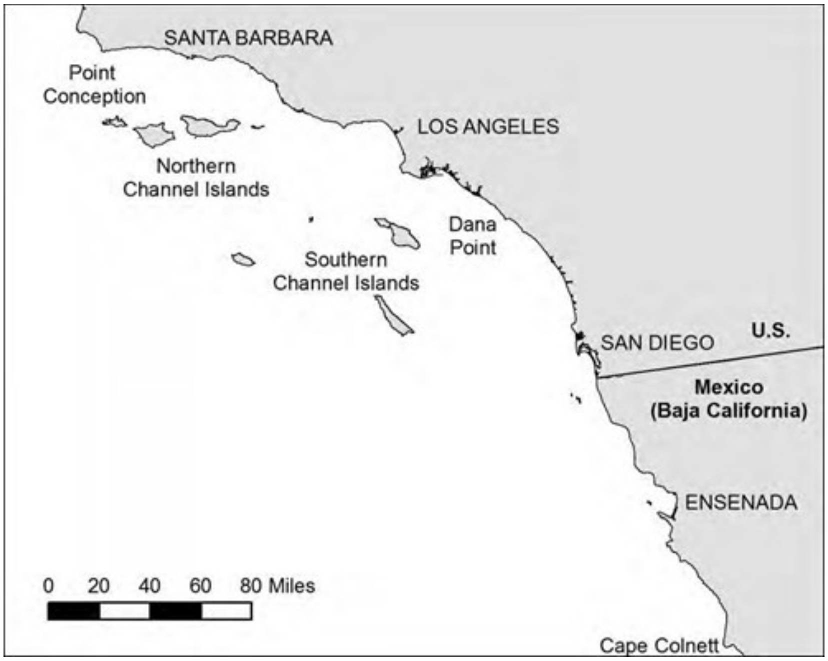
The deep discharge and high initial dilution traps discharged diluted wastewater at a depth of more than 130 ft (40 m) below the ocean surface (Rogowski et al. 2012). This keeps the outfall plume away from the near-shore environment (Rogowski et al. 2013, City of San Diego (COSD)). Another favorable feature of the PLOO is the location of the discharge near the break in the mainland shelf (Figure I-1). The shelf drops precipitously immediately offshore from the diffuser facilitating plume dispersal.

The pipeline and diffusers with their supporting bed of ballast rock form an artificial reef. The pipe and rock, covered with encrusted organisms (tube worms, anemones, barnacles), provide food and shelter to a variety of fish and invertebrates. This artificial habitat covers an area of about 22 acres (9 hectares) off Point Loma (assuming a 36 ft (11m) width of pipe and ballast rock) (Wolfson and Glinski 1986).

I.3 ACTION AREA

The marine waters off the Point Loma are located in the Southern California Bight - a broad ocean embayment created by an indentation of California's coastline south of Point Conception (Figure I-2). The Southern California Bight extends from Point Conception south to Cabo Colnett, Baja California, Mexico, and west to the Santa Rosa-Cortes Ridge. The continental shelf in this area has several submarine valleys and submerged mountains whose peaks form the offshore islands. Submarine ridges and troughs in the Southern California Bight generally run northwest to southeast, with the exception of the east-west trending Santa Barbara Channel.

Figure I-2:
Southern California Bight



The Southern California Bights' large urban population centers and busy harbors make it one of the most heavily utilized marine ecosystems on earth, yet it supports a diverse assemblage of marine life including marine algae and plants, invertebrates, fish, sea turtles, marine mammals, sea birds, and a wide variety of habitats (Dailey et al. 1993, Schiff et al. 2000, Leet et al. 2001, Allen et al. 2005, 2006, 2011, Allen and Cross 2006, California Marine Life Protection Act (CMLPA) 2009, Pondella et al. 2012, Ranasinghe et al. 2012, Setty et al. 2012, Southern California Coastal Water Research Project (SCCWRP) 2012, 2021a, United States Department of the Navy (USDON) 2013.

Marine habitats in the Southern California Bight range from sandy beaches and rocky coasts to deep, soft- and hard-bottom areas. Intertidal zones include sandy beaches, rocky shores, tidal flats, coastal marsh, and manmade structures. There are nearly 40 tidally-influenced estuaries and lagoons with associated open water, soft bottom, tidal mud flats, and eelgrass beds.

Sandy and soft-bottom substrates dominate shorelines and subtidal habitats in the southern region. These substrates lack the relief or structural complexity of hard-bottom habitats, but support species adapted to low-relief, dynamic environments. Invertebrates and bottom-dwellingfish are the most common species in soft substrate areas.

Hard-bottom habitats like rocky reefs are less common but generally have greater productivity and species diversity than soft-bottom habitats. Kelp forests are associated with shallow rock bottoms, while deep-sea corals and sponges are found in deep rock habitats. Kelp forest extending through the water column form dense surface canopies and promote high productivity and diversity of marine life.

The Southern California Bights' broad continental shelf includes channels, basins, and canyons, interspersed by shallower ridges. Underwater pinnacles and rocky outcrops are important aggregation sites for fish and other species. Marine canyons contain unique deep-water communities and provide foraging areas for seabirds and marine mammals. The marine environment surrounding the Channel Islands affords a distinctive ecological setting, with nutrient-rich waters and high-relief rocky habitats fostering substantial biodiversity.

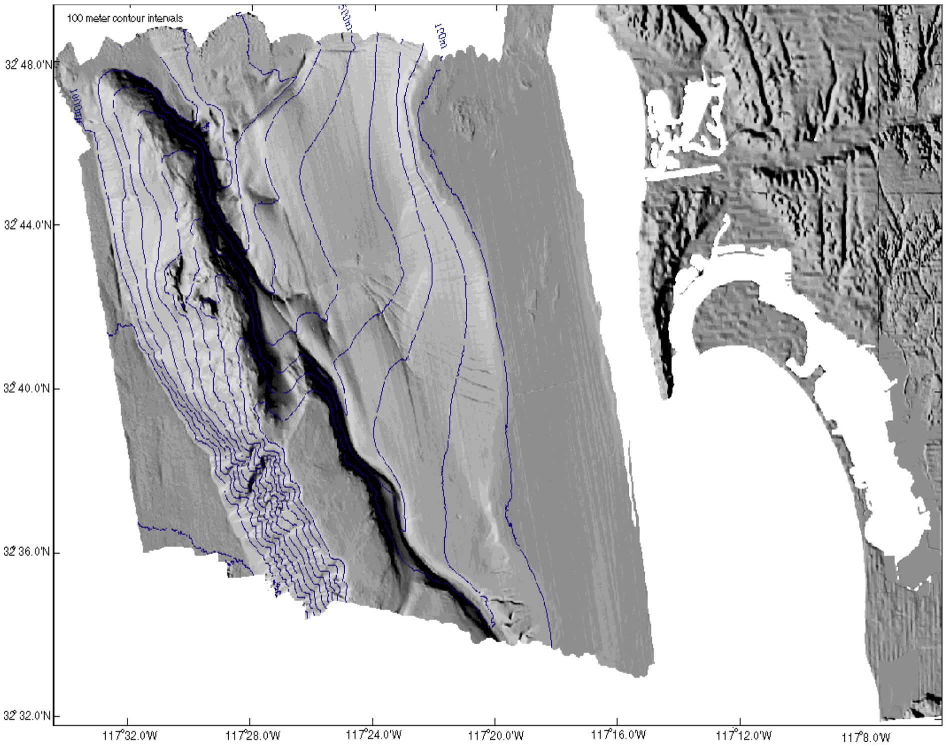
I.4 ENVIRONMENTAL SETTINGS

I.4.1 Oceanographic Conditions

Bathymetry

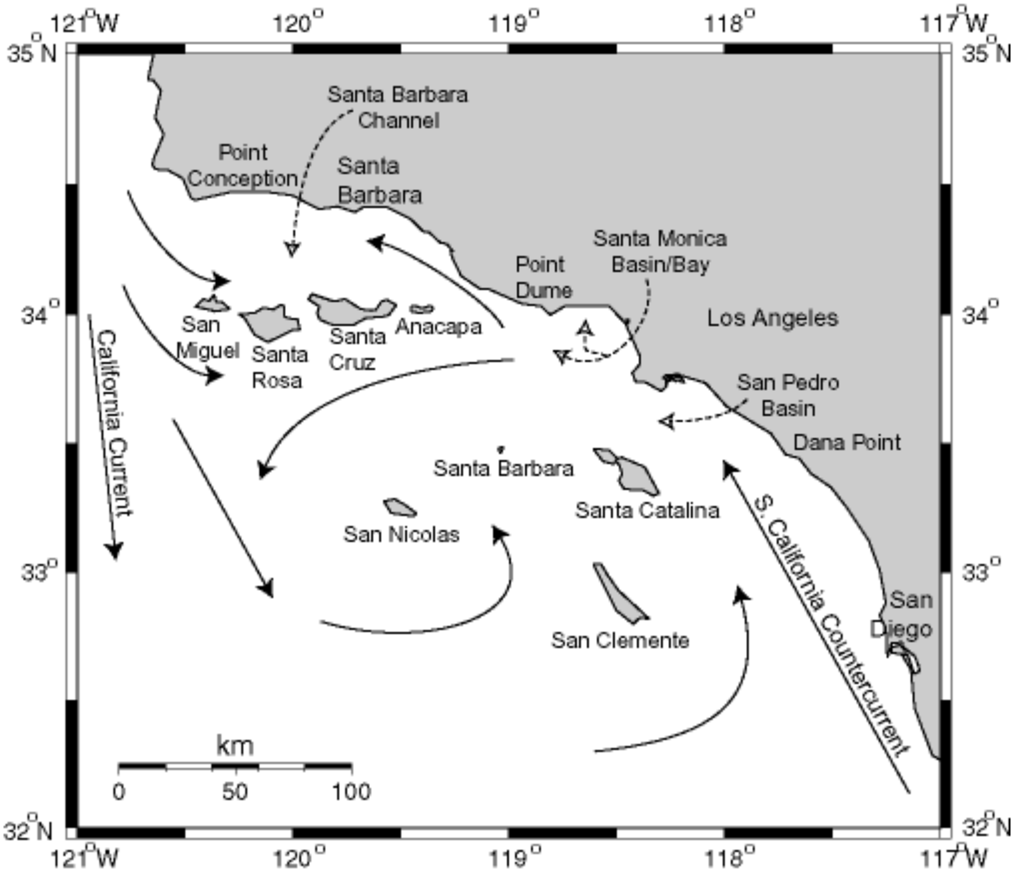
Point Loma's shoreline is primarily rocky reef with an occasional cobble or sand pocket beach. The principal feature of the nearshore marine environment is a large, 6-mile-long (10 km) kelp bed extending from the tip of Point Loma to the Mission Bay/San Diego River Jetty (Figure I-1). The kelp bed grows on a pavement-like mudstone/sandstone terrace from depths of about 25 ft (7.6 m) to about 90 ft (27 m) between 1/2 mi (0.8 km) from shore and 1 mi (1.6 km) from shore. The terrace is incised by shallow surge channels and covered in parts by cobbles and boulders. The terrace edge, the remnant of a now submerged seacliff, lies in 100 ft (30 m) depths. Here thebottom relief increases and pinnacles and large boulders rise above the fine gray bottom sands (California Department of Fish and Game (CDFG) 1968). In Figure I-3, the demarcation between the white nearer shore areas and the darker gray offshore waters corresponds roughly to this break (off Point Loma only). This also corresponds with the outer limit of the kelp bed, or about 90 ft (27 m) depth.

**Figure I-3:
Seafloor Bathymetry Off San Diego, California**



Map from: USGS 1998.
Note: Each minute of latitude on the vertical axis represents 1 nautical mile.

Figure I-4:
Circulation Patters in the Southern California Bight



(After Hickey, B. M., 1992, Progress in Oceanography, V30: 37-115)

Below the thermocline, the California Undercurrent flows northward with speeds ranging from 3 to 25 centimeters per second; the maximum water velocity occurs at a depth of 60 m (National Research Council 1990). This northward flow opposes the California Current at the surface and spans the entire mid-latitude eastern boundary of the North Pacific (Pierce et al. 2000). The California Undercurrent is typically found inshore of the California Current and is composed of water originating in the Equatorial Pacific (Noble 2009). The flow of the California Undercurrent is relatively weak; its maximum strength occurs during the summer months and a secondary maximum occurs in the winter (Hickey 1993, Perry et al. 2007). This water mass can be delineated from deep water contained farther offshore in the California Current because the water of the California Undercurrent contains higher nutrient concentrations and lower dissolved oxygen concentrations.

Deepwater circulation can be divided into three seasonal patterns (California State University, Long Beach (CSULB) 2013). From December to February, flow is strengthened and partially displaces the California Current to the west. From March to June, along-shore winds strengthen and drive the surface waters to create upwelling of deep cold water to the surface along the coast. The shift offshore creates a condition in which the California Current intensifies in localized areas due to bottom topography and current strength. July to November the California Current dominates, weakening the California Undercurrent (Perry et al. 2007). In general, the water contained in the California Undercurrent does not reach the surface. However, during periods of weak California Current flow (winter months or during an El Niño event), the California Undercurrent may reach the surface offshore of Los Angeles, join the California Countercurrent and flow as far north as Vancouver Island, Canada.

Upwelling

Upwelling is a wind driven, dynamic process that brings nutrient-rich deep water to the surface and nutrient-poor surface waters offshore through the interaction of currents, density, or bathymetry (Noble 2009). In wind driven upwelling, warmer surface waters are transported perpendicular to the direction of the wind. Deep, cold water moves vertically into the euphotic zone to replace the nutrient-poor surface water that was transported offshore.

Winds that promote upwelling are generally strong along the California coastline; upwelling in this region occurs throughout the year with the strongest upwelling in the spring and summer months (Schwing et al. 2000, Perry et al. 2007). In the Southern California Bight, upwelling tends to be limited to late winter and early spring due to a reduction in wind stress. Coastal upwelling appears to be the dominant process affecting the physical and ecological structure of eastern boundary current systems, including the California Current System. Coastal upwelling substantially affects regional and local oceanic circulation, thermohaline structure and stability, and water mass exchange between the coastal and deep ocean waters. Intense upwelling has been correlated to recruitment success for commercially important fish stocks in coastal California waters.

I.4.2 Biological Conditions

Marine life can be conveniently grouped into categories that reflect their spatial position in the ocean. Pelagic species occupy the water column. Benthic species live directly above the bottom, on the bottom, or in the sediments. A general description of the food chain follows, beginning with the smallest organisms and ending with the largest.

Plankton

Plankton float or drift passively with currents and form the base of the oceanic food web. Plankton include a wide variety of bacteria (bacterioplankton), plant-like organisms and algae (phytoplankton), and animals (zooplankton) including fish larvae (ichthyoplankton). Although most planktonic species are microscopic, the term plankton is not synonymous with small size; some jellyfish can be as large as 10 ft (3 m) in diameter. Phytoplankton aggregate near the surface. They are grazed on by zooplankton, ichthyoplankton, and small fishes which in turn are consumed by larger fishes, birds, mammals, and humans.

Phytoplankton

Marine phytoplankton are microscopic, single celled plants that use sunlight and chlorophyll to photosynthesize organic matter. Phytoplankton in the ocean's surface layers produce most of the organic matter in the sea and are crucial to overall ocean productivity. The distribution of most marine organisms is linked to phytoplankton productivity.

In general, phytoplankton are patchily distributed, occurring in regions with optimal conditions for growth. Nearshore ocean waters typically have a higher nutrient content and foster greater primary productivity and plankton biomass than open ocean waters.

In the Southern California Bight, waters from both the north and the south mix and promote increased phytoplankton abundance and diversity (Hardy 1993, Schiff et al. 2000, Kim et al. 2009). Over 280 species of phytoplankton have been reported there (Eppley 1986). The diversity of phytoplankton species in the region reflects the transition from subarctic waters in the north to more subtropical waters in the south. Highest levels of productivity occur in the spring/summer months with the lowest levels of production occurring during the winter months.

Along the California coast, there is a decrease in phytoplankton production in the surface waters during El Niño conditions due in part to a decrease of upwelling strength (Kahru and Mitchell 2000, Hernández de la Torre et al. 2004). This causes the chlorophyll maximum to occur deeper in the water column (McGowan 1984, Bjorkstedt et al. 2013, Chenillat et al. 2013). In addition, El Niño conditions weaken the California Current and tend to favor an increase in subtropical species (Leet et al. 2001). Following an El Niño, coastal phytoplankton abundance increases to long-term average levels (Lavaniegos et al. 2003, Hernández de la Torre et al. 2004).

Conversely, La Niña conditions cause a shift towards more subarctic phytoplankton species (Goes et al. 2001).

Zooplankton

Zooplankton do not photosynthesize, but instead, rely upon phytoplankton as a source of food. They are taxonomically and structurally diverse, ranging in size from microscopic unicellular organisms to large multicellular organisms. Zooplankton may be herbivorous (consuming plants), carnivorous (consuming animals), detrivorous (consuming dead organic material), or omnivorous (consuming a mixed diet). Examples of zooplankton include foraminifera, pteropods, copepods, and myctophid fish.

Along the California coast the abundance of zooplankton is correlated with the strength of the California Current such that high levels of flow result in high zooplankton biomass (Dawson and Pieper 1993). Zooplankton biomass tends to reach its maximum in the summer months, coinciding with peak krill (*Euphausia*) biomass. The high abundance of euphasiids attracts whales to congregate and feed off the California and Mexico coastlines (Burtenshaw et al. 2004).

In the Southern California Bight, El Niño and La Niña conditions affect the distribution of zooplankton (Suntsov et al. 2012). During strong El Niño events, macrozooplankton biomass declines substantially (Roemmich and McGowan 1995, McGowan et al. 1998). During the 1998 El Niño event, the macrozooplankton biomass was lower than ever documented in the 1951 to

1998 record (Hayward 2000). Southern, warm-water species become more abundant during El Niño events and northern, cool-water species decline.

During La Niña conditions, macrozooplankton biomass is anomalously high and subarctic species are more abundant (Schwing et al. 2000). Increased upwelling during a La Niña event can negatively impact the recruitment of benthic nearshore organisms (urchins, barnacles, and crabs); these organisms are dependent on relaxed upwelling conditions to transport planktonic larvae onshore for settlement (Schwing et al. 2000).

Nekton

Nekton are pelagic organisms that swim freely, are generally independent of currents, and, range in size from microscopic to gigantic, such as whales. Nekton include invertebrates (e.g., squid) and vertebrates (fish, sea turtles, and marine mammals). Endangered nekton are discussed in subsequent sections.

Marine Habitats and Ecology

The Southern California Bight is influenced by two major oceanic currents: the southward-flowing, cold-water California Current and the northward-flowing, warm-water California Countercurrent (Perry et al. 2007, CSULB 2013). These currents mix in the Southern California Bight and strongly influence patterns of ocean water circulation, sea temperatures, and distributional trends of marine flora and fauna along thesouthern California coast and Channel Islands (Dailey et al. 1993, Schiff et al. 2000, Horn and Allen 1978, Leet et al. 2001, Horn et al. 2006, Miller and Schiff 2011, Ranasinghe et al. 2012, Setty et al. 2012, Koslow et al. 2013).

High species richness is a product of the region’s complex oceanographic topography and the convergence of multiple, influential water masses (Noble 2009). These include:

- large scale climate processes such as the El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Pacific Gyre Oscillation (NPGO) that can affect long-term trends (Bjorkstedt et al. 2013)
- the California Current System coupled with local gyres that transport distinct water masses into and out of the Southern California Bight throughout the year
- seasonal changes in local weather patterns

Relatively warm waters and a more stratified water column are typically present during the dry season from May to September while cooler waters and weaker stratification characterize ocean conditions during the wet season from October to April. Winter storms bring higher winds, rain, and waves creating a well-mixed, non- stratified water column. Surface waters begin to warm by late spring and are then subjected to increased surface evaporation. Once the water column becomes stratified, minimal mixing conditions typically remain throughout the summer and into early fall. Toward the end of the year, surface water cooling along with increased storm frequency returns the water column to well-mixed conditions.

The Southern California Bight is home to more than 5,000 species of marine invertebrates, over 480 species of marine fish, 5 species of sea turtles, 39 species of marine mammals, and 195 species of coastal and offshore birds (Dailey et al. 1993, Schiff et al. 2000, Allen et al. 2005, 2006, 2011, Allen and Cross 2006, CMLPA 2009, SCCWRP 2012, 2021a, USDON 2013). The diversity of marine life is greatest in southern California and declines to the north through the region (Horn and Allen 1978, Horn et al. 2006). The Point Loma area is located within a transitional zone between subarctic and subtropical water masses. Point Conception, California (34.5 °North) is the distinguished biogeographical boundary between subtropical species (i.e., species with preferences of temperatures above 50 to 68 degrees Fahrenheit (°F) (10 to 20 degrees Celsius (°C)) of the San Diego Province and temperate species (i.e., species with temperature preferences below 59 °F (15 °C)) of the Oregon Province (Horn et al. 2006, Suntsov 2012).

The California Current system is rich in microscopic organisms (i.e., diatoms, tintinnids, and dinoflagellates) which form the base of the food chain in the area (Hardy 1993). Small coastal pelagic fish and squid depend on this planktonic food supply and in turn are fed upon by larger species. Groundfish (e.g., flatfish, roundfish, skates/sharks/chimeras, rockfish, etc.) are important recreational and commercial species (Love 2006). The shelf and slope demersal rockfish are the most specious genus of fish off the western coast of North America (Love et al. 2002). These fish are typically the dominant species in many ichthyological surveys, in terms of abundance and diversity, especially between the 20 to 200 m isobaths. Migratory species (e.g., tuna, billfish, sharks, dolphinfish, and swordfish) and coastal pelagic species (e.g., anchovies, mackerels, sardines, and squids) support extensive fisheries in the area (Hackett et al. 2009).

The diverse habitats of the Southern California Bight greatly influence the distribution marine fauna and flora in the area (Horn et al. 2006, Miller and Schiff 2011). Cross and Allen (1993) defined fish habitats in three broad categories: the pelagic zone, soft substrate habitats (i.e., bays, estuaries, open coast), and hard substrate and kelp bed habitats (i.e., rocky habitats, reefs). The pelagic zone, relating to open water, is the largest habitat in the area with 40% of the fish species inhabiting this area. This zone is subdivided into three distinct regions: epipelagic (up to 50 m deep), mesopelagic (50 to 500 m deep), and bathypelagic regions (greater than 500 m deep). The epipelagic region is inhabited by small, planktivorous schooling fish (e.g., northern anchovy), predatory schooling fish (e.g., Pacific mackerel), and large solitary predators (e.g., blue shark).

Abundance of all epipelagic species changes seasonally with fish moving offshore to spawn.

The mesopelagic region is characterized by steep environmental gradients and fish that are small, slow growing, long-lived, and reproduce early and repeatedly (e.g., bigeye lightfish). The bathypelagic zone is a rather uniform region containing large, sluggish, fast growing, short-lived fish, that reproduce late and typically only once (e.g., bigscale and hatchetfish) (Cross and Allen 1993, Love et al. 2009).

Typical fish utilizing soft substrates (sand, silt, and mud) include sharks, skates, rays, smelts, flatfish (flounders), gobies and northern anchovies. Regions with hard substrates and kelp beds (*Macrocystis*) are not as abundant as other benthic habitats in the Southern California Bight, but provide productive habitats for many species.

Shallow reefs (i.e., <30 m depth) are the most common type of hard substrate (i.e., coarse sand, calcareous organic debris, rocks) found in the area. These reefs also support kelp beds, which serve as nursery areas for various fish species. Rocky intertidal regions are often turbulent, dynamic environments, where organisms must cope with stresses associated with tides (e.g., changes in temperature, salinity, oxygen, and pH) and wave impact. Deep reef fish, found along deep banks and seamounts, are typically large, mobile species (e.g., rockfish and spiny dogfish).

Kelp beds promote a high diversity of associated marine organisms (Foster and Schiel 1985, Foster et al. 2013). Smaller fish feed on high plankton densities in the area, while larger fish congregate to feed on smaller species. Kelp beds are especially important habitats for young-of-the-year rockfish species, such as the kelp rockfish, whose densities positively correlate to the size of the kelp bed.

Inshore areas (bays and estuaries) provide nursery habitats and feeding grounds to a variety of species, some of commercial importance (e.g., California halibut) (Allen et al. 2006). San Diego Bay's seagrass beds are used by schooling species, such as anchovies and topsmelt (Allen et al. 2002) with the highest abundance and biomass of fish occurring in the spring (i.e., April) and summer (i.e., July). Juvenile northern anchovy, topsmelt, and slough anchovy comprise up to 79% of the fish in the Bay.

The influence of the California Current on the physical and biological environment of the Southern California Bight fluctuates significantly on a year-to-year basis (Noble 2009, Bjorkstedt et al. 2013, Koslow et al. 2013, Miller and McGowan 2013). It is also affected by larger-scale climate variations, such as ENSO, PDO, and NPGO (Dayton and Tegner 1984, 1990, Tegner and Dayton 1987, 1991, Dayton et al. 1992, Hickey 1993, Tegner et al. 1996, 1997, Horn and Stephens 2006, Parnell et al. 2010, Miller and Schiff 2011, Miller et al. 2013). These events can initiate large shifts in the global climate, atmospheric circulation, and oceanographic processes (Doney et al. 2012, Chenillat et al. 2013, U. S. NMFS 2013a, NOAA 2021, Sydeman et al. 2013).

I.5 REGULATORY FRAMEWORK

I.5.1 Endangered Species Act

The ESA of 1973 (16 U.S.C. §§ 1531 et seq.) establishes protection over and conservation of endangered species and the ecosystems on which they depend (NOAA 2021b, USFWS 2021a,b). An endangered species is a species that is in danger of extinction throughout all or a significant portion of its range. The ESA establishes procedures for nominating species for protection and prohibits actions that would jeopardize their continued existence. All federal agencies are required to implement protection programs for endangered species and to use their authority to further the purposes of the ESA.

I.5.2 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §§ 1361 et seq.) (NMFS 2021a) creates the authority to protect marine mammals in waters or on lands under U. S. jurisdiction. It defines federal responsibility for conserving marine mammals (whales, dolphins, porpoises, seals, sea lions, and sea otters). The MMPA prohibits harassing, capturing, disturbing, or, killing marine mammals except under special permit. It creates a Marine Mammal Commission, Regional offices, and Fisheries Science Centers to implement research and protection.

I.5.3 California Endangered Species Act

The California Endangered Species Act (CESA) of 1970, as amended in 1984, is part of the California Fish and Game Code and is administered by the California Department of Fish and Wildlife (CDFW 2021b). It establishes measures to conserve, protect, restore, and enhance endangered species and their habitats. Certain species that are not recognized as endangered under the federal ESA may be listed as endangered under the CESA. The provisions included in the CESA generally parallel those in the federal ESA, but also apply to species petitioned for listing (i.e., state candidates).

I.6 ENDANGERED SPECIES

Twenty-eight endangered species covered under the federal ESA, the federal Marine Mammal Protection Act, and/or the CESA may occur in the vicinity of Point Loma (Table I-1): eight marine mammals, seven birds, five sea turtles, six fish, and two invertebrates. Their population biology, status, distribution, and potential environmental effects of the PLOO on endangered species are discussed in the following paragraphs.

Table I-1:
Endangered and Threatened Species That May Occur in the Vicinity of Point Loma

Endangered and Threatened Species That May Occur in the Vicinity of Point Loma California Department of Fish and Wildlife (CDFW 2021c) National Marine Fisheries Service (NOAA 2021d) U.S. Fish and Wildlife Service (USFWS 2021b)		
Marine Mammals		
Blue Whale	*Balaenoptera musculus*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
Humpback Whale	*Meaptera novaeangliae*	Endangered
Northern Right Whale	*Eubalaena japonica*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sperm Whale	*Physeter macrocephalus*	Endangered
Western North Pacific Gray Whale	*Eschrichtius robustus*	Endangered
Guadalupe Fur Seal	*Arctocephalus townsendi*	Threatened
Fish		
Ocean Whitetip Shark	*Carcharhinus longimanus*	Threatened
Giant Manta Ray	*Manta birostris*	Threatened
Chinook Salmon	*Oncorhynchus tshawytscha*	Threatened
Steelhead Trout	*Oncorhynchus mykiss*	Endangered
Green Sturgeon	*Acipenser medirostris*	Threatened
Scalloped Hammerhead Shark	*Sphyrna lewini*	Endangered
Turtles		
Green Sea Turtle	*Celonia mydas*	Endangered
Loggerhead Sea Turtle	*Caretta*	Endangered
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered
Olive Ridley Sea Turtle	*Lepidochelys olivacea*	Endangered
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered
Mollusks		
Black Abalone	*Haliotis cracherodii*	Endangered
White Abalone	*Haliotis sorenseni*	Endangered
Birds		
California Least tern	*Sterna antillarum browni*	Endangered
Light-footed Clapper Rail	*Rallus longirostris levipes*	Endangered
Western Snowy Plover	*Charadrius alexandrines nivosus*	Threatened
Guadalupe Murrelet	*Synthliboramphus hypoleucus*	Threatened
Marbled Murrelet	*Brachyramphus marmaoratus*	Threatened
Scripp's Murrelet	*Synthlibramphus scrippsi*	Threatened
Short-tailed Albatross	*Phoebastria albatross*	Endangered

I.6.1 Whales

Marine mammals are warm-blooded, have fur or hair, breathe air through lungs, bear live young, and nurse them with milk. They have streamlined bodies and most have an insulating layer of blubber. Two types of marine mammals pass through or inhabit San Diego coastal waters; cetaceans and pinnipeds. Whales are members of the first group that also includes dolphins and porpoises (NMFS 2021b, Perrin et al. 2008). Cetaceans are entirely aquatic, have two front flippers, and tails with horizontal extensions that provide swimming power. The great whales, like blue, gray, and humpback whales, have rows of closely spaced baleen plates that filter out and trap plankton and small fish. Sperm whales, dolphins, and porpoises have teeth for grasping prey.

The second group of marine mammals, pinnipeds (sea lions and seals), regularly haul out on land to rest, breed, and give birth (NMFS 2021d). Sea lions have visible external ears and can walk on all four flippers by rotating their rear flippers forward under their body. Their swimming power comes from large front flippers. Seals have no external ears and can only crawl on land because their front flippers are small and their hind flippers cannot rotate forward. Seals swimming power comes from their large, fan-like rear flippers.

Of the species of great whales that may pass by Point Loma, seven are endangered: the blue whale, the fin whale, the humpback whale, the right whale, the sei whale, the sperm whale and a very occasional visitor may include the western North Pacific Gray whale (Table I-1). The other great whales, the eastern Northern Pacific gray whale and the minke whale, were previously endangered but have now recovered. There are no endangered dolphins or porpoises in the San Diego area.

Gray whales are found mainly in shallow coastal waters in the North Pacific Ocean, although during migration, they do sometimes cross deep waters far from shore. There are two geographic distributions of gray whales in the North Pacific. The eastern North Pacific stock found along the west coast of North America and the western North Pacific stock primarily found along the coast of eastern Asia.

Although western and eastern stocks of gray whales were thought to be relatively isolated from each other, recent satellite tagging data and photo-identification and genetic matches have shown that some western North Pacific gray whales may migrate across the northern Gulf of Alaska to join the eastern rock along the west coast of British Columbia, the United States, and Mexico (Jones and Swartz 2009).

Eastern North Pacific gray whales spend the summer feeding in the northern Bering and Chukchi seas, but some feed along the Pacific coast during the summer, in waters off of Southeast Alaska, British Columbia, Washington, Oregon, and northern California. Each year in the fall, the gray whales migrate from their summer feeding grounds, heading south along the coast of North America to spend the winter in their wintering and calving areas off the coast of Baja California, Mexico, to return north from mid-February to June. This is the longest migration of any mammal traveling 9,000 – 12,000 round trip miles each year. During the return trip they pass closer to shore and can readily be observed from Point Loma.

The gray whale, *Eschrichtius robustus*, is the most common whale observed along the San Diego coast and the most easily seen from shore (Jefferson et al. 2011). These large whales can grow to about 50 ft (15 m) long and weigh approximately 80,000 pounds (lb) (35,000 kilograms (kg)). Gray whales are found only in the north Pacific Ocean – an Atlantic form is extinct (Jones and Swartz 2009).

Hunted practically to extinction, the gray whale has staged a remarkable comeback since it was listed as endangered throughout its range under the ESA in 1973. Today, gray whales are protected under the MMPA. The eastern North Pacific stock was once listed as endangered under the ESA but was delisted in 1994 based on evidence that the population had nearly recovered to its estimated original population size and was not in danger of extinction throughout all or a significant portion of its range. Its current population estimate is approximately 20,000 individuals (Carretta et al 2014). In 1999, NOAA Fisheries conducted a review of the status of the eastern North Pacific stock of gray whales and recommended the continuation of its classification as non-threatened based on the continued growth of the population. NOAA continues to monitor the abundance and calf production of the stock, especially in light of recent climatic changes occurring in their arctic feeding grounds.

However, the western North Pacific stock of gray whales has not recovered. It is listed as endangered under the ESA and depleted under the MMPA. Gray whales usually feed in shallow waters less than 200 ft (60 m) deep (Perrin et al. 2008). They are primarily bottom feeders whose prey includes a wide range of invertebrates living on or near the seafloor. The whales filter amphipods and other crustaceans with their baleen plates. Although generally fasting during the migration and calving season, opportunistic feeding occurs in the shallow coastal waters along the migration path and in the calving lagoons. The gray whale is preyed on by killer whales. Many exhibit attack scars indicating not all attacks are fatal, however fatalities are known (Jones and Swartz 2009).

Gray whales are susceptible to entanglement in fishing gear and ship strikes. No gray whales were observed entangled in California gillnet fisheries between 2007 and 2011 (Carretta and Enriquez 2012), but previous mortality in the swordfish drift gillnet fishery has been observed and there have been recent sightings of free-swimming gray whales entangled in gillnets (Carretta et al. 2014). Although acoustic pingers are known to reduce the entanglement of cetaceans in the California drift gillnet swordfish fishery (Carretta and Barlow 2011), it is unknown whether pingers have any effect on gray whale entanglement. Most data on human-caused mortality and serious injury of gray whales is from strandings. There are few at-sea reports of entangled animals alive or dead. Strandings represent only a fraction of actual gray whale deaths (natural or human-caused), as reported by Punt and Wade (2012), who estimated that only 3.9% to 13.0% of gray whales that die in a given year end up stranding and being reported.

For 2007-2011, as reported by NMFS (Carretta et al. 2013), the total mortality of eastern north Pacific gray whales attributed to ship strikes was six deaths. Additional mortality from ship strikes probably goes unreported because the whales either do not strand or have no evident signs of trauma when observed at sea.

As with other great whales that may occur in the Point Loma region, the NMFS has not designated any critical habitat for gray whales (NMFS 2013a).

Minke whales, *Balaenoptera acutorostrata*, the smallest of the baleen whales, can occur year-round off California (Carretta et al. 2014). These sleek, baleen whales feed on krill and schooling fish such as herring, pollock, and cod (Jefferson et al. 2011). Minke whales are lunge feeders, often plunging through patches of krill or shoaling fish. They frequent shallower water more often than any other whales except gray whales. Minke whales are prey for killer whales. Increasing levels of anthropogenic sound in the world's oceans is considered a habitat concern for whales, particularly for baleen whales that communicate using low-frequency sound (McDonald et al. 2008, Hildebrand 2009, Rolland et al. 2012).

As with other whales, entanglement in commercial gillnets and ship strikes pose a threat to minke whales. Minke whales may occasionally be caught in coastal set gillnets off California and in offshore drift gillnets off California and Oregon (Carretta et al. 2014).

Ship strikes were implicated in the death of one minke whale in 1977, but the reported minke whale mortality due to ship strikes was zero for the period 2004-2008 (Carretta et al. 2014).

Although rare in California (estimated population is in the low to mid hundreds (Carretta et al. 2014)), minke whales are relatively abundant elsewhere and are not listed as endangered under the ESA. Like the gray whale, minke whales are protected under the Marine Mammal Protection Act but are not considered depleted.

The other whales that periodically traverse the area off Point Loma are deeper water species. The most spectacular of these is the blue whale, *Balaenoptera musculus*. Blue whales, the largest animal that has ever lived, can reach over 100 ft (30 m) in length and weigh as much as 330,000 lb (150,000 kg) (Perrin et al. 2008). Preying almost exclusively on zooplankton, especially krill, they lunge feed and consume approximately 12,000 lb (5,500 kg) of krill per day.

The blue whale inhabits all oceans and typically occurs near the coast over the continental shelf, though it is also found in oceanic waters (Sears and Perrin 2008). The U. S. west coast is a feeding area for blue whales during summer and fall (Carretta et al. 2014). They are regularly observed in the Southern California Bight most often along the 200-m (656 ft) isobath.

Blue whales have been documented to be preyed on by killer whales (Jefferson et al. 2011). While there is little evidence that killer whales attack this species in the north Atlantic or southern hemisphere, 25% of photo-identified whales in the Gulf of California show rake scars from killer whale attacks (Sears and Perrin 2008).

Blue whales are susceptible to ship strikes and entanglement in fishing gear (Redfern et al. 2013). Between 1988 and 2007, 21 blue whale deaths were reported along the California coast and eight of these whales were confirmed to have died as a result of ship strikes (Berman-Kowalewski et al. 2010). The offshore drift gillnet fishery is the only fishery that is likely to entangle blue whales off southern California, although no fishery mortality or serious injuries have been observed (Carretta et al. 2013). The drift gillnet fisheries for swordfish and sharks along the Pacific coast of Baja California, Mexico may take animals from this population as well. Some gillnet mortality of large whales goes unobserved because whales swim away with a portion of the net; however, fishermen report blue and fin whales usually swim through nets without entangling and with little damage to the nets (Carretta et al. 2014).

Tagged blue whales exposed to simulated mid-frequency military sonar sounds showed significant behavioral responses, including cessation of feeding, increased swimming speeds, and movement away from the simulated sound sources, even though the simulated source levels were orders of magnitude lower than some operational military sonar systems (Goldbogen et al. 2013). This study suggests that sonar sources could disrupt feeding and displace whales from high-quality feeding areas, with negative implications for individual fitness and population health.

The current best available abundance estimate for the Eastern North Pacific stock of blue whales that occur off California, Oregon, and Washington is 1,647 (Carretta et al. 2014.)

As a result of commercial whaling, blue whales were listed as endangered under the Endangered Species Conservation Act of 1969. This protection was transferred to the ESA in 1973. They are still listed as endangered and consequently the Eastern North Pacific stock is automatically considered as depleted under the MMPA.

Fin whales, *Balaenoptera physalus*, like blue whales, occur mainly in offshore waters (Jefferson et al. 2011). They do, however, venture closer to shore after periodic upwelling that leads to increased krill density. Recent observations show aggregations of this, second largest of the baleen whales, year-round off southern California (Carretta et al. 2014). Fin whales feed on krill, small schooling fishes, squid, and copepods. They are not known to have a significant number of predators, but in areas where killer whales are abundant, some fin whales exhibit attack scars on their flippers, flukes, and flanks.

The organochlorines DDE, DDT, and PCBs have been identified in fin whale blubber, but at lower concentrations than in toothed whales that feed at higher levels in the food chain (Marsili and Focardi 1996). Female fin whales contain lower burdens than males, likely due to mobilization and export of contaminants during pregnancy and lactation (Gauthier et al. 1997).

Fin whales are susceptible to ship strikes and entanglement in fishing gear (Carretta et al. 2014). Ship strikes were implicated in the deaths of seven fin whales during 2007-2011 (Carretta et al. 2013). During 2007-2011, there were an additional four injuries of unidentified large whales attributed to ship strikes. Documented ship strike deaths and serious injuries are derived from actual counts of whale carcasses and are considered minimum values (Carretta et al. 2013).

As with blue whales, the offshore drift gillnet fishery is the only fishery that is likely to pose a threat of entanglement for fin whales. One fin whale death has been observed in over 8,000 sets since 1990 when NMFS began observing the fishery (Carretta et al. 2014).

Moore and Barlow (2011) present evidence of increasing fin whale abundance in the California Current region. They predict continued increases in fin whale numbers over the next decade that may result in fin whale densities reaching "current ecosystem limits." The best available abundance estimate of fin whales in California, Oregon, and Washington waters is 3,051 (Carretta et al. 2014).

Historical whaling drastically reduced fin whale and other whale stocks. Populations began to recover with implementation of the International Whaling Commission, ESA, and the Marine Mammal Protection Act. Fin whales are listed as endangered under the ESA, and as depleted under the MMPA.

Humpback whales, *Meaptera novaeangliae*, are distinguished by their long pectoral fins (flippers) and complex, repetitive vocalizations (Jefferson et al. 2011). The migratory population of humpbacks present in California offshore waters during summer and fall ranges from Costa Rica to southern British Columbia (Carretta et al. 2014). Humpback whales feed on schools of fish and krill and reach a length of 60 ft (18 m). In the southern California feeding grounds, humpback whales feed on a wide variety of invertebrates and small schooling fish. Feeding occurs both at the surface and in deeper waters, wherever prey is abundant. Humpback whales are the only species of baleen whale that cooperate when feeding in large groups (Perrin et al. 2008).

This species is known to be attacked by both killer whales and false killer whales as evidenced by tooth rake scars on their bodies and fins (Jefferson et al. 2011). Humpback whales observed on the feeding grounds off Washington and California have the highest rate of rake marks of any of their observed feeding grounds.

Entanglement in fishing gear poses a threat to humpback whales throughout the Pacific Ocean. Pot and trap fisheries are the most commonly documented source of mortality and serious injury of humpback whales in U. S. west coast waters (Carretta et al. 2013). Between 2007 and 2011, there were 16 documented humpback whale interactions with pot/trap fisheries. Gillnet and unidentified fisheries accounted for 1 death and 9 serious injuries of humpback whales between 2007 and 2011 (Carretta et al. 2014). An additional number of whales are likely entangled in fishing gear from Mexican fisheries, though quantitative data are not presently available for most of these fisheries.

Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes. Younger whales spend more time at the surface, are less visible, and are found closer to shore, making them more susceptible to collisions (USDON 2013). Eight humpback whales were reported struck by vessels with four resulting deaths between 2007 and 2011 (Carretta et al. 2013). The recorded number of serious injuries and mortality from ship strikes is a fraction of the total because additional mortality from ship strikes goes unreported.

Organochlorines, including PCBs and DDE, have been identified from humpback whale blubber (Gauthier et al. 1997). As with blue whales, these contaminants are transferred to young through the placenta, leaving newborns with contaminant loads equal to that of their mothers (Elfes et al. 2010). Humpback whales feed higher on the food chain, consuming prey carrying higher contaminant loads than the krill that blue whales feed on.

The Central North Pacific stock of humpback whales is the focus of whale-watching activities in both its feeding grounds (Alaska) and breeding grounds (Hawaii) (NMFS 2021b). Regulations addressing minimum approach distances and vessel operating procedures are in place to help protect the whales; however, there is still concern that whales may abandon preferred habitats if the disturbance is too high (USDON 2013).

In 2011 the estimated abundance of humpback whales in the entire Pacific Basin was about 22,000 with approximately 2,000 in California and Oregon waters (Barlow et al. 2011).

As a result of commercial whaling, humpback whales were listed as endangered under the Endangered Species Conservation Act in 1970, and again under the ESA in 1973. The species is still listed as endangered under the ESA and is considered as depleted under the MMPA. Based on evidence of population recovery in many areas, the species was considered by NMFS for removal or downlisting from the ESA (NMFS 2021d).

Prior to being hunted by man, the right whale, *Eubalena japonica*, occurred from the Bering Sea to central Baja California (NMFS 2021b). It was targeted early for exploitation because it was slow moving, easy to approach, provided large quantities of meat, oil, and bone, and floated after being killed – thus the common name – the right whale to kill. Right whales are large baleen whales with adults about 50 ft (15 m) length and can weigh up to 14,000 lb (6,350 kg) (Perrin et al. 2008). They consume zooplankton, krill and copepods. Unlike other baleen whales, right whales are skimmers: they feed by removing prey from the water using baleen while moving with their mouth open through a patch of zooplankton. There are no reliable estimates of current abundance or trends for right whales in the North Pacific. They would be rarely sighted in southern California waters and highly unlikely in the Point Loma area.

The North Pacific right whale has been listed as endangered under the ESA since 1973 when it was listed as the "northern right whale." It was listed as a separate, endangered species in April 2008. The species is designated as depleted under the MMPA.

The sei whale, *Balaenoptera borealis*, is the fastest great whale and can reach speeds well over 20 miles per hour. Sei whales occur rarely in offshore waters in southern California (Carretta et al. 2014). They are present as early as May and June, but primarily are encountered during July to September and leave California waters by mid-October. Sei whales feed on a diversity of prey, including copepods, krill, fish, and cephalopods like squid, cuttlefish, and octopus (Jefferson et al. 2011).

The best curren20t estimate of abundance for the eastern north Pacific stock of sei whales that occur off California, Oregon, and Washington waters out to 300 nautical miles is 126 animals (Carretta et al. 2014). Sei whales, like other large baleen whales, are subject to occasional attacks by killer whales. Based on the statistics for other large whales, it is likely that ship strikes and bycatch also pose a threat to sei whales along the west coast. The sei whale is listed as endangered under the ESA and as depleted under the MMPA.

The only great whale with teeth instead of baleen, the sperm whale, *Physeter macrocephalus*, is by far the most abundant worldwide. During the past 2 centuries, commercial whalers took about 1,000,000 sperm whales (NMFS 2021b). Its current population is estimated at roughly one million – four times the combined total population of the other five endangered large whale species. Sperm whales attain lengths of 60 ft (18 m) and are distinguished by an extremely large head (Perrin et al. 2008). Feeding primarily on squid and fish, sperm whales can make dives of over ten thousand feet deep lasting an hour and a half. Broadly distributed in the north Pacific, sperm whales are found year-round off California, with peak abundance in summer (Carretta et al. 2014).

Contaminants including organochlorines and several heavy metals have been identified in sperm whales, but vary widely in concentration based upon life history and geographic location with northern hemisphere individuals generally carrying higher burdens (Evans et al. 2004). Unlike other marine mammals, females appear to bioaccumulate toxins at greater levels than males, which may be related to possible dietary differences between females who remain at relatively low latitudes compared to more migratory males (Wise et al. 2009).

Bycatch of sperm whales in the California swordfish drift gillnet fishery has rarely been documented since the inception of the observer program in 1990 (Carretta et al. 2013). This fishery has been the subject of field study every year since 1990, and through 2012 a total of 8,365 drift gillnet sets have been observed. Ten sperm whales have been recorded entangled during this time. All of the entanglements occurred from October through December in waters deeper than 4,900 ft (1,500 m), in proximity to steep continental shelf bathymetry. One sperm whale died as the result of a ship strike in Oregon in 2007 (Carretta et al. 2014).

Large populations of sperm whales exist in waters several thousand miles west and south of California, but there is no evidence that sperm whale move from there into U. S. west coast waters (Carretta et al. 2014). The most precise, recent estimate of sperm whale abundance for the California to Washington stock is 971 animals. As a result of previous whaling, sperm whales are listed as endangered under the ESA, and the California to Washington stock is considered depleted under the MMPA.

I.6.2 Seals and Sea Lions

The other endangered marine mammal, the Guadalupe fur seal, *Arctocephalus townsendi*, is an occasional but uncommon visitor to San Diego offshore waters. Severely reduced by hunting in the 1800s, the Guadalupe fur seal was considered extinct by the turn of the century. A small, remnant breeding colony was discovered by Carl Hubbs of the Scripps Institution of Oceanography on Guadalupe Island in 1954 and the population has grown since then (Hubbs 1956). Guadalupe fur seals feed on crustaceans, squid and fish (NMFS 2021e). The Guadalupe fur seal breeds mainly on Guadalupe Island about 100 mi (161 km) off the Baja California coast. Guadalupe fur seals may migrate at least 230 mi (600 km) from their rookery sites, based on observations of individuals in the Southern California Bight (Carretta et al. 2014). The Guadalupe fur seal population is now in the process of recovering (Gallo 1994).

Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals in Mexico and the United States. In the United States there have been no reports of mortality or injuries for Guadalupe fur seals (Carretta et al. 2014). No information is available for human-caused mortality or injuries in Mexico. The Guadalupe seal is listed as threatened under the ESA and depleted under the MMPA.

The Steller sea lion was originally listed under the ESA throughout its range in 1990. However the Eastern DPS was recently delisted (NMFS 2013c). It is seldom seen in southern California except near the Channel Islands. It ranges from Baja California to Alaska but prefers the colder temperate to sub-arctic waters of the North Pacific Ocean (NMFS 2021f). Steller sea lions are opportunistic marine predators, feeding on a variety of fish including mackerel, sculpin, rockfish, salmon, squid, and octopus (Perrin et al. 2008). Among pinnipeds, they are only surpassed in size by the walrus and elephant seal. Although the Steller sea lion may be able to avoid being hit by ships, could be subject to entanglement in fishing gear (Carretta et al. 2005).

I.6.3 Birds

Of the seven species of endangered birds in Table I-1, only the California least tern (*Sternula antillarum browni*) would be regularly encountered in marine waters off Point Loma. Once common along the southern California coast, the least tern population diminished to a low of about 600 pairs in the early 1970s as a result of loss of wetland habitat and increasing human disturbance (USFWS 2009). Implementation of mitigation measures following their classification as an endangered species helped the species slowly recover. The California least tern historically nested on beaches, often near estuaries. Now, active management is required to create and maintain safe nesting sites. Fencing, signs, education, and predator control are all employed to protect the species. Least terns are generally present at nesting areas between mid-April and late September, often with two waves of nesting during this time.

California least terns are distributed along the U. S. Pacific Coast from San Francisco to Baja California (USFWS 2021c). Foraging habitats include nearshore ocean waters, bays, and salt marshes. They plunge-dive to capture prey, usually within 1 mi (1.6 km) from shore in waters less than 60 ft (18 m) deep. Prey species include anchovies, smelt, and gobies. Peak foraging behavior typically occurs from the end of May through mid-July after chicks hatch. California least terns eggs, chicks, and adults are preyed upon by gulls, ravens, hawks, crows, rodents, raccoons, and coyotes. The California least tern was federally listed as endangered in 1970 and was listed as endangered by the state of California in 1971.

The 2012 California least tern breeding survey estimated 4,293-6,421 breeding pairs established 6,636 nests and produced 557-628 fledglings at 49 locations (Frost 2013). The estimated number of breeding pairs in 2012 was less than recorded in 2011, which represented the lowest count recorded since 2002. The fledgling to breeding pair ratio in 2012 was approximately half that in 2011. Since 1977, this ratio has been less than 0.50 for only 13 years, which includes the last 11 years. Continuing the upward trend observed in the previous four years, chick mortality in 2012 continued to be a factor at specific sites, possibly due to limited or inappropriate food sources. In addition to avian predators, which were responsible for the highest predation rates over the last several years, coyotes also contributed to the highest predation rates documented in 2012.

The closest California least tern breeding area to the Point Loma outfall is the Naval Base Coronado. The nesting sites there accounted for an estimated 803-1,023 breeding pairs, 1,068 nests, and 17-19 fledglings in 2012 (Frost 2013). As for the rest of California, least tern mortality due to non-predation factors at Naval Base Coronado was greater than mortality due to predation in 2012. State-wide, of non-predation egg mortality events, the highest death rate (55%) was attributed to abandonment prior to the expected hatching date, leading to the loss of 2,038 eggs. Abandonment post-term or failure to hatch was estimated to constitute 26% of non-predation state-wide mortality.

The light-footed clapper rail, *Rallus longirostris levipes*, is a hen-sized bird with long legs and toes. It has a tawny breast, gray-brown back, and gray and white striped flanks (USFWS 2021d).

They feed primarily on invertebrates such as snails, crab, insects and worms and are year-round inhabitants of coastal estuaries. Light-footed clapper rails historically ranged from Santa Barbara County to San Quintin, Baja California, Mexico. Loss and degradation of southern California wetlands resulted in the species being listed as federally endangered in 1970 and California state endangered in 1971. In the vicinity of Point Loma, light-footed clapper rails inhabit the Tijuana River Valley, the Sweetwater Marsh National Wildlife Refuge, and the San Diego River Flood Control Channel.

The light-footed clapper rail population fell to its lowest level in 1989 when only 163 pairs were recorded in eight southern California marshes. The population then slowly increased to 325 and 307 pairs censused in 1996 and 1997, respectively in 15 of 16 California coastal wetlands (Zembel et al. 1997). The 34th annual census of the light-footed clapper rail in California was conducted from 2 March to 21 June 2013 (Zembel et al. 2013). Thirty coastal wetlands were surveyed by assessing call counts from Mugu Lagoon in Ventura County, south to Tijuana Marsh National Wildlife Refuge on the Mexican border. For the second year in a row the California population of the light-footed clapper rail exceeded 500 breeding pairs. A total of 525 pairs exhibited breeding behavior in 22 marshes in 2013. This was the highest count on record, representing an increase of four pairs over the breeding population detected in 2012, and 18.5% larger than the former high count in 2007. The Tijuana Marsh National Wildlife Refuge was at its third highest recorded level with 105 breeding pairs, an increase of 4% over the 2012 breeding season but 26% lower than the record high of 142 pairs in 2007. The Tijuana Marsh National Wildlife Refuge comprised 20% of the breeding population of this rail in California.

The western snowy plover, Charadrius alexandrinus nivosus, is a small, pale-colored shorebird with dark patches on its upper breast (USFWS 2021e). It feeds by probing the sand at the beach-surf interface for small crustaceans and marine worms. It breeds on coastal beaches from southern Washington to southern Baja California, Mexico. In southern California, snowy plovers typically nest in association with federally endangered California least terns. The western snowy plover is threatened by habitat loss, human disturbance, and nest/egg destruction by native and introduced predators and domesticated pets. Western snowy plovers nest in San Diego Bay along the Silver Strand and at the south San Diego Bay Saltworks. They are occasional visitors to the Point Loma shoreline. A 2006 breeding season census of western snowy plovers by the USFWS observed 95 adults in San Diego Bay and Tijuana Estuary and a total of 1,723 adults state-wide (USFWS 2007). The Pacific coast population of western snowy plovers was listed as threatened under the ESA in 1993. In 2012, a 0.6 mi (0.96 km) stretch of Coronado City Beach to the south of Point Loma was designated as western snowy plover critical habitat (USFWS 2012).

The last four bird species in Table I-1 – the Guadalupe murrelet, marbled murrelet, Scripps's murrelet, and short-tailed albatross are strictly sea birds, usually found well offshore in southern California waters (USDON 2013). These endangered birds would rarely be seen in the Point Loma area.

I.6.4 Sea Turtles

Five species of sea turtles occasionally visit San Diego ocean waters: green, loggerhead, leatherback, olive Ridley, and hawksbill – all are protected under the ESA (Table I-1). The NMFS and the USFWS share Federal jurisdiction for sea turtles, with NMFS having lead responsibility in the marine environment and USFWS having lead responsibility on nesting beaches (NMFS 2021g).

Sea turtles are saltwater reptiles with streamlined bodies built for trans-oceanic navigation (Wyneken et al. 2013). Although they live most of their life in the ocean, females return to land to lay their eggs on nesting beaches. Recovery plans for the U.S. Pacific populations of sea turtles provide a wealth of information on their distribution, diet, growth, reproduction, behavior, and health (NMFS and USFWS 1998a,b,c,d,e). These plans also discuss threats to the continued existence of sea turtles and define procedures and goals for their recovery.

All five species of sea turtles forage along the California coast in the summer and early fall when sea temperatures are warmest (Eckert 1993). There are no known sea turtle nesting sites in the San Diego area or anywhere on the west coast of the United States (USDON 2013).

Most commonly seen in San Diego marine waters, the east Pacific green sea turtle, *Chelonia mydas*, nests on beaches of the Pacific coast of Mexico and ranges throughout the north Pacific Ocean (NMFS 2021h). Adults have three-foot-wide shells with a radiating pattern of brown, black, and cream colored markings and weigh about 200-300 lb (90-136 kg). The biting edge of their lower jaw is serrated. They eat algae and sea grasses. Green sea turtles are often found from July through September off the coast of California. As for the other endangered sea turtles discussed here, there is no designated green turtle critical habitat in the San Diego region.

In the past, Green sea turtles have aggregated at the southern end of San Diego Bay, attracted to the warm water effluent from a power plant (McDonald et al. 1995, McDonald et al. 2012). A 20-year monitoring program of these turtles indicated an annual abundance of between 16 and 61 turtles (Eguchi et al. 2010). Local researchers have used genetics and satellite telemetry to determine that the turtles are part of the Eastern Pacific nesting populations, and migrate thousands of miles to lay their eggs on beaches off the coast of Mexico. Within San Diego Bay, the turtles can most often be seen surfacing within the South San Diego Bay National Wildlife Refuge, which provides a protected foraging and rest area, as well as a prime study site for turtle biologists. The power plant, which had continuously operated since 1960, ceased operation in December 2010. The closure of the power plant may impact these resident turtles and alter movement patterns but they will still be present in the bay, although their range within the bay may enlarge to other areas where they have not normally been found. (Turner-Tomaszewicz and Seminoff 2012, POSD 2021). The green turtles' greatest threat in San Diego Bay is being hit by boats traveling over the 5-mile-per-hour speed limit posted throughout the southern portion of the bay. (POSD 2021).

The loggerhead turtle, *Caretta*, is a reddish-brown sea turtle with a large head. Adult loggerheads average about 200-300 lb (91-136 kg) with shells about 3 ft (1 m) wide (NMFS 2014i). They take over two decades to mature and in the northern Pacific are only known to nest in southern Japan. Their diet consists of crabs, shrimp, mollusks and jellyfish. Most recorded sightings in California are juveniles (Battey 2014).

The leatherback sea turtle, *Dermochelys coriacea*, is the largest sea turtle, reaching over 6 ft in diameter and weighing as much as 1,400 lb (635 kg) (NMFS 2021j). Unlike other species which have solid shells covered with scales, the leatherbacks' shell is a bony matrix covered with a firm, rubbery skin with seven longitudinal ridges or keels (Wyneken et al. 2013). Most sea turtles are cold-blooded and prefer to live in warm waters. Leatherbacks are the exception, and are more likely to be found in colder waters at higher latitudes because of their unique ability to maintain an internal body temperature higher than that of the environment (Dutton 2006). These large sea turtles feed mostly on jellyfish and nest in the tropics and subtropics. Along the western U. S coast, leatherbacks are mostly seen in waters over the continental slope, with greatest densities off central California (NMFS 2013a). The majority of loggerheads observed in the eastern North Pacific Ocean are juveniles, believed to have come from nesting beaches in Japan (USDON 2013).

The olive Ridley turtle, *Lepodochelys olivacea*, is the smallest sea turtle in Pacific waters. Their shell is heart-shaped to round and may be colored grey-brown, black, or, olive. Olive Ridleys' are primarily carnivores and eat a wide variety of food including crab, shrimp, lobster, jellyfish, and tunicates (NMFS 2021k). In San Diego waters, loggerheads, leatherbacks, and olive Ridleys are most often seen well offshore, unlike green sea turtles which tend to hug the shoreline (USDON 2013).

Like other Pacific sea turtles, the hawksbill turtle, *Eretmochelys imbricata*, makes vast oceanic excursions and could occur off the U. S. west coast (NMFS 2021l). Hawksbills were originally considered to be omnivores, but subsequent research revealed they are primarily specialist sponge carnivores, preferring only a few species of sponge (Vicente 1994). There have been few hawksbill sightings north of Baja California Sur and its appearance in San Diego waters would be extremely unlikely (USDON 2013).

I.6.5 Fish

In 1997, the NMFS listed the southern California Evolutionary Significant Unit of West Coast steelhead (*Oncorhynchus mykiss*) as endangered (Federal Register: 18 August 1997 [Volume 62, Number 159, Pages 43937-43954]). In March of 1999, NMFS added nine species of salmon and steelhead to the Endangered Species list and designated critical habitat for them in 2005 (NMFS 2005c). Though most of these are Pacific northwest species, the chinook salmon and steelhead range south to California (NMFS 2005c). Chinook salmon are mostly encountered north of Point Conception.

Steelhead trout are usually dark-olive in color, shading to silvery-white on the underside with a heavily speckled body and a pink to red stripe running along their sides (USFWS 2021f). Steelhead are born in freshwater streams and later move into the ocean where most of their growth occurs. After 1 to 4 years in the ocean, they return to their home freshwater stream to spawn. Some steelhead, however, spend their entire life in freshwater: these fish are called rainbow trout. Steelhead tend to move immediately offshore on entering the marine environment although, in general, steelhead tend to remain closer to shore than other Pacific salmon species (Beamish et al. 2005).

Steelhead occurred historically in all San Diego County watersheds that drain into the ocean (NMFS 2012). Currently, steelhead in southern California range only as far south as San Mateo Creek in northern San Diego County (USDON 2013). Both steelhead and chinook salmon are occasionally caught in ocean waters off San Diego but do not enter streams in the San Diego Metropolitan area.

One other fish that may be found in the waters off San Diego and that is currently listed as endangered is the Scalloped Hammerhead Shark. It is ESA endangered for the Eastern Pacific DPS. They are moderately large sharks with a global distribution that includes the west coast of the United States. The most distinguishing characteristic is its “hammer-shaped” head. The greatest threats to this shark are overfishing and bycatch (USFWS 2021g).

Three other fish in Table I-1 are listed as threatened. The Oceanic Whitetip Shark is ESA threatened throughout its range that includes the west coast. They are large, pelagic sharks found in tropical and subtropical oceans. They live offshore in deep water; but spend much of their time near the surface. Oceanic whitetip sharks are long-lived, late maturing and have only moderate productivity. Their main threat is bycatch in commercial fisheries combined with demand for its fins. They are often caught in pelagic longline, purse seine and gillnet fisheries and their fins are highly valued in the international trade for shark products. As a result populations have declined throughout their range. They became listed as threatened in 2018 under provisions of the ESA (NOAA 2021f).

The Giant Manta Ray is the world’s largest ray with a wingspan of up to 29 ft. They are filter feeders and eat large quantities of zooplankton. They are slow-growing, migratory and exist in small highly fragmented populations that are sparsely distributed across the world. The main threat to manta rays is commercial fishing, both overfishing and bycatch. Target fishing of the species still exists despite prohibitions in a significant portion of the species range. Other threats include marine debris/pollution, vessel strike, entanglement and recreational fishing interactions. In 2018, NOAA Fisheries listed the species as threatened under the ESA (NOAA 2021g).

The Green Sturgeon is an anadromous fish, meaning it can live in both fresh and salt water. They have a complex life history that includes spawning and juvenile rearing in rivers followed by migrating to saltwater to feed, grow and mature before returning to freshwater to spawn. They are long-lived, slow growing fish. They are vulnerable to many stressors and threats including blocked access to spawning grounds and habitat degradation caused by dams and culverts. The southern Distinct Population Segment (sDPS) is listed as threatened under the ESA. Twenty-seven species of sturgeon can be found in the temperate waters of the Northern Hemisphere. Two of these species, including the Green Sturgeon, reside on the west coast of North America. Although Green Sturgeons have successfully existed throughout North America for 200 million years, they are thought to have experienced a large decline the last century. Harvest of adults and destruction of spawning and rearing habitat are considered a main reason for the decline. Threats include insufficient water flow rates in spawning areas, contaminants, bycatch, poaching, invasive species, impassable barriers and unfavorable water conditions. In April 2007, the sDPS population of North America was listed as threatened under the ESA and critical habitat was designated in 2009. None of the critical habitat exists in the Point Loma area (NOAA

2021h).

I.6.6 Invertebrates

The white abalone, *Haliotis sorenseni*, was historically found from Punta Abreojos, Baja California, Mexico, to Point Conception, California (NMFS 2021n). Inhabiting deeper water than any other abalone species, white abalone in southern California typically occur from 60 to 195 ft (18 to 59 m), with the highest densities between 130 and 165 ft (40 and 50 m) (Butler et al. 2006). They reproduce by broadcast spawning and reach sexual maturity at age 4 to 6 years at a size of 3 to 5 inches. Newly settled individuals feed on benthic diatoms, bacterial films, and single-celled algae found on coralline algal substrates. As they grow larger, white abalone feed on drift and attached algae. Adult white abalone can reach a shell length of up to 9 inches. Except for some isolated survivors, the species is currently distributed only around the Santa Barbara Channel Islands and along various banks far offshore from Point Loma.

Inhabiting deeper water initially provided white abalone a refuge from divers, but a commercial fishery began in the early 1970s and together with increasing recreational take, over-harvesting lead to the collapse of the fishery in the 1980s. The state of California suspended all forms of harvesting of the white abalone in 1996 and, in 1997, and imposed an indefinite moratorium on the harvesting of all abalone in central and Southern California (NMFS 2008). The white abalone was federally listed as an endangered species on 29 May 2001 (NMFS 2001). Critical habitat is not designated for white abalone.

The black abalone, *Haliotis cracherodii*, inhabits the intertidal and shallow subtidal zones where it has been easily targeted for exploitation (NMFS 2021o). It has experienced dramatic population declines due to recreational and commercial fishing and withering syndrome disease (VanBlaricom et al. 2009). The state of California imposed a moratorium on black abalone harvesting 1993 and adopted an Abalone Recovery Management Plan 2005 (CDFG 2005). There is concern that the low remaining densities of both black and white abalone may be insufficient for continued reproductive success (VanBlaricom et al. 2009).

The black abalone was proposed as a candidate for listing as an endangered species in 2005 (NMFS 2005d) and listed as endangered under the ESA on 14 January 2009 (NMFS 2009). Critical habitat was designated for black abalone in 2011 (NMFS 2011b). The designated critical habitat extends north of the Palos Verdes Peninsula and in waters surrounding Santa Catalina Island and the Channel Islands, but not in the vicinity of the PLOO discharge.

I.7 ENVIRONMENTAL EFFECTS

Twenty eight endangered species; eight marine mammals, seven birds, five sea turtles, six fish, and two invertebrates, may occur in the Point Loma area (Table I-1).

Endangered species in southern California are subject to a variety of natural and human influences (Davidson et al. 2011, Van Der Hoop et al. 2013, NOAA 2021e). Changes in wide-scale oceanographic regimes can alter endangered species foraging success through impacts on prey distributions and locations, which in turn affects reproductive success and survival (O'Shea and Odell 2008, Simmonds and Eliott 2009, Salvadeo et al. 2010, 2013, Fiedler et al. 2013, NMFS 2013a). Climate shifts can transform the type and the intensity of human activities, such as fishing, shipping, oil and gas extraction, and coastal construction, all of which may have an impact on endangered species (Alter et al. 2010, Hoegh-Guldberg and Bruno 2010, Doney et al. 2012, Hazen et al. 2012). Other potential anthropogenic stressors include noise, bioaccumulation of chemicals, overfishing, marine debris, and habitat deterioration or destruction (Crain et al. 2009, Halpern et al. 2009, Jackson et al. 2011, Hilborn and Hilborn 2012, NAVFAC 2013). Incidence of disease, parasitism, and adverse effects from algal blooms may also pose a threat to the health of endangered species (Brodie et al. 2006, Walsh et al. 2008, Bossart et al. 2011, NOAA 2021a). These impacts have the potential to alter the physiology, behavior, growth, and reproduction of individual species, shift patterns of larval dispersal and recruitment, modify the composition of ecological communities, and, change the structure, function, productivity, and resilience of marine ecosystems

For marine mammals and sea turtles, ship strikes and fisheries bycatch (accidental or incidental catch) are the primary cause of human-related mortality in southern California ocean waters (Harvey et al. 2010, Carretta et al. 2013, Geijer and Read 2013). In addition to these direct effects, marine mammals and sea turtles may also be indirectly effected by noise, bioaccumulation, habitat alteration, and depletion of prey species (Redfern et al. 2013, NMFS 2021g, NOAA 2021e). In 1994, the MMPA was amended to formally address these issues (16 U.S.C. 1361-1407: PL103-238:108 Stat. 532).

The Marine Mammal Protection Act requires the NMFS to document human-caused mortality and injury of marine mammals as part of assessing marine mammal stocks (Roman et al. 2013, Carretta et al. 2014). A NMFS report summarizes records of human-caused mortality and injury from 2007 to 2011 for U. S. west coast marine mammal populations (Carretta et al. 2013). Among marine mammals, pinnipeds were most commonly injured or killed by anthropogenic activity followed by small cetaceans and large whales. The primary causes of pinniped injury and mortality were recreational hook and line fishery interactions, shootings, and entrainment into power plant water intakes. Vessel strikes and fishery-related entanglements were the most common form of mortality and injury to whales. Net fisheries accounted for most of the injuries and mortalities for small cetaceans. Sea turtles and sea birds are also at risk of entanglement in fishing gear (Carretta and Enriquez 2012). Impacts of commercial fisheries that utilize nets, pots, and traps are likely to be greater than the number of observed incidents because derelict gear can entangle animals for as long as it remains in the environment (EPA 2012, Reeves et al. 2013).

Habitat deterioration and loss is an issue for almost all coastal marine mammals (Davidson et al. 2011, Roman et al. 2013). Anthropogenic noise is a potential habitat level stressor especially in areas of industrial activity or commercial ship traffic (McDonald et al. 2008, Hildebrand 2009). Noise is a particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals (USDON 2013). It may induce marine mammals to leave a habitat, impair their ability to communicate, or cause stress (Rolland et al. 2012, Erbe et al. 2012). Noise can create behavioral disturbances and mask other sounds including the marine mammals' own vocalizations (Southall et al. 2012). With ecotourism on the rise, marine life viewing activities like whale watching have the potential to impact the behavior and migration of marine mammal populations (NMFS 2011a, NMFS 2013a, NOAA 2021e).

Endangered species are also subject to bioaccumulation of toxic chemicals. Natural and synthetic chemicals enter the ocean through various sources including rivers and streams, storm drains, industrial discharges, municipal wastewater discharges, dredge and disposal activities, aerial fallout, vessel activities and spills, mineral mining, oil exploration and extraction, and through hydrothermal vents and hydrocarbon seeps (Setty et al. 2012, Hutchinson et al. 2013). Some of the chemical constituents entering the ocean remain dissolved and are distributed by ocean currents and eddies. Many are physically or chemically bound to particulate matter and settle to the bottom.

Marine organisms can absorb dissolved chemicals directly from seawater (by the gills or epidermis), and indirectly through contact with sediment, by ingesting sediment particles or suspended particulate matter, and through assimilation from food organisms (Newman 2009, Allen et al. 2011, Laws 2013). Chemical compounds accumulate in an organism’s tissue if they cannot be metabolized and eliminated faster than they are absorbed. Tissue concentration can also increase as these chemicals are passed through the food web from lower to higher trophic levels (Bienfang et al. 2013, Daley et al. 2014, Weis 2014). The degree to which bioaccumulation occurs depends on the solubility, particle affinity, oxidation state, volatility, and degradability of the specific chemical (Laws 2013). These differences determine how chemical compounds are distributed within biological communities and throughout the environment (Whitacre 2014). The potential impacts of bioaccumulation by marine organisms include comprised immune response and disease resistance, altered behavior, diminished breeding success, developmental abnormalities, population declines via direct mortality, and shifts in the composition of communities by affecting top predators and keystone species (Newman 2009, NAVFAC 2013).

The species most at risk from bioaccumulation of toxic compounds are those at the highest trophic levels, especially marine mammals (O’Hara and O’Shea 2005, Tornero et al. 2014). Marine mammals are vulnerable to bioaccumulation because they have long life spans and large blubber stores that can serve as repositories for lipophilic chemicals (Moore et al. 2013). Marine mammals and sea turtles would generally acquire toxic pollutants from the food they consume. Bioaccumulation of anthropogenic contaminants may also increase susceptibility to other stressors including parasitism and disease (O’Hara and O’Shea 2005, Bossart 2011).

Anthropogenic contaminants of emerging concern (CECs) include a wide variety of chemicals including pharmaceuticals and personal care products (PPCPs), lawn care, agriculture products, and industrial chemicals among others.

Wastewater discharges are generally known to contain CECs, however other sources also exist. Considerable effort is currently underway to try and understand the sources, fates and effects of these chemicals in the marine environment (SCCWRP 2021c). For example, a specific CEC in marine mammal tissue has been the flame retardant Polybrominated diphenyl ethers (PBDEs); relevant information from characterization studies in both Southern California and San Francisco Bay area, indicate that the wastewater outfalls are not a significant source of this pollutant (Sutton et al. 2017, 2019). Additionally, since they were banned from use, PBDEs appear to be declining in the environment. Dodder et al. (2012) found that outfalls of wastewater treatment plants in the Southern California Bight are not considered to be major sources of PBDEs, rather highest PBDE concentrations have been found at the mouths of urban rivers, indicating that urban runoff is likely the primary source of input to coastal marine waters, and not wastewater outfalls. Additionally, the levels of PBDEs in offshore ocean sediments are now so low that the SCCWRP Bight '18 study plan omitted the need for sampling and analysis of PBDEs in the offshore shelf strata where the wastewater discharge occurs through the PLOO (Dodder et al. 2016; SCCWRP Bight '18 report). Although PBDEs are now banned, other substances are replacing them in the marketplace, along with the thousands of other CECs in use today.

Historically, the PLOO monitoring program has not included routine monitoring for these substances because of the lack of analytical methods and toxicological data with which to put monitoring results into context. Limited special studies have been conducted that have identified CECs in the PLOO discharge; but have not found conclusive evidence of effects. Past studies of direct exposure of Flatfish to CECs in PLOO effluent found no significant biological responses in fish exposed to effluent compared to controls, even at concentrations 10 times of those encountered in the environment near the PLOO (Vidal-Dorsch et al 2014). The study also noted that the concentrations of estrogenic compounds detected in the PLOO effluent was lower than the levels shown to cause estrogenic effects in other fish species and was a likely explanation as to why estrogenic responses were absent. When looking at the reproductive status of hornyhead turbot near municipal outfalls in the Southern California Bight, Forsgren et al (2012) concluded that although widespread exposure to estrogenic compounds was suggested, it did not appear to impact reproductive function and the populations were either stable or increasing in the Southern California Bight.

In view of the present uncertainty for the presence, concentration, and effects of CECs in the ocean environment and marine life adjacent to the PLOO, it is difficult at this time to definitively characterize what effect, if any, the PLOO may be contributing.

San Diego is an active member of the SCCWRP. As such San Diego will continue to participate in local/regional monitoring efforts and actively engage in ongoing research efforts directed at CECs in the marine environment. In conjunction with these efforts, it is anticipated that in the future the PLOO monitoring program may be adjusted, similar to other major dischargers in Southern California, to include appropriate CECs. This will result in providing information specific to the PLOO discharge, as well as contributing to the knowledge base in support of research efforts.

Marine debris is a potential threat to endangered marine mammals (EPA 2012, Howell et al. 2012). Marine debris flows into the ocean from rivers, harbors, estuaries, and, though prohibited in U. S. waters, occasionally from vessels at sea (NOAA 2008). Ingestion of debris can have fatal consequences for whales. The stomach contents of two sperm whales that stranded in California included extensive amounts of discarded fishing netting (NMFS 2013a). Another Pacific sperm whale contained nylon netting in its stomach when it washed ashore in 2004 (NMFS 2013a). Seals and sea lions are also subject to entanglement in marine debris (Carreta et al. 2013). A recent study by Oregon State University found Steller sea lions entangled with rubber bands used on crab pots, hard plastic packing bands from cardboard boxes, fishing line and hooks, and other fishing gear (Oregon State University 2011).

Sea turtles are exposed to a wide variety of natural and anthropogenic threats (Santidrián Tomillo et al. 2012, NMFS 2013a, Wyneken et al. 2013). Nesting beaches are threatened by hurricanes and tropical storms. Hatchlings are preyed on by herons, gulls, and sharks. Juveniles and adults are eaten by sharks and other large marine predators. Sea turtles are also killed or injured by fisheries and by vessel strikes (Carretta et al. 2005, Hazel et al. 2007, Wallace et al. 2010, Work et al. 2010). Marine debris can be detriment as well. Floating plastic garbage can be mistakenly ingested by sea turtles. Leatherback sea turtles in particular may mistake floating plastic garbage as jellyfish, an important component of the leatherback diet (Lazar and Gračan 2011). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown all life stages (Mrosovsky et al. 2009).

All the nearshore birds in Table I-1 became endangered because of habitat loss and disturbance. These bay and estuarine species – California least tern, light-footed clapper rail, and western snowy plover occasionally forage over San Diego coastal waters. The primary threat to their well-being in ocean waters would be exposure to bioaccumulated toxic compounds from prey captured in the area (Arnold et al. 2007).

Regional evaluations have shown that virtually all bottom-dwelling fish populations in southern California have detectable levels of DDT and PCBs as a result of past discharge practices, now discontinued (SCCWRP 2012). The highest concentrations are on or near the Palos Verdes shelf off Whites Point in Los Angeles, an area with highly contaminated sediments, the result of historical discharge. Fish tissue burdens of DDT and PCBs decline to the north and south across the Southern California Bight. A study by Parnell et al in 2008 demonstrated that the major source PCB contamination off Point Loma was a result of the disposal of contaminated sediments from San Diego Bay being deposited at an offshore dredge disposal site and not the PLOO. Concentrations of chlorinated hydrocarbons in fish from reference areas are now less than 5% of levels measured two decades ago (Allen et al. 2011). Contaminant burdens in fish tissues at Point Loma are comparable to those at reference sites beyond the influence of the discharge (COSD 2008-2016, 18, 20, Appendix C5). Endangered birds feeding in the Point Loma area should not be exposed to a higher risk of bioaccumulation from the discharge of treated wastewater.

Overall, there was no evidence that the discharge of wastewater via the Point Loma outfall has caused abnormal body burdens of any toxic pollutants known to have adverse effects on marine fishes or their consumers. Fishes collected in the region do not appear to be significantly affected by the discharge of wastewater from the outfall or from other possible sources of contamination. Concentrations of most contaminants were generally similar across zones or stations, and no relationship relevant to the PLOO was evident. These results are consistent with findings of other assessments of bioaccumulation in fishes off San Diego (COSD 2007, 2015, 2020a, Parnell et al. 2008). Finally, the absence of physical abnormalities or any indication of disease (e.g., fin rot, tumors) on local fishes indicates that populations in the Point Loma region remain healthy after 20 years of wastewater discharge (e.g., see COSD 2020a, Appendix C5).

Of the five species of endangered sea turtles that may pass through the San Diego marine environment (Table I-1), the green sea turtle would be most common and the one found closest to shore. Green turtles are subject to entrainment in coastal power plants, perhaps attracted to the lush growth of algae on the cooling water intake structures (Seminoff 2007). Green turtles have also been struck by boats and entangled in fishing gear in southern California (Carretta et al. 2005). Although capable of deep dives, most sea turtles passing San Diego would be in surface waters. They should not be exposed to the effluent plume which is normally trapped below the thermocline, especially during the summer when turtles would be most prevalent. The potential impact of discharged debris is minimized by screens in the Point Loma wastewater headworks and in the final effluent channel that remove entrained material greater than 5/8 inch in diameter.

The other endangered species possibly occurring at Point Loma, the steelhead trout, green sturgeon and black abalone should not be jeopardized by the discharge. Steelhead trout and green sturgeon would be transitory, and the black abalone, if present, would be well inshore of the outfall, beyond potential adverse influence.

Operation of the PLOO could affect endangered species by altering physical, chemical or biological conditions including: water quality, biological integrity (e.g., species abundance and diversity), food web dynamics (e.g., availability of prey), habitat suitability, and the health of organisms (e.g., bioaccumulation of toxic substances, disease, and parasitism). The City monitors changes in ocean conditions over space and time and assesses any impacts of wastewater discharge or other man-made or natural influences on the local marine environment. Monitoring results are contained in Annual and subsequent Biennial Monitoring Reports (COSD 2008-2016, 18, 20). The monitoring program has six components along with special studies: coastal oceanographic conditions, water quality and plume dispersion, sediment conditions, macrobenthic communities, demersal fish and megabenthic invertebrates, and contaminants in fish tissues. The overall findings are summarized in the following paragraphs.

There has been no indication of change in any physical or chemical water quality parameter (e.g., dissolved oxygen, pH) attributable to wastewater discharge off Point Loma. Instead, changes in oceanographic parameters have historically been associated with varying climate regimes and with natural events such as storm activity and the presence of plankton blooms.

Benthic conditions off Point Loma show some changes that may be expected near large ocean outfalls, though restricted to a relatively small, localized region near the discharge site. For example, sediment quality data have indicated slight increases over time in sulfide content and biological oxygen demand at sites nearest the discharge, where the physical presence of the outfall structure has caused relatively coarse sediment particles to accumulate. Other measures of environmental impact such as concentrations of sediment contaminants (e.g., trace metals, pesticides) show no patterns related to wastewater discharge (COSD 2008-2016, 18, 20, Appendices C1-C5).

Some descriptors of benthic community structure (e.g., abundance, species diversity) or indicators of environmental disturbance (e.g., brittle star populations) have shown temporal differences between reference areas and sites nearest the outfall. However, results from environmental disturbance indices such as the Benthic Response Index that are used to evaluate the condition of benthic assemblages indicate that benthic invertebrate communities in the Point Loma region remain characteristic of natural conditions (COSD 2008-2016, 18, 20, Appendix C1).

Analyses of bottom dwelling fish and trawl-caught invertebrates reveal no spatial or temporal patterns that can be ascribed to effects of wastewater discharge. Instead, historical data (1991-2020) indicates that patterns of change in benthic communities are related to large-scale oceanographic events or specific site conditions (e.g., near dredge material disposal sites) (Appendices C1-C5). The lack of physical anomalies and other symptoms of disease in local fish, as well as the low level of contaminants in fish tissues, are also indicative of a healthy marine environment.

I.8 CUMULATIVE IMPACTS

Cumulative impacts are defined in the National Environmental Protection Act (NEPA) (42 USC § 4321 *et seq*. and 32 CFR 775, respectively) as: the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7).

In general, the effects of a particular action or group of actions must meet all of the following criteria to be considered cumulative impacts:

- Effects of several actions occur in a common locale or region;
- Effects on a particular resource are similar in nature, such that the same specific element of a resource is affected in the same specific way; and
- Effects are long-term as short-term impacts dissipate over time and cease to contribute to cumulative impacts.

The discharge of wastewater from commercial activities, including municipal wastewater treatment plants, power generating stations, industrial plants (e.g., desalination plants), and storm water from drains into open ocean waters, bays, or estuaries can introduce chemical and biological constituents potentially detrimental to estuarine and marine habitats (Perry 2009, Hutchinson et al. 2013). These constituents include pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, and toxic chemical compounds (Crain et al. 2009, Stein and Cadien 2009, Setty et al. 2012). Historically, wastewater discharges have been one of the largest inputs of these constituents into coastal waters. However, wastewater discharges have been regulated under increasingly stringent requirements over the last 40 years and mass emissions of most constituents have been significantly reduced (Lyon and Sutula 2011, SCCWRP 2012). Nonpoint sources and storm water runoff, on the other hand, has not been managed as effectively and continues to be a substantial remaining source of contamination of coastal areas and the ocean (Setty et al. 2012, Howard et al. 2014).

Human activities, such as shipping, oil and gas extraction, and coastal construction have the potential to directly or indirectly affect endangered species (Alter et al. 2010, Hoegh-Guldberg and Bruno 2010, Doney et al. 2012, Hazen et al. 2012). Other possible cumulative threats to endangered species include degradation of water quality, habitat modification, pollution (chemicals, marine debris, etc.), introduction of exotic species, and disease (Field et al. 2003, Horn and Stevens 2006, O'Shea and Odell 2008, Pinnegar and Engelhard 2008, Crain et al. 2009, Halpern et al. 2009, Hoegh-Guldberg and Bruno 2010, Thrush and Dayton 2010, Doney et al. 2012, Hazen et al. 2012, Howell et al. 2012, SCCWRP 2012, NMFS 2013a, Howard et al. 2014, Maruya et al. 2014). Cumulative impacts could alter the physiology, behavior, growth, and reproduction of individual species, shift patterns of larval dispersal and recruitment, modify the composition of ecological communities, and, change the structure, function, productivity, and resilience of marine ecosystems.

Fishing and non-fishing activities, individually or in combination, can adversely affect endangered species (Jackson et al. 2001, 2011, Dayton et al. 2003, Chuenpagdee et al. 2003, Hanson et al. 2003, Jackson 2008, Baum and Worm 2009, Worm et al. 2009, Norse 2010, Hilborn and Hilborn 2012, NMFS 2013b, Laugen et al. 2014). Potential impacts of commercial fishing include over-fishing of targeted species and bycatch (Dieter et al. 2003, PFMC 2004, Hseih et al. 2006, Carretta and Enriquez 2012, PFMC and NMFS 2012). Indirect effects may include removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (continued catch by lost or discarded gear), and generation of marine debris (Reeves et al. 2013). Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats (NMFS 2013b). Recreational fishing also poses a threat because of the large number of participants and the intense, concentrated use of specific habitats (Coleman et al. 2004, Ihde et al. 2011, United Nations Food and Agricultural Organization (UNFAO) 2012, Arlinghaus et al. 2013).

Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal (Davidson et al. 2011, Hutchinson et al. 2013, Moore et al. 2013). Natural stresses include storms and climate-based environmental shifts, as well as algal blooms and hypoxia (Kim et al. 2009, SCCWRP 2013).

A number of factors Influence water quality and biological conditions in the Point Loma area. Potential influences on water quality include regional point and non-point source discharges, such as: local river outflows, harbors, marinas, storm drains, and urban runoff, as well as the PLOO discharge. (Bartlett et al. 2004, Parnell et al. 2008, Parnell and Riser 2012).

The PLOO discharges at a depth of approximately 100 m, which inhibits wastewater from reaching surface waters due to thermal stratification, which typically results in the plume being trapped offshore at depths of 40 to 60 m below the surface (COSD 2018; Rogowski et al., 2012, 2013; Svejkovsky, 2015-2017, Hess 2018-2021). During spring and summer months, when algal blooms are most prevalent in the Southern California Bight region (Smith et al., 2018), thermal stratification is strongest and plume trapping depths are greatest (Bartlett et al., 2004). Even during the winter months, when vertical stratification of the water column is weakest, the PLOO plume does not typically rise to the surface (Svejkovsky 2015-2017, Hess 2018-2021). Thus, little probability exists that the PLOO could contribute nitrogen to the upper 60 m of the water column even during the times of year when the highest potential exists for algal blooms to occur. Nitrogen is considered to be the limiting nutrient for phytoplankton blooms in coastal waters. During periods of upwelling into coastal waters the upwelling is considered to be the largest contributor of nitrogen to the nutrient load, however, it is also recognized that treated wastewater discharges are a source of nitrogen and on a more consistent basis. However, it is unlikely that the PLOO directly drives phytoplankton blooms on a local scale.

According to reports from Ocean Imaging Inc., from 2015 through 2017 there were no red tide events directly associated with the PLOO (Svejkovsky, 2015-2017, Hess 2018-2021). Nevertheless, red tides have been recorded in the Southern California Bight region for over a century, with the most recent occurring in 2020 when a Harmful Algal Bloom (HAB) contributed to fish mortality along the much of the Southern California coast. And yet there continues to be no evidence to indicate a direct correlation with the PLOO wastewater discharge (Allen, 1933; Hess 2018-2021Horner et al., 1997; Kim et al., 2009; McGowan et al., 2017; Svejkovsky, 2015-2017, Torrey, 1902). Blooms tend to originate in shallower waters off northern San Diego County and move south, or off southern San Diego and move north (Svejkovsky, 2015-2017, Hess 2018-2021, Appendix F).

Research is underway to better understand what contributes to HABs (SCCWRP 2021b) and the role of the treated wastewater discharges. San Diego, through its participation in SCCWRP, will continue to participate in these efforts, as well as any other special studies that may be necessary in association with climate change. It is anticipated that in the next permit period the PLOO monitoring program may be modified to align with these efforts by additional monitoring for nutrients. This can provide information specific to the PLOO, as well as contribute valuable information to the HAB research endeavors by others. As always, San Diego will continue to participate in Bight Regional Monitoring efforts.

The effects of the Point Loma discharge on water quality and biological conditions are evident only in deep waters within or near the zone of initial dilution (ZID) (COSD 2008-2016, 18, 20, Appendix C). Organic enrichment of the sediments due to the outfall discharge is not occurring beyond the ZID. Contaminant loading of sediments is not evident in the discharge vicinity. Sediment chemistry is comparable to reference areas along southern California's outer continental shelf. Biological conditions do not indicate any environmentally-significant changes associated with the discharge. A balanced indigenous population of shellfish, fish and wildlife exist immediately beyond the ZID (COSD 2008-2016, 18, 20, Appendix C).

The discharge of treated wastewater at Point Loma would, therefore, make a minimal contribution to regional cumulative impacts on endangered species and their critical habitat.

I.9 CONCLUSION

Operation of the Point outfall could potentially impact endangered species through changes in environmental conditions that affect the species or their habitat. Monitoring data and research show effects of the Point Loma discharge only in deep water near the outfall where minor water and sediment quality alterations have been observed. Marine communities in the Point Loma area remain characteristic of natural conditions with no suggestion of ecologically-significant changes.

There is no indication of adverse impacts from operation of the PLOO on environmental conditions or biological communities that could affect the health and well-being of endangered species or threaten their critical habitat. Future flows and contaminant loads from the PLOO will be less than historically permitted levels.

The PLOO discharge complies with all federal and state standards including State of California Ocean Plan standards for the water quality, protection of marine aquatic life, protection of human health (noncarcinogens) and protection of human health (carcinogens).

Additionally, a significant modification in San Diego's wastewater system will be initiated during the period of the renewed permit which will improve the quality of the discharge and reduce the flow through the PLOO. San Diego will begin operating new wastewater treatment and water reclamation facilities that will significantly reduce the flow and associated pollutants discharged through the PLOO. By the end of 2027, Phase 1 of Pure Water is expected to begin full operation, eventually diverting on average up to 52 mgd of wastewater away from the PLWTP to produce 30 mgd of water suitable for potable reuse and up to 11.9 mgd of reclaimed water for non-potable reuse (e.g., irrigation, industrial and commercial uses). This diversion will ultimately result in a nearly 20% reduction in flow discharged through the PLOO. In addition, tests conducted at the Phase 1 Demonstration Facility have shown a significant portion of the pollutants that would have been released at the PLOO discharge will be eliminated through the use of advanced technologies such as ozonation and biological activated carbon filtration. In addition to a reduction in conventional pollutants such as suspended solids and nutrients, many CECs, including persistent organic pollutants (POPs) and PPCPs etc., are completely removed from the system at a greater efficiency than traditional wastewater treatment processes.

Thus, the proposed future discharge of treated wastewater from the PLOO is not likely to affect endangered species or threaten their critical habitat.

REFERENCES

Allen, M. J. 2006. Pollution. The Ecology of Marine Fishes: California and Adjacent Waters. In: L. G. Allen, D. J. Pondella and M. H. Horn (eds). University of California Press. Berkeley, CA.

Allen, L. G. and J. N. Cross. 2006. Surface Water. Chapter 12. pp. 320-341 in: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press: Berkeley, CA. 670 p.

Allen, M. J., S. L. Moore, K. C. Schiff, D. Diener, S. B. Weisberg, J. K. Stull, A. Groce, E. Zeng, J. Mubarak, C. L. Tang, R. Gartman, and C .I. Haydock 1998. Assessment of Demersal Fish and Megabenthic Invertebrate Assemblages on the Mainland Shelf of Southern California in 1994. Southern California Coastal Water Research Project, Westminster, CA.

Allen, L. G., A. M. Findlay, and C. M. Phalen 2002. Structure and Standing Stock of Fish Assemblages of San Diego Bay, California from 1994 to 1999. Bulletin of Southern California Academy of Science 101(2):49-85. Berkeley, California.

Allen, M.J., A.K. Groce, D. Diener, J. Brown, Steinert, G. Deets, J.A. Noblet, S.L Moore,D. Diehl, E.T. Jarvis, V. Raco-Rands, Thomas, Y. Ralph, R. Gartman, D. Cadien, Weisberg, and T. Mikel. (2002). SouthernCalifornia Bight 1998 Regional Monitoring Program: V. Demersal Fishes and Megabenthic.

Allen, M. J., R. W. Smith, E. T. Jarvis, V. R. Rands, B. B. Bernstein, and K. T. Herbinson 2005. Temporal Trends in Southern California Coastal Fish Populations Relative to 30-Year Trends in Oceanic Conditions. In: Fish Populations pp. 264-285.

Allen, L. G., D. J. Pondella, II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press, Los Angeles. 670 p.

Allen, M. J., D. Cadien, E. Miller, D. W. Diehl, K. Ritter, S. L. Moore, C. Cash, D. J. Pondella, V. Raco-Rands, C. Thomas, R. Gartman, W. Power, A. K. Latker, J. Williams, J. L. Armstrong, and K. Schiff 2011. Southern California Bight 2008. Regional Monitoring Program: Volume IV. Demersal Fishes and Megabenthic Invertebrates. Southern California Coastal Water Research Project, Costa Mesa, CA.

Allen W. E., (1933) "Red water" in La Jolla Bay in 1933. Science 78: 12– 13.

Araújo, S., I. S. Henriques, S. M. Leandro, A. Alves, A. Pereira, and A. Correia 2014. Gulls Identified As Major Source of Fecal Pollution In Coastal Waters: A Microbial Source Tracking Study. Science of the Total Environment 470–471:84–91.

Arlinghaus, R., S. J. Cooke, and W. Potts 2013. Towards Resilient Recreational Fisheries on a Global Scale through Improved Understanding of Fish and Fisher Behavior. Fisheries Management and Ecology 20:91–98.

Alter, S. E., M. P. Simmonds, and J. R. Brandon 2010. Forecasting the Consequences of Climate-Driven Shifts in Human Behavior on Cetaceans. Marine Policy 34(5), 943-954. doi: 10.1016/j.marpol.2010.01.026.

Arnold, J. M., J. A. Boyce, and R. J. Bellmer 2007. Damage Assessment and Restoration Planning for Marine Birds. NOAA Restoration Center. Silver Springs, MD. 62p.

Barlow, J., J. Calambokidis, E. A. Falcone, C. S. Baker, A. M. Burdin, P. J. Clapham, and J. K. B. Ford 2011. Humpback Whale Abundance in the North Pacific Estimated by Photographic Capture Recapture with Bias Correction from Simulation Studies. Marine Mammal Science 27:793-818.

Barnette, M. C. 2001. A Review of the Fishing Gear Utilized Within the Southeast Region and their Potential Impacts on Essential Fish Habitat. National Marine Fisheries Service. Southeast Regional Office. St. Petersburg, Fl. 68p.

Bartlett, D., P. Dayton, P. Frank, L. Levin, E. Parnell, L. Shaffer, and C. Winant 2004. Point Loma Outfall Project Report. Scripps Institution of Oceanography. September 2004. 60 p.

Battey, T. 2014. A Guide to the Amphibians and Reptiles of California. http://www.californiaherps.com/turtles/pages/c.caretta.html

Baum, J. K. and B. Worm 2009. Cascading Top-Down Effects of Changing Oceanic Predator Abundances. Journal of Animal Ecology 2009 doi: 10.1111/j.1365-2656.2009.01531.x. 16 p.

Beamish, R. J., G. A. McFarlane, and J. R. King. 2005. Migratory Patterns of Pelagic Fishes and Possible Linkages Between Open Ocean and Coastal Ecosystems off the Pacific Coast of North America. Deep Sea Research II. 52:739-755.

Benjamin S. G. and J. A. Carton 1999. Interannual and Decadal Variability in the Tropical and Midlatitude Pacific Ocean. Journal of Climate. Vol.12: Issue 12: 3402-3418.

Bienfang, P. K., H. Trapido-Rosenthal, and E. A. Laws 2103. Bioaccumulation/Biomagnifications in Food Chains. In: Environmental Toxicology. E. A. Laws (ed) 2013. Springer Publications. Print ISBN 978-1-4614-5763-3. Pp. 35-69.

Berman-Kowalewski, M., F. M. D. Gulland, S. Wilkin, J. Calambokidis, B. Mate, J. Cordaro, D. Rotstein, J. St. Leger, P. Collins, K. Fahy, and S. Dover 2010. Association between Blue Whale (*Balaenoptera musculus*) Mortality and Ship Strikes along the California Coast. Aquatic Mammals 36(1):59-66.

Bjorkstedt, E., Goericke, R., McClatchie, S., Weber, E., Watson, W., Lo, N., Peterson, W., Brodeur, R., Bograd, S., Auth, T., Fisher, J., Morgan, C., Peterson, J., Durazo, R.,Gaxiola-Castro, G., Lavaniegos, B., Chavez, F., Collins, C. A., Hannah, B., Field, J., Sakuma, K., Satterthwaite, W., O'Farrell, M., Sydeman, W., Thompson, S.A., Warzybok, P. Bradley, R., Jahncke, J., Golightly, R., Schneider, S., Largier, J., Kim, S.Y., Melin, S., DeLong, R., and J. Abell 2013. State of the California Current 2011- 2012: Ecosystems Respond to Local Forcing as La Niña Wavers and Wanes, CalCOFI Reports 53, 41-78.

Bossart, G. D. 2011. Marine Mammals as Sentinel Species for Oceans and Human Health. Veterinary Pathology: 48(3) 676-690.

Brodie, E. C., F. M. D. Gulland, D. J. Greig, M. Hunter, J. Jaakola, J. Leger, T. A. Leighfield, and F. M. Van Dolah 2006. Domoic Acid Causes Reproductive Failure in California Sea Lions (*Zalophus Californianus*). Marine Mammal Science, 22(3): 700–707.

Burtenshaw, J. C., E. M. Oleson, J. A. Hildebrand, M. A. McDonald, R. K. Andrew, B. M. Howe, and J. A. Mercer 2004. Acoustic and Satellite Remote Sensing of Blue Whale Seasonality and Habitat in the Northeast Pacific. Deep-sea Research II 51:967-986.

Butler, J., M. Neuman, D. Pinkard, R. Kvitek, and G. Cochrane 2006. The Use of Multibeam Sonar Mapping Techniques to Refine Population Estimates of the Endangered White Abalone (*Haliotis sorenseni*). Fishery Bulletin, 104(4), 521-532.

Carretta, J. V. 2013. A Review of Sperm Whale (*Physeter macrocephalus*) Bycatch in the California Swordfish and Thresher Shark Drift Gillnet Fishery. Marine Mammal and Turtle Division. Southwest Fisheries Science Center. National Marine Fisheries Service, NOAA. 10p.

Carretta, J. V. and J. Barlow 2011. Long-Term Effectiveness, Failure Rates, and “Dinner Bell” Properties of Acoustic Pingers in a Gillnet Fishery. Marine Technology Society Journal 45(5): 7-15.

Carretta, J. V. and L. Enriquez 2012. Marine Mammal and Seabird Bycatch in California Gillnet Fisheries In 2011. NOAA Technical Memorandum NMFS. November 2012. 18p.

Carretta, J. V., T. Price, D. Petersen, and R. Read 2005. Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996–2002. Marine Fisheries Review 66(2): 21-31. http://spo.nmfs.noaa.gov/mfr662/mfr6623.pdf.

Carretta, J. V., S. M. Wilkin, M. M. Muto, and K. Wilkinson 2013. Sources of Human-Related Injury and Mortality for U. S. Pacific West Coast Marine Mammal Stock Assessments, 2007-2011. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-514. 87p.

Carretta, J. V., Oleson, D. W. Weller, A. R. Lang, K. A. Forney, J. Baker, B. Hanson, K. Martien, M. M. Muto, T. Or, H. Huber, M. S. Lowry, J. Barlow, D. Lynch, L. Carswell, R. L. Brownell Jr., and, D. K. Mattila 2014. U.S. Pacific Marine Mammal Stock Assessments: 2013. U. S. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC.

Carter, M., C. Hilbern, F. Mazzillo, C. Culver, and G. Langlois 2013. Southern California Perspective on Harmful Algal Blooms. CalCOFI Rep. Vol. 54. 4 p.

CDFG (California Department of Fish and Game) 1968. The Marine Environment Offshore from Point Loma, San Diego County. Marine Resources Operations. Fish Bulletin 140.

CDFG 2005. Abalone Recovery and Management Plan. Adopted by the California Fish and Game Commission. December 9, 2005. FINAL. 353 p.

CFR (Code of Federal Regulations) 2013. 50 CFR §402.14 - Formal Consultation. Title 50: Wildlife and Fisheries. Subpart B: Consultation Procedures. Tuesday, October 1, 2013. http://www.gpo.gov/fdsys/pkg/CFR-2013-title50-vol11/pdf/CFR-2013-title50-vol11-sec402-14.pdf

Chenillat, F., P. Riviere, X. Capet, P. J. S. Franks, and B. Blanke 2013. California Coastal Upwelling Onset Variability: Cross-Shore and Bottom-Up Propagation in the Planktonic Ecosystem. PLoS ONE 8(5):e62281.

CMLPA (California Marine Life Protection Act) 2009. Regional profile of the MPLA South Coast Study Region (Point Conception to the California-Mexico Border) Second Edition. June 25, 2009. 193p.

Coleman, F. C., W. F. Figueira, J. S. Ueland, and L. B. Crowder 2004. The Impact of United States Recreational Fisheries on Marine Fish Populations. Science 305: 1958-1960.

Colford, J. M. Jr., T. J. Wade, K. C. Schiff, C. C. Wright, J. F. Griffith, S. K. Sandhu, S. S. Burns, M. P. Sobsey, G. P. Lovelace, S. B, and Weisberg 2007. Water Quality Indicators and the Risk of Illness at Beaches with Nonpoint Sources of Fecal Contamination. Epidemiology. 18(1):27-35. January 2007.

Conversi, A. and J. A. McGowan 1992. Variability of Water Column Transparency, Volume Flow and Suspended Solids near San Diego Sewage Outfall (California): Fifteen Years of Data. Chemistry and Ecology 6: 133-147.

COPC 2021. California Ocean Protection Council. Overview of ocean Coastal Laws. www.opc.ca.gov

COSD (City of San Diego) 2000. City of San Diego. (2020). International Wastewater Treatment Plant Final Baseline Ocean Monitoring Report for the South Bay Ocean Outfall (1995–1998). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2008. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2007. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2009. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2008. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2010. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2009. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2011. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2010. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2012. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2011. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2013. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2012. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2014. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2013. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2015. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2014. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2016. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2015. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2016. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 20015. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2018. City of San Diego. (2018). Biennial Receiving Waters Monitoring and Assessment Report for the Point Loma and South Bay Ocean Outfalls, 2016–2017 including addendums. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2020. City of San Diego. (2020). Biennial Receiving Waters Monitoring and Assessment Report for the Point Loma and South Bay Ocean Outfalls, 2018– 2019, including addendums. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Crain, C. M., B. S. Halpern, M.W. Beck, and C. V. Kappel 2009. Understanding and Managing Human Threats to the Coastal Marine Environment. The Year in Ecology and Conservation Biology, 2009: Ann. N.Y. Acad. Sci. 1162:39–62 (2009). doi: 10.1111/j.1749-6632.2009.04496.x _c 2009 New York Academy of Sciences.

Cross, J. N. and L. G. Allen 1993. Fishes. In: Ecology of the Southern California Bight. Dailey, M. D., D. J. Reish, and J. W. Anderson (eds). University of California Press. Berkeley, California. pp.459-540.

CSULB (California State University, Long Beach) 2013. Oceanography of the Southern California Bight. Perspectives on the Pacific Ocean Offshore

Daley, J. M., G. Paterson, and K. G. Drouillard 2014. Bioamplification as a Bioaccumulation Mechanism for Persistent Organic Pollutants (POPs) in Wildlife. In: Whitacre, D. M. (ed) 2014. Reviews of Environmental Contamination and Toxicology. Vol. 227:107-155. Springer. New York. Print: ISBN 978-3-319-01326-8. eBook: ISBN 978-3-319-01327-5. Online: http://www.springer.com/environment/environmental+toxicology/book/978-3-319-01326-8.

Davidson, A. D., A. G. Boyer, H. Kim, S. Pompa-Mansilla, M. J. Hamilton, D. P. Costa, G. Ceballos, and J. H. Brown 2011. Drivers and Hotspots of Extinction Risk in Marine Mammals. Proceedings of the National Academy of Sciences. 6 p. http://www.pnas.org/content/109/9/3395

Dawson, J. K. and R. E. Pieper 1993. Zooplankton. In: M. D. Dailey, D. J. Reish, and J. W. Anderson (eds). Ecology of the Southern California Bight. Berkeley: University of California Press. pp. 266-304.

Dayton, P. K. and M. J. Tegner 1984. Catastrophic Storms, El Niño, and Patch Stability in a Southern California Kelp Forest Community. Science 224: 283-285.

Dayton, P. K., M. J. Tegner, P. E. Parnell, and P. B. Edwards 1992. Temporal and Spatial Patterns of Disturbance and Recovery in a Kelp Forest Community. Ecological Monographs 62(3): 421-445.

Deysher, L. E. 1984. Recruitment Processes in Benthic Marine Algae. Ph.D. Dissertation. University of California, San Diego. 324p.

Dieter, B. E., D. A. Wion, and R. A. McConnaughey 2003. Mobile Fishing Gear Effects on Benthic Habitats: A Bibliography. NOAA Tech. Memo. NMFS-AFSC-135, 206 p.

Dodder NG, Maruya KA, Lauenstein GG, Ramirez J, Ritter KJ, Schiff KC. (2012) Distribution and sources of polybrominated diphenyl ethers in the Southern California Bight. Environmental Toxicology and Chemistry,Vol 31(10): 2239-45.

Dodder N., Schiff K., Latker A., and Tang C. (2016) Southern California Bight 2013 Regional MonitoringProgram: Volume IV. Sediment Chemistry. SCCWRP Technical Report 922.

Doney S.C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley 2012. Climate Change Impacts on Marine Ecosystems Ann. Rev. Marine. Sci. 2012.4:11-37.

Doyle, M. J., W. Watson, N. M. Bowlin, and S. B. Sheavly 2011. Plastic Particles in Coastal Pelagic Ecosystems of the Northeast Pacific Ocean. Marine Environmental Research 71(1):41-52.

Dutton, P. H. 2006. Building our Knowledge of the Leatherback Stock Structure. SWoT Report-State of the World's Sea Turtles, I, 10-11. http://seaturtlestatus.org/report/swot-volume-1

Eckert, K. L. 1993. The Biology and Population Status of Marine Turtles in the North Pacific Ocean. NOAA/NMFS Tech. Memo SWFSC 186. 156 p.

Eguchi, T., J. A. Seminoff, R. A. LeRoux, P. H. Dutton, and D. L. Dutton 2010. Abundance and Survival Rates of Green Turtles in an Urban Environment: Coexistence of Humans and an Endangered Species. Mar. Biol. 157(8):1869–1877.

Elfes, C. T., G. R. Vanblaricom, D. Boyd, J. Calambokidis, P. J. Clapham, R. W. Pearce, J. Robbins, J. C. Salinas, J. M. Straley, P. R. Wade, and M. M. Krahn 2010. Geographic Variation of Persistent Organic Pollutant Levels in Humpback Whale (*Megaptera novaeangliae*) Feeding Areas of the North Pacific and North Atlantic. U. S. Department of Commerce. Paper 166. 14 p.

Eppley, R. W. (ed) 1986. Plankton Dynamics of the Southern California Bight. Springer-Verlag. 373p.

Erbe C., A. MacGillivray, and R. Williams 2012. Mapping Cumulative Noise from Shipping to Inform Marine Spatial Planning. Journal of the Acoustical Society of America 132(5): 423-428.

Evans, K., M. Hindell, and G. Hince 2004. Concentrations of Organochlorines in Sperm Whales (*Physeter macrocephalus*) from Southern Australian Waters. Marine Pollution Bulletin 48:486-503.

Fiedler, P. C., R. Mendelssohn, D. M. Palacios, and S. J. Bograd 2013. Pycnocline Variations in the Eastern Tropical and North Pacific, 1958–2008. Journal of Climate 26:583-599.

Field, J. C., D. F. Boesch, D. Scavia, R. Buddemeier, V. R. Burkett, D. Cayan, M. Fogarty, M. Harwell, R. Howarth, C. Mason, L. J. Pietrafesa, D. Reed, T. Roye, A. Sallenger, M. Spranger, and J. G. Titus 2003. Potential Consequences of Climate Variability and Change on Coastal Areas and Marine Resources. In: Climate Change Impacts in the United States. US Global Change Research Program: 461-487. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/foundation.htm.

Fiedler, P. C., R. Mendelssohn, D. M. Palacios, and S. J. Bograd 2013. Pycnocline Variations in the Eastern Tropical and North Pacific, 1958–2008. Journal of Climate 26:583-599.

Forsgren K., Bay S., Vidal-Dorsch D., et al. (2012) Annual and Seasonal evaluation of reproductive status in hornyhead turbot at municipal wastewater outfalls in the Southern California Bight. Environ. Toxicol Chem (31): 2701-2710.

Foster, M. S., and D. R. Schiel 1985. The Ecology of Giant Kelp Forests in California: A Community Profile. Biological Report 85. Washington, D.C.: U.S. Fish and Wildlife Service. 185p.

Foster, M. S., D. C. Reed, P. K. Dayton, M. H. Carr, D. P. Malone, J. S. Pearse, and L. Rogers-Bennett 2013. Kelp Forests in California. In M. A. Lang, R. L. Marinelli, S. J. Roberts, and P. R. Taylor (eds). Research and Discoveries: The Revolution of Science through Scuba. Smithsonian Contributions to the Marine Sciences, No. 39, Washington, D.C.: Smithsonian Institution Scholarly Press. pp. 115–132.

Froese, R. and D. Pauly. Editors 2013. FishBase. World Wide Web Electronic Publication. www.fishbase.org, Version (10/2013).

Frost, N. 2013. California Least Tern Breeding Survey, 2012 Season. California Department of Fish and Wildlife. Wildlife Branch. Nongame Wildlife Program Report. 2013-01. Sacramento, CA. 78p.

Gallo, J. P. 1994. Factors Affecting the Population Status of Guadalupe Fur Seal, *Arctocephalus townsendi* (Merriam, 1897), at Isla de Guadalupe, Baja California, Mexico. Ph.D. Thesis, University of California, Santa Cruz. 199 p.

Gauthier, J. M., C. D. Metcalfe, and R. Sears 1997. Chlorinated Organic Contaminants in Blubber Biopsies from Northwestern Atlantic Balaenopterid Whales Summering in the Gulf of St Lawrence. Marine Environmental Research 44(2):201-223.

Geijer, C. K. A. and A. J. Read 2013. Mitigation of Marine Mammal Bycatch in U.S. Fisheries since 1994. Biological Conservation 159:54-60.

Goes, J. I., H. D. R. Gomes, A. Limsakul, W. M. Balch, and T. Saino 2001. El Niño Related Interannual Variations in Biological Production in the North Pacific as Evidenced by Satellite and Ship Data. Progress in Oceanography 49:211-225.

Goldbogen, J. A., B. L. Southall, S. L. DeRuiter, J. Calambokidis, A. S. Friedlaender, E. L. Hazen, E. A. Falcone, G. S. Schorr, A. Douglas, D. J. Moretti, C. Kyburg, M. F. McKenna, and P. L. Tyack 2013. Blue Whales Respond to Simulated Mid-Frequency Military Sonar. Proc. R. Soc. B 2013 280, 20130657, published 3 July 2013.

Guisado, R. and J. Klaas 2013. Surfing California: A Guide to the Best Breaks and SUP-Friendly Spots in California. A Falcon Guide. 343 p.

Gulland, E. M., M. Haulena, D. Fauquier, M. E. Lander, T. Zabka, R. Duerr, and G. Langlois 2002. Domoic Acid Toxicity in Californian Sea Lions (*Zalophus californianus*): Clinical Signs, Treatment and Survival. Veterinary Record 150(15):475-480.

Halpern, B. S. C. V. Kappel, K. A. Selkoe, F. Micheli, C. M. Ebert, C. Kontgis, C. M. Crain, R. G. Martone, C. Shearer, and S. J. Teck 2009. Mapping Cumulative Human Impacts to California Current Marine Ecosystems. Conservation Letters 2:138–148.

Hanson, J., M. Helvey, and R. Strach (eds) 2003. Non-fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures. National Marine Fisheries Service (NOAA Fisheries). Version 1. Southwest Region, Long, Beach, CA.

Hardy, J. T. 1993. Phytoplankton. In: Dailey, M. D., D. J. Reish, and J. W. Anderson (eds). Ecology of the Southern California Bight. Berkeley: University of California Press. pp. 233-265.

Harvey, J., Thomas, K., Goldstein, T., Barakos, J., and F. Gulland 2010. Movement, Dive Behavior, and Survival of California Sea Lions (*Zalophus californianus*) Posttreatment for Domoic Acid Toxidosis. Marine Mammal Science 26(1):36-52.

Hayward, T. L. 2000. El Niño 1997-98 in the Coastal Waters of Southern California: A Timeline of Events. CalCOFl Reports 41:98-116.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson 2007. Vessel Speed Increases Collision Risk for The Green Sea Turtle *Chelonia mydas*. Endangered Species Research, 3(2), 105-113. doi: 10.3354/esr003105.

Hazen E. L., I. D. Schroeder, J. Peterson, W. T. Peterson, W. J. Sydeman, S. A. Thompson, B. K. Wells, and S. J. Bograd 2012. Oceanographic and Climatic Drivers and Pressures. CCIEA Phase II Report 2012: Drivers and Pressures – Ocean and Climate. NOAA Fisheries. 60p.

Hazen, E. L., S. Jorgensen, R. R. Rykaczewski, S. J. Bograd, D. G. Foley, I. D. Jonsen, S. A. Shaffer, J. P. Dunne, D. P. Costa, L. B. Crowder, and B. A. Block 2012. Predicted Habitat Shifts of Pacific Top Predators in a Changing Climate. 13 p. Nature Climate Change Letters. 23 SEPTEMBER 2012. www.nature.com/natureclimatechange.

Hess, M. 2019, Satellite and Aerial Coastal Water Quality Monitoring in the San Diego/Tijuana Region, Annual Summary Report. 1 January 2019 – 31 December 2019. Ocean Imaging. www.oceani.com

Hewitt, J. E., S. F. Thrush, P. K. Dayton, and Erik Bonsdorff 2007. The Effect of Spatial and Temporal Heterogeneity on the Design and Analysis of Empirical Studies of Scale-Dependent Systems. *The American Naturalist*, volume 169 (2007), pp. 398–408.

Hickey, B. M. 1993. Physical Oceanography. In: M. D. Dailey, D. J. Reish, and J. W. Anderson (eds) 1993. Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press. Berkeley, CA. pp. 19-70.

Hilborn, R. and U. Hilborn 2012. Overfishing: What Everyone Needs to Know. Oxford University Press., New York. 150 p.

Hildebrand, J. A. 2009. Anthropogenic and Natural Sources of Ambient Noise in the Ocean. Marine Ecology Progress Series, vol. 395: 5-20.

Hoegh-Guldberg, O. and J. F. Bruno 2010. The Impact of Climate Change on the World's Marine Ecosystems. Science 328:1523-1528.

Horner R.A., Garrison D.L., and Plumley F.G., (1997) Harmful algal blooms and red tide problems on the U.S.west coast. Limnology and Oceanography 42(2).

Howard, M. D. A., G. Robertson, M. Sutula, B. Jones, N. Nezlin, Y. Chao, H. Frenzel, M. Mengel, D.A. Caron, B. Seegers, A. Sengupta, E. Seubert, D. Diehl, and S.B. Weisberg 2012. Southern California Bight 2008 Regional Monitoring Program: Volume VII. Water Quality. Technical Report 710. Southern California Coastal Water Research Project. Costa Mesa, CA

Howard M. D. A., M. Sutula, D. A. Caron, Y. Chao, J. D. Farrara, H. Frenzel, B. Jones, G. Robertson, K. McLaughlin, and A. Sengupta 2014. Anthropogenic Nutrient Sources Rival Natural Sources on Small Scales in the Coastal Waters of the Southern California Bight. Limnol. Oceanogr. 59(1)285-297.

Howell, E. A., S. J. Bograd, C. Morishige, M. P. Seki, and J. J. Polovina 2012. On North Pacific Circulation and Associated Marine Debris Concentration. Marine Pollution Bulletin, 65(1–3):16-22. http://www.sciencedirect.com/science/article/pii/S0025326X11002372

Hubbs, C. L. 1956. The Guadalupe Fur Seal Still Lives! Zoonooz, S. D. Zool. Soc. 29(12):6-9.

Hutchinson, T. H., B. P. Lyons, J. E. Thain, and R. J. Law 2013. Evaluating Legacy Contaminants and Emerging Chemicals in Marine Environments Using Adverse Outcome Pathways and Biological Effects-Directed Analysis. Mar. Pollut. Bull. (2013): http://dx.doi.org/10.1016/j.marpolbul.2013.06.012

Jackson, J. B. C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H, S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S. Steneck, M. J. Tegner, and R. R. Warner 2001. Historical Overfishing and the Recent Collapse of Coastal Ecosystems. Science: 293 (629-638).

Jackson, J. B. C. 2008. Ecological Extinction and Evolution in the Brave New Ocean. PNAS 105: 11458–11465. www.pnas.org.cgi.doi.10.1073.pnas.0802812105.

Jackson, J. B. C., E. Sala, and K. E. Alexander (eds) 2011. Shifting Baselines: The Past and the Future of Ocean Fisheries. Island Press. Washington, D. C. 283 p.

Jefferson, T. A., M. A. Webber, and R. L. Pitman 2011. Marine Mammals of the World: A Comprehensive Guide to their Identification. London, UK, Elsevier: 573 p.

Jones, M. L. and S. L. Swartz 2009. Gray whale *Eschrichtius robustus*. In. Encyclopedia of Marine Mammals. W. F. Perrin, B. Wursig and J. G. M. Thewissen (eds). Academic Press: 503-511.

Kahru, M. and B. G. Mitchell. 2000. Influence of the 1997-98 El Niño on the Surface Chlorophyll in the California Current. Geophysical Research Letters 27:2937-2940.

Kahru M., Kudela R.M., Manzano-Sarabia M., and Mitchell B.G. (2012) Trends in the surface chlorophyll of theCalifornia Current: Merging data from multiple ocean color satellites. Deep Sea Research Part II: Topical Studies in Oceanography 77: 89–98.

Kim H., Miller A.J., McGowan J., and Carter M.L. (2009) Coastal phytoplankton blooms in the Southern California Bight. Progress in Oceanography 82: 137-147.

Koslow, A. J, R. Goericke, and W. Watson 2013. Fish Assemblages in the Southern California Current: Relationships with Climate, 1951–2008. Fisheries Oceanography. 22:207–219.

Laugen, A. T., G. H. Engelhard, R. Whitlock, et al. 2014. Evolutionary Impact Assessment: Accounting for Evolutionary Consequences of Fishing in an Ecosystem Approach to Fisheries Management. Fish and Fisheries. Vol. 15, (1): 65-96. http://dx.doi.org/10.1111/faf.12007.

Lavaniegos, B. E., G. Gaxiola-Castro, L. C. Jimenez-Perez, M. R. Gonzalez-Esparza, T. Baumgartner, and J. Garcia-Cordova 2003. 1997-98 El Niño Effects on the Pelagic Ecosystem of the California Current off Baja California, Mexico. Geofisica Interncional 42:483-494.

Laws, E. A. (ed) 2013. Environmental Toxicology. Springer Verlag. ISBN-13: 9781461457633. 737p. http://www.springer.com/978-1-4614-5763-3

Lazar, B. and R. Gračan 2011. Ingestion of Marine Debris by Loggerhead Sea Turtles, *Caretta*, in the Adriatic Sea. Marine Pollution Bulletin 62(1):43-47.

Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson 2001. California’s Living Marine Resources: A Status Report. California Department of Fish & Game. 592 p.

Lew, D. K. and D. M. Larson 2005. Valuing Recreation and Amenities at San Diego County Beaches. Coastal Management 33:71–86.

Love, M. S. 2006. Subsistance, Recreational and Commercial Fisheries. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds). 2006. Chapter 22. pp. 567-594.

Love, M. S., M. Yoklavich, and L. Thorsteinson 2002. The Rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.

Love, M. S, M. Yoklavich, and D. M. Schroeder 2009. Demersal Fish Assemblages in the Southern California Bight Based on Visual Surveys in Deep Water. Environ. Biol. Fish 84:55–68.

Lyon, G. S., and M. A. Sutula 2011. Effluent Discharges to the Southern California Bight from Large Municipal Wastewater Treatment Facilities from 2005 to 2009. In: SCCWRP Annual Report 2011. 14 p.

Martin, A. and S. Gruber 2005. Amplification of Indicator Bacteria in Organic Debris on Southern California Beaches. Technical Paper 0507. Weston Solutions, Inc. Presented at StormCon 2005. Orlando, FL, USA. July 2005. 7 p.

Marsili, L., and S. Focardi 1996. Organochlorine Levels in Subcutaneous Blubber Biopsies of Fin Whales (*Balaenoptera physalus*) and Striped Dolphins (*Stenella coeruleoalba*) from the Mediterranean Sea. Environmental Pollution 91(1):1-9.

Maruya, K. A., D. Schlenk, P. D. Anderson, N. D. Denslow, J. E. Drewes, A. W. Olivieri, G. I. Scott, and S. A. Snyder 2014. An Adaptive, Comprehensive Monitoring Strategy for Chemicals of Emerging Concern (CECs) in California's Aquatic Ecosystems. Integrated Environmental Assessment and Management. Volume 10, Issue 1:69–77.

McDonald, D., P. Dutton, D. Mayer, and K. Merkel 1995. Review of The Green Turtles of South San Diego Bay in Relation to The Operations of the SDG&E South Bay Power Plant. Prepared for San Diego Gas & Electric Company. 27 p.

McDonald, M., J. Hildebrand, S. Wiggins, and D. Ross 2008. 50 Year Comparison of Ambient Ocean Noise Near San Clemente Island: A Bathymetrically Complex Coastal Region off Southern California. Journal of the Acoustical Society of America: 1985-1992.

McDonald, B. D., R. L. Lewison, S. V. Madrak, J. A. Seminoff, and T. Eguchi 2012. Home Ranges of East Pacific Green Turtles *Chelonia mydas* in a Highly Urbanized Temperate Foraging Ground. Marine Ecology Progress Series 461:211-221.

McGowan, J. A. 1984. The California El Niño, 1983. Oceanus 27:48-51.

McGowan, J. A., D. R. Cayan, and L. M. Dorman 1998. Climate-ocean Variability and Ecosystem Response in the Northeast Pacific. Science 281:210-217.

McGowan J.A., Deyle E.R., Ye H., Carter M.L., Perretti C.T., Seger K.D., de Verneil A. and Sugihara G. (2017) Predicting coastal algal blooms in southern California. Ecology 98: 1419-1433.

Miller, E. F. and K. Schiff 2012. Descriptive Trends in Southern California Fishes, 1994-2008. SCCWRP Annual Report 2012: 129-144.

Miller, E. F. and J. A. McGowan 2013. Faunal Shift in Southern California’s Coastal Fishes: A New Assemblage and Trophic Structure Takes Hold. Estuarine, Coastal and Shelf Science. Vol. 127:29-36.

Miller A. J., H. Song, and A. C. Subramaniana 2013. The Physical Oceanographic Environment during the CCE Years: Changes in Climate and Concepts. Deep-Sea Research II. Special Issue on the California Current Ecosystem. 27 p.

Moore, J. E. and J. Barlow 2011. Bayesian State-Space Model of Fin Whale Abundance Trends From a 1991-2008 Time Series of Line-Transect Surveys in the California Current. Journal of Applied Ecology: 1-11.

Moore, J. E. and J. P. Barlow 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE 8(1):e52770. doi:10.1371/journal.pone.0052770. 12 p.

Moore, M. J., J. van der Hoop, S. G. Barco, A. M. Costidis, F. M. Gulland, P. D. Jepson, K. T. Moore, S. Raverty, and, W. A. McLellan (eds) 2013. Criteria and Case Definitions for Serious Injury and Death of Pinnipeds and Cetaceans Caused by Anthropogenic Trauma. Dis. Aquat. Org. Vol. 103: 229–264.

Morejohn, G. V., J. T. Harvy, and L. T. Krasnow 1978. The Importance of *Loligo Opalescens* in the Food Web of Marine Vertebrates in Monterey Bay, California. California Department of Fish and Game Fish Bulletin 169:67-98.

Mrosovsky, N., G. D. Ryan, and M. C. James 2009. Leatherback Turtles: The Menace of Plastic. Marine Pollution Bulletin 58:287-289.

National Research Council 1990. Monitoring southern California's Coastal Waters. Washington, D.C.: National Academy Press.

NAVFAC (Naval Facilities Engineering Command) 2013. Ecosystem Technical Report for the Hawaii-Southern California Training and Testing EIS/OEIS. NAVFAC Biological Resource Services. Arlington, VA. 66p.

Nezlin N.P., Sutula M.A., Stumpf R.P., and Sengupta A. (2012) Phytoplankton blooms detected by SeaWiFSalong the central and southern California coast. Journal of Geophysical Research 117: C07004.

Nezlin N.P., McLaughlin K., Booth J.A.T., Cash C.L., Diehl D.W., Davis K.A., Feit A., Goericke R., Gully J.R., andHoward M.D. (2018) Spatial and temporal patterns of chlorophyll concentration in the southern California bight. Journal of Geophysical Research: Oceans 123: 231-245.

Newman, M. C. 2009. Fundamentals of Ecotoxicology. CRC Press. Chelsea, Mi. ISBN-13: 978-1420067040. 571 pages

NMFS 2001. Endangered and Threatened Species; Endangered Status of White Abalone. Final Rule. Federal Register 66(103): 29046-29055.

NMFS 2005c. Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. https://www.fisheries.noaa.gov/search-critical-habitat

NMFS 2005d. Revision of Species of Concern List, Candidate Species Definition, and Candidate Species List. https://www.fisheries.noaa.gov

NMFS 2008. White Abalone Recovery Plan (*Haliotis sorenseni*). Long Beach, CA: National Marine Fisheries Service, Southwest Regional Office.

NMFS 2009. Endangered and Threatened Wildlife and Plants; Endangered Status for Black Abalone. [Final Rule]. Federal Register 74(9):1937-1946.

NMFS 2011a. California Whale Watching Guidelines. NOAA Fisheries Service. Southwest Regional Office. 2 p. www.fisheries.noaa.gov/west-coast/marine-life-viewing-guidelines/share-shore-watch-marine-mammals-responsibly

NMFS 2011b. Endangered and Threatened Wildlife and Plants: Final Rulemaking To Designate Critical Habitat for Black Abalone. Federal Register 76. No. 208.

NMFS 2012. Southern California Steelhead Recovery Plan. Southwest Region, Protected Resources Division, Long Beach, California. Executive Summary and Two Volumes.

NMFS 2013a. National Marine Fisheries Service Endangered Species Act Section 7 Consultation Biological and Conference Opinion. The U.S. Navy's Training Exercises and Testing Activities in the Southern Hawaii-California raining and Testing Study Area from December 2013 through December 2018. Dec. 13, 2013. 457 p.

NMFS 2013b. Groundfish Essential Fish Habitat Synthesis: A Report to the Pacific Fishery Management Council. NOAA NMFS Northwest Fisheries Service Center, Seattle WA. April 2013. 485p.

NMFS 2013c. Endangered and Threatened Species; Delisting of the Eastern Distinct Population Segment of Steller Sea Lion under the Endangered Species Act; Amendment to Special Protection Measures for Endangered Marine Mammals Federal Register / Vol. 78, No. 213 / Monday, November 4, 2013.

NMFS 2021a. The Marine Mammal Protection Act of 1972. http://www.nmfs.noaa.gov/pr/laws/mmpa/.

NMFS 2021b. Cetaceans: Whales, Dolphins, and Porpoises. NOAA Fisheries. Office of Protected Resources. http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/

NMFS 2021c. Pinnipeds: Seals, Sea Lions, and Walruses. NOAA Fisheries. Office of Protected Resources. http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/

NMFS 2021d. North Pacific Population of the Humpback Whale and Notice of Status Review. https://www.federalregister.gov/articles/2013/08/29/2013-21066/endangered-and-threatened-wildlife-90-day-finding-on-a-petition-to-delist-the-north-pacific

NMFS 2021e . Guadalupe Fur Seal. http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/guadalupefurseal.htm

NMFS 2021f. Steller Sea Lion. http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/stellersealion.htm.

NMFS 2021g. Sea Turtles. NOAA Fisheries. https://www.fisheries.noaa.gov/find-species

NMFS 2021h. Green Turtle. https://www.fisheries.noaa.gov/find-species

NMFS 2021i. Loggerhead Turtle. https://www.fisheries.noaa.gov/find-species.

NMFS 2021j. Leatherback Turtle. https://www.fisheries.noaa.gov/find-species.

NMFS 2021k. Olive Ridley https://www.fisheries.noaa.gov/find-species

NMFS 2021l. Hawksbill Turtle. https://www.fisheries.noaa.gov/find-species

NMFS 2014m. Steelhead Trout. https://www.fisheries.noaa.gov/find-species

NMFS 2021n. White Abalone. https://www.fisheries.noaa.gov/find-species

NMFS 2021o. Black Abalone. https://www.fisheries.noaa.gov/find-species

NMFS and USFWS (U. S. National Marine Fisheries Service and U. S. Fish and Wildlife Service) 1998a. Recovery plan for U.S. Pacific Populations of the East Pacific green turtle, (*Chelonia mydas*). National Marine Fisheries Service. Silver Springs, MD. 61p. https://www.fisheries.noaa.gov/find-species

NMFS and USFWS 1998b. Recovery plan for U.S. Pacific Populations of the loggerhead turtle, (*Caretta caretta*). National Marine Fisheries Service. Silver Springs, MD. 71p.

NMFS and USFWS 1998c. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle, (*Dermochelys coriacea*). National Marine Fisheries Service. Silver Springs, MD. 76p.

NMFS and USFWS 1998d. Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle, (*Lepidochelys olivacea*). National Marine Fisheries Service. Silver Springs, MD. 62p.

NMFS and USFWS 1998e. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle, (*Eretmochelys imbricata*). National Marine Fisheries Service. Silver Springs, MD. 95p.

NOAA (National Oceanic and Atmospheric Administration) 2007. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT. Public Law 94-265. As amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479). 178p.

NOAA 2008. Interagency Report on Debris Sources, Impacts, Strategies and Recommendations. Silver Spring, MD: National Oceanic and Atmospheric Administration. 62 p.

NOAA 2021. What is an El Niño. NOAA Fisheries Web Site. http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html.

NOAA 2021a. What is a Harmful Algal Bloom. NOAA. http://www.noaa.gov/what-is-harmful-algal-bloom/

NOAA 2021b. NOAA laws and Policies http://www.fisheries.noaa.gov/topic/laws-policiesl

NOAA 2021c. NOAA Fisheries Web Site. http://www.nmfs.noaa.gov/

NOAA 2021d. ESA Endangered and Threatened Species Directory 2021. https://www.fisheries.noaa.gov/

NOAA 2021e. Marine Mammals. Human Impacts. NOAA Fisheries. Office of Protected Resources. https://fisheries.noaa.gov/topic/marine-mammal-protection

NOAA 2021f. Oceanic Whitetip Shark. www.fisheries.noaa.gov/species/oceanic-whitetip-shark

NOAA 2021g. Giant Manta Ray. https://www.fisheries.noaa.gov/search?oq=giant=manta=ray

NOAA 2021h. Green Sturgeon. https://www.fisheries.noaa.gov/search?oq=green=sturgeon

Noble, M. A. 2009. Introduction to the Physical Oceanography of the Southern California Bight. Geological Society of America Special Papers. V. 454. 169p.

Norse, E. A. 2010. Ecosystem-Based Spatial Planning and Management of Marine Fisheries: Why and How? Bulletin of Marine Science. Volume 86(2)179-195.

O'Hara, T. M. and T. J. O'Shea. 2005. Assessing Impacts of Environmental Contaminants. In: Reynolds, J.E. III, W.F. Perrin, R.R. Reeves, S. Montgomery, and T.J. Ragen, (eds). Marine Mammal Research: Conservation Beyond Crisis. Baltimore, MD: Johns Hopkins University Press. p. 63-83.

O’Shea, T. J. and K. K. Odell 2008. Large-scale Marine Ecosystem Change and the Conservation of Marine Mammals. J. Mammalogy 89(3):529-533.

Oregon State University 2011. Sea Lion Entanglement in Marine Debris Preventable, Study Finds. Press Release. http://oregonstate.edu/urm/ncs/archives/2011/apr/sea-lion-entanglement-marine-debris-preventable-study-finds

Parnell, E., and K. Riser 2012. Evaluation of Anthropogenic Impacts on the San Diego Coastal Ecosystem. Annual Project Report (2011-2012). Submitted to City of San Diego Public Utilities Department. UCSD Contract OO-19958/H074007. 15 p.

Parnell, P. Ed, A. K. Groce, T. D. Stebbins, and Paul K. Dayton 2008. Discriminating Sources of PCB Contamination in Fish on the Coastal Shelf off San Diego, California (USA). Marine Pollution Bulletin 56 (2008) 1992–2002.

Parnell, P. E., P. K. Dayton, R. A. Fisher, C. C. Loarie, and R. D. Darrow 2010. Spatial Patterns of Fishing Effort off San Diego: Implications for Zonal Management and Ecosystem Function. Ecol. Appl. 20:2203–2222. http://dx.doi.org/10.1890/09-1543.1

Perrin, W. F., S. Leatherwood and A. Collet 2008. Encyclopedia of Marine Mammals. San Diego, CA. Academic Press. 1316 p.

Perry, B., P. M. DiGiacomo, and B. Holt 2007. Oceanography of the Southern California Bight. http://geology.campus.ad.csulb.edu/people/bperry/scbweb/circulation.htm

Perry, B. 2009. Coastal Systems and Human Impacts. CSU Long Beach Department of Geological Sciences Course Web Book. http://geology.campus.ad.csulb.edu/people/bperry/geology303/geol303text.html

PFMC (Pacific Fishery Management Council) 2004. Appendix 10, Pacific Coast Groundfish Essential Fish Habitat, the Effects of Fishing Gears on Habitat: West Coast Perspective. Pacific States Marine Fisheries Commission, Portland, OR.

PFMC (Pacific Fishery Management Council) and NMFS (National Marine Fisheries Service) 2012.

Pierce, S. D., R. L. Smith, P. M. Kosro, J. A. Barth, and C. D. Wilson 2000. Continuity of the Poleward Undercurrent along the Eastern Boundary of the Mid-Latitude North Pacific. Deep-Sea Research II 47:811-829.

Pinnegar, J. K. and G. H. Engelhard 2008. The 'Shifting Baseline' Phenomenon: A Global Perspective. Rev. Fish. Biol. Fisheries 18:1–16.

Pondella, D., J. Williams, J. Claisse, R. Schaffner, K. Ritter, and K. Schiff. 2011. Southern California Bight 2008 Regional Monitoring Program: Volume V. Rocky Reefs. Southern California Coastal Water Research Project, Costa Mesa, CA.

POSD 2021. Progress Report: Evaluation of Fine Scale Movements of East Pacific Green Sea Turtles in San Diego Bay. Space and Naval Warfare Systems Center, Pacific Environmental Readiness Division Naval Facilities Engineering Command Southwest September2016 https://www.portofsandiego.org/search?keyeord=turtles.

Punt, A. E. and P. R. Wade 2012. Population Status of the Eastern North Pacific Stock of Gray Whales In 2009. Journal of Cetacean Research and Management 12(1): 15-28.

Ranasinghe, J. A., K. C. Schiff, C. A. Brantley, L .L. Lovell, D .B. Cadien, T. K. Mikel, R. G. Velarde, S. Holt, and S. C. Johnson. 2012. Southern California Bight 2008 Regional Monitoring Program: VI. Benthic Macrofauna. Technical Report No. 65, Southern California Coastal Water Research Project, Costa Mesa, CA.

Redfern, J. V., M. F. McKenna, T. J. Moore, J. Calambokidis, M. L. DeAngelis, E. A. Becker, J. Barlow, K. A. Forney, P. D. Fiedler, and S. J. Chivers 2013. Assessing the Risk of Ships Striking Large Whales in Marine Spatial Planning. Conservation Biology 27(2):292-302.

Reeves, R. R., K. McClellan, and T. B. Werner 2013. Marine Mammal Bycatch in Gillnet and Other Entangling Net Fisheries, 1990 To 2011. Endangered Species Research 20: 71–97. doi: 10.3354/esr00481.

Roemmich, D. and J. McGowan 1995. Climatic Warming and the Decline of Zooplankton in the California Current. Science 267:1324-1326.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, S. Y. Kim, P. E. Parnell, and P. Dayton 2012. Final Report: Point Loma Ocean Outfall Plume Behavior Study. Prepared for City of San Diego Public Utilities Department by Scripps Institution of Oceanography, University of California, San Diego. San Diego, CA.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, and W. Middleton 2013. Ocean Outfall Plume Characterization Using an Autonomous Underwater Vehicle. Water Science &Technology, 67(4): 925–933.

Rolland, R.M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Kraus 2012. Evidence that Ship Noise Increases Stress in Right Whales. Proc. R. Soc. B. Biological Sciences 279:2363-2368.

Roman, J., I. Altman, M. M. Dunphy-Daly, C. Campbell, M. Jasny, and A. J. Read 2013. The Marine Mammal Protection Act at 40: Status, Recovery, and Future of U.S. Marine Mammals. Ann. N.Y. Acad. Sci. 2013:1-21.

RWQCB and EPA (San Diego Regional Water Quality Control Board and U. S. Environmental Protection Agency) 2017. Waste Discharge Requirements and National Pollutant Discharge Elimination System Permit for the City of San Diego E.W. Blom Point Loma Metropolitan Wastewater Treatment Plant Discharge to the Pacific Ocean through the Point Loma Ocean Outfall, San Diego County. Order No. R9-2017-0007. NPDES No. CA0107409. http://www.waterboards.ca.gov/sandiego/

Salvadeo, C. J., D. Lluch-Belda, A. Gómez-Gallardo, J. Urbán-Ramírez, and C. D. MacLeod 2010. Climate Change and a Poleward Shift in the Distribution of the Pacific White-Sided Dolphin in the Northeastern Pacific. Endangered Species Research 11: 13-19.

Salvadeo, C. J., S. E. Lluch-Cota, M. O. Maravilla-Chávez, S. T. Álvarez-Castañeda, M. Mercuri, and A. Ortega-Rubio 2013. Impact of Climate Change on Sustainable Management of Gray Whale (*Eschrichtius robustus*) Populations: Whale-Watching and Conservation. Arch. Biol. Sci., Belgrade, 65 (3):997-1005.

Santidrián Tomillo, P., V. S. Saba, G. S. Blanco, C. A. Stock, F. V. Paladino, and J. R. Spotila 2012. Climate Driven Egg and Hatchling Mortality Threatens Survival of Eastern Pacific Leatherback Turtles. PLoS ONE 7(5):e37602.

SCCWRP (Southern California Coastal Water Research Project) 2012. Southern California Bight 2008 Regional Monitoring Program. January 2012. Coastal Ecology Synthesis Report. Southern California Coastal Water Research Project: Costa Mesa, CA

SCCWRP 2013. Harmful Algal Blooms in Coastal Waters. http://www.sccwrp.org/ResearchAreas/Nutrients/HarmfulAlgalBloomsHABs.aspx

SCCWRP 2021a. Southern California Bight Regional Monitoring. Bight Program Documents - Southern California Coastal Water Research Project (sccwrp.org)

SCCWRP 2021b. http://www.sccwrp.org/about/research-areas/eutrophication/harmful-algal-blooms

SCCWRP 2021c. Research Areas CECs. https://www.sccwrp.org/about/research-areas/emerging-contaminants/□

Schiff, K. C., M. J. Allen, E. Y. Zeng, and S. M. Bay 2000. Southern California. Mar. Pollution Bull. 41(1): 76-93.

Schiff, K., R. Gossett, K. Ritter, L. Tiefenthaler, N. Dodder, W. Lao, and K. Maruya 2011. Southern California Bight 2008 Regional Monitoring Program: III. Sediment Chemistry. Southern California Coastal Water Research Project, Costa Mesa, CA.

Scholin, C. A., F. Gulland, G. J. Doucette, S. Benson, M. Busman, F. P. Chavez, J. Cardaro, R. DeLong, A. De Vogelaere, J. Harvey, M. Haulena, K. Lefebvre, T. Lipscomb, S. Loscutoff, L. J. Lowenstine, R. Marin III, P. E. Miller, W. A. McLellan, P. D. R. Moeller, C. L. Powell, T. Rowles, P. Silvagni, M. Silver, T. Spraker, V. Trainer, and F. W. Van Dolah 2000. Mortality of Sea Lions Along the Central California Coast Linked to a Toxic Diatom Bloom. Nature 403:80-84.

Schwing, F. B., C. S. Moore, S. R. Ralston, and K. M. Sakuma 2000. Record Coastal Upwelling in the California Current in 1999. CalCOFI Reports 41:148-160.

Schwing, F. B., T. Murphree, L. deWitt and P. M. Green 2002. The Evolution of Oceanic and Atmospheric Anomalies in the Northeast Pacific during the El Niño and La Niña Events of 1995-2001. Progress in Oceanography 54: 459-491.

Sears, R. and W. F. Perrin 2008. Blue Whale. In: Encyclopedia of Marine Mammals. W.F. Perrin, B. Wursig and J. G. M. Thewissen. San Diego, CA, Academic Press:120-124.

Seminoff, J. 2007. Green Sea Turtle 5-Year Review: Summary and Evaluation. U. S. National Marine Fisheries Service and U. S. Fish and Wildlife Service. August 2007. 105 p.

Setty, K., K. Schiff, and S. Weisberg (eds) 2012. Forty Years after the Clean Water Act: A Retrospective Look at the Southern California Coastal Ocean. Southern California Coastal Water Research Project. Costa Mesa, CA. Technical Report 727. 52p.

Simmonds, M. P., and W. J. Eliott 2009. Climate Change and Cetaceans: Concerns and Recent Developments. Journal of the Marine Biological Association of the United Kingdom 89(1):203-210.

Smith J., Connell P., Evans R.H., Gellene A.G., Howard M.D.A., Jones B.H., Kaveggia S., Palmer L., Schnetzer A., Seegers B.N., Seubert E.L., Tatters A.O., and Caron D.A. (2018) A decade and a half of Pseudo-nitzschia spp. and domoic acid along the coast of southern California. Harmful Algae 79: 87-104

Southall, B., J. Calambokidis, P. Tyack, D. Moretti, A. Friedlaender, S. DeRuiter, J. Goldbogen, E. Falcone, G. Schorr, A. Douglas, A. Stimpert, J. Hildebrand, C. Kyburg, R. Carlson, T. Yack, and J. Barlow 2012. Biological and Behavioral Response Studies of Marine Mammals in Southern California, 2011. Final Project Report, 8 March 2012.

Stein, D. 2013. The History and Current Status of the California Red Sea Urchin Fishery. California Department of Fish and Wildlife. Power Point Presentation. 21 p. http://www.fgc.ca.gov/meetings/subcommittees/061813mrcurchin.pdf

Sutton R., Chen D., Sun J., Greig D., and Wu Y. (2019) Characterization of brominated, chlorinated, and phosphate flame retardants in San Francisco Bay, an urban estuary. Science of The Total Environment, Vol652: 212-223.

Sutton R., Sedlak M., Sun J., and Lin, D. (2017) Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations. 2017 Revision. SFEI Contribution No. 815. San Francisco Estuary Institute: Richmond, CA.

Suntsov, A., J. A. Koslow, and W. Watson 2012. The Spatial Structure of Coastal Ichthyoplankton Assemblages off Central and southern California. California Cooperative Oceanic Fisheries Investigations Reports. 53:153-170.

Svejkovsky J. (2015-2017). Satellite and Aerial Coastal Water Quality Monitoring in the San Diego/Tijuana Region. Annual Summary Reports. Ocean Imaging Inc., Littleton, CO.

Sydeman, W. J., J. A. Santora, S. A. Thompson, B. Marinovic, and E. D. Lorenzo 2013. Increasing Variance in North Pacific Climate Relates to Unprecedented Ecosystem Variability off California. Global Change Biology 19:1662-1675.

Tegner, M. J., P. K. Dayton, P. B. Edwards, K. L. Riser, D. B. Chadwick, T. A. Dean, and L. Deysher 1995. Effects of a Large Sewage Spill on a Kelp Forest Community: Catastrophe or Disturbance? Mar. Env. Res. 40(2): 181-224.

Thrush, S. F. and P. K. Dayton 2010. What Can Ecology Contribute to Ecosystem-Based Management? Annu. Rev. Mar. Sci. 2:419–41.

Tornero, V., T. J. Teresa, J. Sylvina, R. S. Wells, and J. Singh 2014. Eco-toxicants: A Growing Global Threat. Primatology Monographs. Primates and Cetaceans. Field Research and Conservation of Complex Mammalian Societies. Pp. 309-332. http://link.springer.com/chapter/10.1007/978-4-431-54523-1_16.

Turner-Tomaszewicz, C. and J. A. Seminoff 2012. Turning off the Heat: Impacts of Power Plant Decommissioning on Green Turtle Research in San Diego Bay. Coastal Management 40:73–87.

Torrey H.B. (1902) An unusual occurrence of dinoflagellata on the California coast. American Naturalist 36: 187– 192.

UCSD (University of California, San Diego) 2013. Draft Environmental Assessment and Initial Study SIO/UCSD Marfac Berthing Wharf and Pier Replacement UCSD Project Number: 963990/4425. April 2013. 167 p.

USDON (United States Department of the Navy) 2008. Southern California (SOCAL) Range Complex. Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). December 2008. 2 Volumes.
http://www.nmfs.noaa.gov/pr/pdfs/permits/socal_eis_vol1.pdf
http://www.nmfs.noaa.gov/pr/pdfs/permits/socal_eis_vol2.pdf

USDON 2013. Hawaii-Southern California Training and Testing Activities. Final Environmental Impact Statement/Overseas Environmental Impact Statement. August 2013. 3 Volumes. http://hstteis.com/DocumentsandReferences/HSTTDocuments/FinalEISOEIS.aspx

USFWS (United States Fish and Wildlife Service) 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover. Vol. 1. 190p.

USFWS 2009. Spotlight Species Action Plan (2010-2014) – California Least Tern. Fish and Wildlife Office, Carlsbad, CA. 4p.

USFWS 2012. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Pacific Coast Population of the Western Snowy Plover. Final Rule. Federal Register 06-19-2012.
https://www.federalregister.gov/articles/2012/06/19/2012-13886/endangered-and-threatened-wildlife-and-plants-revised-designation-of-critical-habitat-for-the#h-139

USFWS 2021a. Endangered Species Act of 1973. http://www.fws.gov/

USFWS 2021b. Endangered Species. https://www.fws.gov/endangered

USFWS 2021c. California Least Tern. https://ecos.fws.gov/ecp/species/8104

USFWS 2021d. Light-footed Clapper Rail. https://ecos.fws.gov/ecp/species/6035

USFWS 2021e. Western Snowy Plover. www.fws.gov/arcata/es/birds/wsp/plover.html

USFWS 2021f. Steelhead Trout.
www.fws.gov/fisheries/freshwater-fish-of-america/steelhead_trout.html

USFWS 2021g. Scollaped Hammerhead Shark. https://ecos.fws.gov/ecp/species/6035

VanBlaricom, G., J. Butler, A. DeVogelaere, R. Gustafson, C. Mobley, M. Neuman, and D. Richards 2009. Status Review Report for Black Abalone (*Haliotis cracherodii* Leach, 1814). Long Beach, CA: National Marine Fisheries Service. 135 p.

Van der Hoop, J. M., M. J. Moore, S. G. Barco, T. V. Cole, Pierre-Yves Daoust, A. G. Henry, D. F. McAlpine, W. A. McLellan, T. Wimmer, and A. R. Solow 2013. Assessment of Management to Mitigate Anthropogenic Effects on Large Whales. Conserv. Biol. 27(1): 121–133.

Vicente, V.P. 1994. Spongivory in Caribbean Hawksbill Turtles, *Eretmochelys imbricata*: Data from Stranded Specimens. Page 185-188 *in* B.A. Schroeder, and B.E. Witherington (compilers). Proc. of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation, Jekyll Island, Georgia. NOAA Tech. Memo. NMFS-SEFSC-341. 281 pp.

Vidal-Dorsch DE., Bay SM., Greenstein DJ., et al. (2014) Biological Responses of Marine Flatfish Exposed toMunicipal Wastewater Effluent. Environ. Toxicol. Chem;33:583591

Walsh, P. J., S. L. Smith, L. E. Fleming, H. Solo-Gabriele, and W. H. Gerwick (eds) 2008. Oceans and Human Health: Risks and Remedies from the Seas, Academic Press, Amsterdam. 644 p.

Weis, J. S. 2014. Bioaccumulation/Storage/Detoxification. In: Weis, J. S. (ed). 2014. Physiological, Developmental and Behavioral Effects of Marine Pollution. Springer Link. Pp. 355-392. Print: ISBN: 978-94-007-6948-9. Online: http://link.springer.com/chapter/10.1007/978-94-007-6949-6_10.

Weis, J. S. (ed) 2014. Physiological, Developmental and Behavioral Effects of Marine Pollution. Springer Link. 452 p. Print: ISBN: 978-94-007-6948-9. Online: http://www.springer.com/environment/environmental+toxicology/book/978-94-007-6948-9

Whitacre, D. M. (ed) 2014. Reviews of Environmental Contamination and Toxicology. Vol. 227. Springer. New York. 171 p. Print: ISBN 978-3-319-01326-8. eBook: ISBN 978-3-319-01327-5. Online: http://www.springer.com/environment/environmental+toxicology/book/978-3-319-01326-8.

Wise, J. P., Sr., R. Payne, S. S. Wise, C. LaCerte, J. Wise, C. Gianios, Jr.,W. D. Thompson, C. Perkins, T. Zheng, C. Zhu, L. Benedict, and I. A. Kerr 2009. A Global Assessment of Chromium Pollution Using Sperm Whales (*Physeter macrocephalus*) as an Indicator Species. Chemosphere 75(11):1461-1467.

Work, P. A., A. L. Sapp, D. W. Scott, and M. G. Dodd 2010. Influence of Small Vessel Operation and Propulsion System on Loggerhead Sea Turtle Injuries. Journal of Experimental Marine Biology and Ecology 393(1-2):168-175.

Worm, B., R. Hilborn, J. K. Baum, T. A. Branch, J. S. Collie, C. Costello, M. J. Fogarty, E. A. Fulton, J. A. Hutchings, S. Jennings, O. P. Jensen, H. K. Lotze, P. M. Mace, T. R. McClanahan, C. Minto, S. R. Palumbi, A. M. Parma, D. Ricard, A. A. Rosenberg, R. Watson, and D. Zeller 2009. Rebuilding Global Fisheries. Science 325:578-584.

Woshner, V. M. 2006. Persistent Contaminants in Selected Species of Marine Mammals in US Waters: A Review of the Literature from 1995 through 2005. National Marine Fisheries Service, Office of Protected Resources. 37p.

Wright, M. E., H. M. Solo-Gabrielea, S. Elmira, and L. E. Fleming 2009. Microbial Load from Animal Feces at a Recreational Beach. Marine Pollution Bulletin 58 (11):1649–1656.

Wyneken, J. K., J. Lohmann, and J. A. Musick (eds) 2013. The Biology of Sea Turtles. Vol. III. CRC Press. 458 p.

Zembal, R., S. M. Hoffman, and J. R. Bradley 1997. Light-footed Clapper Rail Management and Population Assessment. California Department of Fish and Game. 26 p.

Zembal, R., S. M. Hoffman, and J. Konecny 2013. Status and Distribution of the Light-footed Clapper Rail in California, 2013. California Department of Fish and Wildlife, Wildlife Management, Nongame Wildlife Unit Report, 2013-02. Sacramento, CA. 24 p.

APPENDIX J

ESSENTIAL FISH HABITAT ASSESSMENT

City of San Diego
Public Utilities Department

March 2022

Table of Contents

Section **Page**

List of Figures

List of Tables

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
BOD	biochemical oxygen demand
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
City	City of San Diego
CEC	contaminant of emerging concern
CFR	Code of Federal Regulations
CMLPA	California Marine Life Protection Act
COSD	City of San Diego
CPS	Coastal Pelagic Species
CPS FMP	Coastal Pelagic Species Fisheries Management Plan
CSULB	California State University, Long Beach
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
EFH	Essential Fish Habitat
EFHA	Essential Fish Habitat Assessment
ENSO	El Niño-Southern Oscillation
EPA	United States Environmental Protection Agency
FDA	United States Food and Drug Administration
FMCs	fishery management councils
FMPs	fishery management plans
ft	foot
HAB	Harmful Algal Bloom
HAPC	Habitat Areas of Particular Concern
HMS	Highly Migratory Species
IPHC	International Pacific Halibut Commission
km	kilometer
km^2	square kilometers
Ocean Plan	Water Quality Control Plan, Ocean Waters of California
OEHHA	California Office of Environmental Health Hazard Assessment
PCBs	polychlorinated biphenyls
PDO	Pacific Decadal Oscillation

PFMC	Pacific Fishery Management Council
PLOO	Point Loma Ocean Outfall
PLWTP	Point Loma Wastewater Treatment Plant
POTW	publicly owned treatment works
Pure Water	Pure Water San Diego Program
lb	pound
m	meter
mi	mile
mgd	million gallons per day
MLMA	California Marine Life Management Act
MPA	Marine Protected Area
NFMP	California Nearshore Fishery Management Plan
nm	nautical mile
NMFS	United States National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOEP	National Ocean Economics Program
NPDES	National Pollutant Discharge Elimination System
RWQCB	California Regional Water Quality Control Board, San Diego
SCCOOS	Southern California Coastal Ocean Observing System
SCCWRP	Southern California Coastal Water Research Project
SIO	Scripps Institution of Oceanography
SWRCB	State Water Resources Control Board
U.S.C.	United States Code
UNFAO	United Nations Food and Agricultural Organization
USDON	United States Department of the Navy
WSFMP	White Seabass Fishery Management Plan
ZID	zone of initial dilution

J.1 INTRODUCTION

This document is in support of the City of San Diego's (City's) application to the United States Environmental Protection Agency (EPA) and the California Regional Water Quality Control Board, San Diego (RWQCB) requesting renewal of its National Pollutant Discharge Elimination System (NPDES) permit for the discharge of treated wastewater to the Pacific Ocean from the 23,760-foot (ft)-long, approximately 310-ft deep Point Loma Ocean Outfall (PLOO). The City's application requests renewal of modified secondary treatment requirements for the Point Loma discharge in accordance with provisions of Section 301(h) and 301(j)(5) of the Clean Water Act (RWQCB and EPA 2017). The current 5-year discharge permit for the modified Point Loma discharge expires on September 30, 2022 (RWQCB and EPA 2017). The renewal application will not request any increase in currently permitted discharge flows or mass emissions. Treatment operations at the Point Loma Wastewater Treatment Plant (PLWTP) will be conducted to ensure compliance with applicable water quality standards established in the California Ocean Plan (State Water Resources Control Board (SWRCB) 2019).

During the upcoming renewed permit cycle, estimated to begin by 2024, changes to the City's wastewater system will result in a significant improvement to the discharge through the PLOO. By the end of 2027 Phase 1 of the Pure Water San Diego Program (Pure Water) is expected to begin operation. On average, Pure Water will divert up to 52 million gallons per day (mgd) of wastewater away from the PLWTP to produce 30 mgd of water suitable for potable reuse, and up to 11.9 mgd of reclaimed water for non-potable reuse (e.g., irrigation, industrial and commercial uses). This diversion will not only augment San Diego's local water supply; but will also reduce the flow and pollutants discharged through the PLOO.

The purpose of the Essential Fish Habitat (EFH) assessment is to provide the appropriate federal regulatory agencies with information that can be used as the basis to initiate actions that may be required to demonstrate compliance with the provisions of the federal Magnuson-Stevens Fishery Conservation Act, as amended (the MSA). The EFH assessment is intended to compliment an Endangered Species Act assessment that has also been prepared in order that it may be reviewed in concert with the EFH assessment.

The marine environment in the vicinity of Point Loma supports a wide variety of commercial fisheries. These fisheries are protected and managed by the Magnuson-Stevens Fishery Conservation and Management Act and the Sustainable Fisheries Act through their "Essential Fish Habitat" provisions (National Oceanic and Atmospheric Administration (NOAA) 2007, 2014a,b). At the time of preparation of this NPDES application, consultations between EPA and NOAA Fisheries were ongoing regarding Endangered Species and Essential Fish Habitat effects associated with the PLOO discharge regulated under Order No. R9-2017-0007. Due to the timing of finalizing that review and the completion of this application, information from that review could not be included in this renewal application. If necessary, the information presented herein may be augmented in the future for use in any Endangered Species and Essential Fish Habitat assessment that may be necessary in conjunction with the renewal process for Order No. R9-2017-0007.

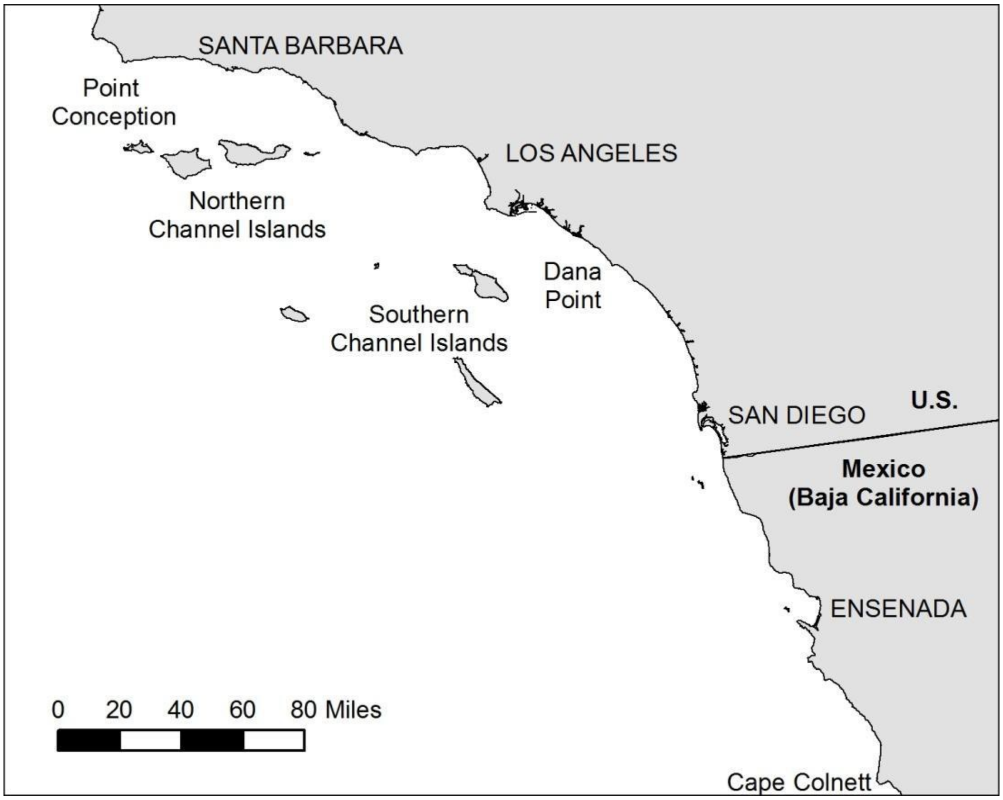
In this assessment, the term "fish" includes both cartilaginous species - sharks, skates, and rays -and bony species. Cartilaginous fish, as the name implies, have a skeleton of cartilage, which is partially calcified, but is not true bone. Bony fish also have cartilage, but their skeletons consist of calcified bone. Fish are generally categorized as pelagic (living in the water column), benthic (living on or near the ocean bottom), or demersal (associated with the ocean bottom, but also feeding in the water column).

The following sections cover the project area, the PLOO, the environmental setting, commercial fisheries, the regulatory background, fishery management plans (FMPs), species descriptions, life history profiles, designated EFH, and potential impacts of the discharge of treated wastewater from the PLOO.

J.1.1 Project Area

The marine waters off the PLWTP are located in the Southern California Bight - a broad ocean embayment created by an indentation of California's coastline south of Point Conception (Figure J-1). The Southern California Bight extends from Point Conception south to Cabo Colnett, Baja California, Mexico, and west to the Santa Rosa-Cortes Ridge. The continental shelf in this area has several submarine valleys and submerged mountains whose peaks form the offshore islands. Submarine ridges and troughs in the Southern California Bight generally run northwest to southeast; with the exception of the east-west trending Santa Barbara Channel.

Figure J-1:
Southern California Bight



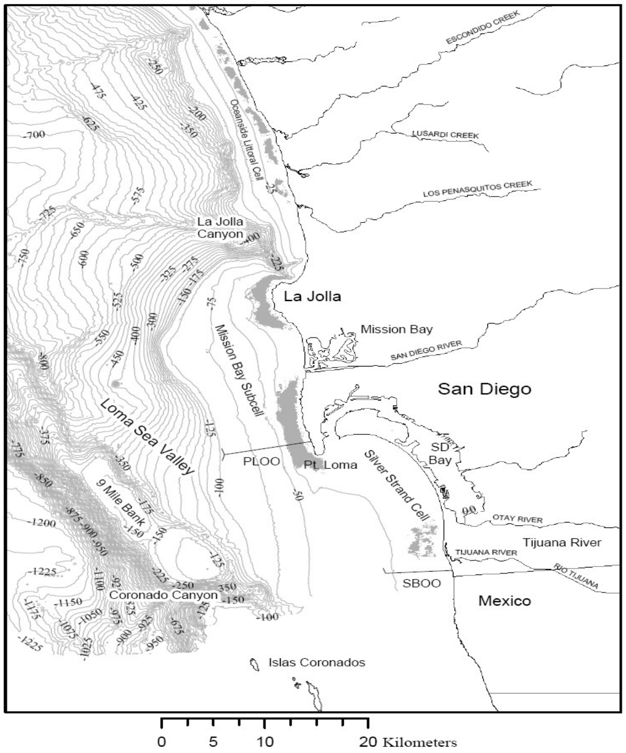
The Southern California Bight's large urban population centers and busy harbors make it one of the most heavily utilized marine ecosystems on earth, yet the Southern California Bight supports a diverse assemblage of marine life including marine algae and plants, invertebrates, fish, sea turtles, marine mammals, sea birds, and a wide variety of habitats (Dailey et al. 1993, Schiff et al. 2000, Leet et al. 2001, Allen et al. 2005, 2006, 2011, Allen and Cross 2006, California MarineLife Protection Act (CMLPA) 2009, Howard et al. 2012, Ranasinghe et al. 2012, Setty et al. 2012, Southern California Coastal Water Research Project (SCCWRP) 2012, 2021a), United States Department of the Navy (USDON) 2013.

Marine habitats in the Southern California Bight range from sandy beaches and rocky coasts todeep, soft- and hard-bottom areas. Intertidal zones include sandy beaches, rocky shores, tidal flats, coastal marsh, and manmade structures. There are nearly 40 tidally-influenced estuaries and lagoons with associated open water, soft bottom, tidal mud flats, and eelgrass beds.

J.1.2 Point Loma Ocean Outfall

The PLWTP treats approximately 140 mgd of wastewater, generated by more than 2.2 million residents and industries (with sourcecontrols) in a 450-square-mile (1,165 square kilometers (km²)) area. The PLWTP's overall capacity is 240 mgd. Treated wastewater is discharged through the PLOO 4.5 miles (mi) (7.2 kilometers (km)) offshore at a depth of approximately 310 ft (95 meters (m)) (Figure J-2; note the grey areas off Point Loma and La Jolla represent kelp beds).

Figure J-2:
Location of the PLOO



The PLOO is one of the longest and deepest ocean outfalls in the world. It was extended to its present location in 1993 and is buried in a trench from shore through the surfzone out to a distance of about 2,600 ft (792 m) offshore. Over the next 400 ft (123 m) the pipeline gradually emerges from the rock trench. Beyond 3,000 ft (914 m) offshore, the remainder of the 4.5 mi (7.2 km) pipeline rests on a bed of ballast rock on the sea floor. The endof the pipeline connects to a perforated "Y" diffuser section of two legs, each 2,500 ft (762 m) long. Wastewater is discharged through diffuser ports ranging in depth from 306 ft (93 m) to 313 ft (95 m). Mathematical models of outfall operation indicate a median (50th percentile) initial dilution of 338:1 at a discharge flow of 240 mgd. The minimum month computed initial dilution (the initial dilution as determined assuming zero ocean currents and using the worst case density conditions from over 13,000 density data profiles) ranged from lows of 202:1 to 206:1, with an average of 204:1.

The deep discharge and high initial dilution traps discharged diluted wastewater at a depth of more than 130 ft (40 m) below the ocean surface (Rogowski et al. 2012). This keeps the outfall plume below the thermocline during periods when it exists and always away from the near-shore environment (Rogowski et al. 2013, City of San Diego (COSD) 2014). Another favorable feature of the PLOO is the location of the discharge near the break in the mainland shelf (Figure J-2). The shelf drops precipitously immediately offshore from the diffuser facilitating plume dispersal.

The pipeline and diffusers with their supporting bed of ballast rock form an artificial reef. The pipe and rock, covered with encrusted organisms (tube worms, anemones, barnacles) provide food and shelter to a variety of fish and invertebrates. This artificial habitat covers an area of about 22 acres (9 hectares) off Point Loma (assuming a 36 ft (11 m) width of pipe and ballast rock) (Wolfson and Glinski 1986).

J.2 ENVIRONMENTAL SETTING

The Southern California Bight is influenced by two major oceanic currents: the southward-flowing, cold-water California Current and the northward-flowing, warm-water California Countercurrent (Perry et al. 2007, California State University, Long Beach (CSULB) 2013). These currents mix in the Southern California Bight and strongly influence patterns of ocean water circulation, sea temperatures, and distributional trends of marine flora and fauna along thesouthern California coast and Channel Islands (Dailey et al. 1993, Schiff et al. 2000, Horn and Allen 1978, Leet et al. 2001, Horn et al. 2006, Miller and Schiff 2012, Ranasinghe et al. 2012, Setty et al. 2012, Koslow et al. 2013).

High species richness is a product of the region's complex oceanographic topography and the convergence of multiple, influential water masses (Noble 2009). These include (1) large scale climate processes such as the El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Pacific Gyre Oscillation (NPGO) that can affect long-term trends (Bjorkstedt et al. 2013, NOAA 2021), (2) the California Current System coupled with local gyres that transport distinct water masses into and out of the Southern California Bight throughout the year,and (3) seasonal changes in local weather patterns. Relatively warm waters and a more stratifiedwater column are typically present during the dry season from May to September while cooler waters and weaker stratification characterize ocean conditions during the wet season from October to April. Winter storms bring higher winds, rain, and waves creating a well-mixed, non-stratified water column. Surface waters begin to warm by late spring and are then subjected to increased surface evaporation. Once the water column becomes stratified, minimal mixing conditions typically remain throughout the summer and into early fall. Toward the end of the year, surface water cooling along with increased storm frequency returns the water column to well-mixed conditions.

The Southern California Bight is home to over 480 species of marine fish and more than 5,000 species of marine invertebrates (Schiff et al. 2000, Allen et al. 2005, 2006, 2011, Allen and Cross 2006, CMLPA 2009, SCCWRP 2012, 2021a). The diversity of fish and invertebrates is greatest in southern California and declines to the north through the region (Horn and Allen 1978, Horn et al. 2006). The Point Loma area is located within a transitional zone between subarctic and subtropical water masses. Point Conception, California (34.5 °North) is the distinguished ichthyofaunal boundary between subtropical species (i.e., species with preferences of temperatures above 50 to 68 degrees Fahrenheit (°F) (10 to 20 degrees Celsius (°C)) of the San Diego Province and temperate fish species (i.e., species with temperature preferences below 59 °F (15 °C) of the Oregon Province (Horn et al. 2006, Suntsov 2012).The California Current system is rich in microscopic organisms (i.e., diatoms, tintinnids, and dinoflagellates) which form the base of the food chain in the area (Hardy 1993). Small coastal pelagic fish and squid depend on this planktonic food supply and in turn are fed upon by larger species. Groundfish (e.g., flatfish, roundfish, skates/sharks/chimeras, rockfish, etc.) are important recreational and commercial species (Love 2006). The shelf and slope demersal rockfish are the most specious genus of fish off the western coast of North America (Love et al. 2002). These fish are typically the dominant species in many ichthyological surveys, in terms of abundance and diversity, especially between the 20 to 200 m isobaths. Highly Migratory Species(HMS) (e.g., tuna, billfish, sharks, dolphinfish, and swordfish) and Coastal Pelagic Species (CPS) (e.g., anchovies, mackerels, sardines, and squids) support extensive fisheries in the area (Hackett et al. 2009).

The diverse habitats of the Southern California Bight greatly influence the distribution of fish and invertebrates in the area (Horn et al. 2006, Miller and Schiff 2012, McClatchie 2014). Cross and Allen (1993) defined fish habitats in three broad categories: the pelagic zone, soft substrate habitats (i.e., bays, estuaries, open coast), and hard substrate and kelp bed habitats (i.e., rocky habitats, reefs). The pelagic zone, relating to open water, is the largest habitat in the area with 40% of the fish species inhabiting this area. This zone is subdivided into three distinct regions: epipelagic (up to 50 m deep), mesopelagic (50 to 500 m deep), and bathypelagic regions (greater than 500 m deep). The epipelagic region is inhabited by small, planktivorous schooling fish (e.g., northern anchovy), predatory schooling fish (e.g., Pacific mackerel), and large solitary predators (e.g., blue shark). Abundance of all epipelagic species changes seasonally with fish moving offshore to spawn. The mesopelagic region is characterized by steep environmental gradients and fish that are small, slow growing, long-lived, and reproduce early and repeatedly (e.g., bigeye lightfish). The bathypelagic zone is a rather uniform region containing large, sluggish, fast growing, short-lived fish, that reproduce late and typically only once (e.g., bigscale and hatchetfish) (Cross and Allen 1993, Love et al. 2009).

Typical fish utilizing soft substrates (sand, silt, and mud) include sharks, skates, rays, smelts, flatfish (flounders), gobies and northern anchovies. Regions with hard substrates and kelp beds(*Macrocystis*) are not as abundant as other benthic habitats in the Southern California Bight, butprovide high productivity habitats for many species.

Shallow reefs (i.e., <30 m depth) are the most common type of hard substrate (i.e., coarse sand, calcareous organic debris, rocks) found in the area. These reefs also support kelp beds, which serve as nursery areas for various fish species. Rocky intertidal regions are often turbulent, dynamic environments, where organisms must cope with stresses associated with tides (e.g., changes in temperature, salinity, oxygen, and pH) and wave impact. Deep reef fish, found along banks and seamounts, are typically large, mobile species (e.g., rockfish and spiny dogfish).

Kelp beds promote a high diversity of fish species (Foster and Schiel 1985, Foster et al. 2013). Smaller fish feed on high plankton densities in the area, while larger fish congregate to feed on smaller ones. Kelp beds are especially important habitats for young-of-the-year rockfish species,such as the kelp rockfish, whose densities positively correlate to the size of the kelp bed.

Inshore areas (bays and estuaries) provide nursery habitats and feeding grounds to a variety of species, some of commercial importance (e.g., California halibut) (Allen et al. 2006). San DiegoBay's seagrass beds are used by schooling species, such as anchovies and topsmelt (Allen et al. 2002) with the highest abundance and biomass of fish occurring in the spring (i.e., April) andsummer (i.e., July). Juvenile northern anchovy, topsmelt, and slough anchovy comprise up to 79% of the fish in the Bay.

The influence of the California Current on the physical and biological environment of the Southern California Bight fluctuates significantly on a year-to-year basis (Noble 2009, Bjorkstedt et al. 2013, Koslow et al. 2013, Miller and McGowan 2013). It is also affected by larger-scale climate variations, such as ENSO, PDO, and NPGO (Dayton and Tegner 1984, 1990, Tegner and Dayton 1987, 1991, Dayton et al. 1992, Hickey 1993, Tegner et al. 1996, 1997, Horn and Stephens 2006, Parnell et al. 2010 and 2019, Miller and Schiff 2012, Miller et al. 2013, NOAA 2021). The El Niño-La Niña Oscillation is the result of interannual changes in sea level pressures between the eastern and western hemispheres of the tropical Pacific; these events caninitiate large shifts in the global climate, atmospheric circulation, and oceanographic processes (Doney et al. 2012, Chenillat et al. 2013, U. S. National Marine Fisheries Service (NMFS) 2013a, NOAA 2021, Sydeman et al. 2013).

El Niño conditions typically last 6 to 18 months although they can persist for longer periods of time. Under normal conditions, rainfall is low in the eastern Pacific and is high over the warm waters of the western Pacific. El Niño conditions occur when unusually high atmospheric pressure develops over the western tropical Pacific and Indian Oceans and low sea level pressuredevelops in the southeastern Pacific. During El Niño conditions, the trade winds weaken in the central and west Pacific; thus, the normal east to west surface water transport and upwelling along South America decreases. This results in increased (sometimes extreme) rainfall across the southern U.S. and Peru and drought conditions in the western

Pacific (Field et al. 2003). La Niña is the opposite phase of El Niño in the Southern Oscillation cycle. La Niña is characterized by strong trade winds that push the warm surface waters back across to the western Pacific increasing upwelling along the eastern Pacific coastline, causing unusually cold sea surface temperatures.

The PDO is a longer-term climatic pattern than El Niño with similar warm and cool phases that may persist for 20 to 30 years (Miller 1996, Benjamin and Carton 1999). PDO warm regimes increases water temperature, giving temporary advantage towarm-water species, allowing them to become more abundant and widespread (CMLPA 2009). PDO cold regimes have the opposite effect, causing cold-water species to grow more abundant and widespread, while warm-water species become less so.

During years experiencing an El Niño event, tropical species (i.e., species with temperature preferences above 68 °F (20 °C)) begin to migrate into the project area, while temperate species, which normally inhabit the area, move north and out of the region (Allen et al. 2005). For example, two tropical species, the Mexican barracuda and scalloped hammerhead shark, were recorded off southern California for the first time during the 1997/1998 El Niño event. Rockfishare particularly sensitive to El Niño, with these events resulting in recruitment failure and adults exhibiting reduced growth. Ultimately, a decline in biomass results and a poor overall conditionin the region becomes evident, such as landings of market squid being dramatically decreased during the 1997/1998 El Niño event (Hayward 2000).

During El Niño years, San Diego Bay often becomes a refuge for subtropical/tropical species that have a normal distribution further south than the study area (Allen et al. 2002). For example, from April 1997 through July 1998, three new fish (bonefish, yellowfin goby, and longtail goby) and three new invertebrate species (arched swimming crab, Mexican brown shrimp, and a bivalve species (*Petricola hertzana*)) were recorded in the southern California estuaries of the San Diego coastal region (i.e., Tijuana Estuary and Los Peñasquitos Lagoon), while northern anchovy, the dominant species in San Diego Bay, was virtually absent during the El Niño event. Southern species moving into these areas are typically incapable of reproducing or establishing permanent populations due to the short-term nature of these events.

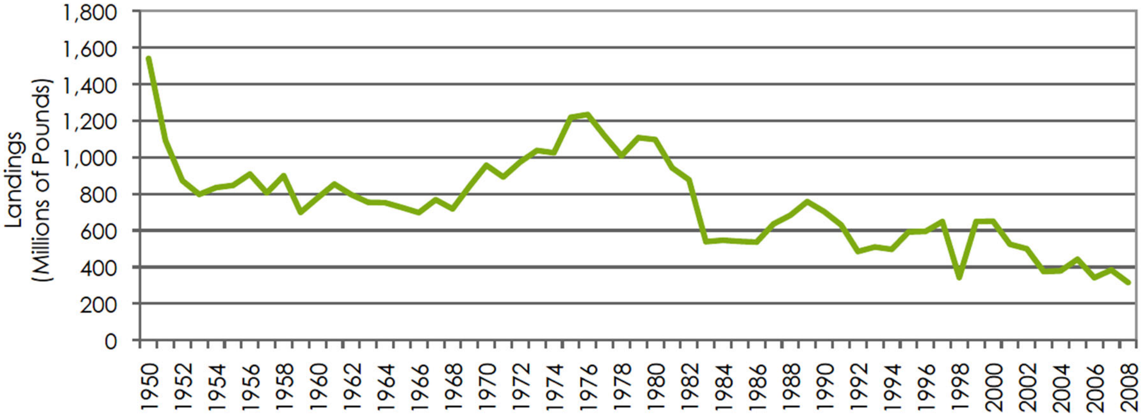
Past La Niña events have not had such a dramatic impact on ichthyofauna and marine invertebrate populations as El Niño events. Nevertheless, La Niña years can result in below normal recruitment for many invertebrate species (e.g., rock crabs), and larval rockfish abundance has been reportedly low during years experiencing La Niña events (Lundquist et al. 2000). Cooling trend years have increased abundance and commercial landings of herring, anchovies, and squid populations (Hayward 2000; Lluch-Belda et al. 2003, Zeidberg et al. 2006.

J.3 COMMERCIAL FISHERIES

Fisheries along the California coast have historically targeted over 285 species in four main groups: groundfish, coastal pelagic fish, highly migratory fish, and invertebrates (California Fisheries Fund 2014). Changing economic conditions and management restrictions have significantly reduced commercial fishing and fishery landings over the last half century

(Figure J-3, from Port of San Diego 2009).

Figure J-3:
California Commercial Landings: 1958-2008



Commercial fishing has been affected by seasonal closures, quota reductions, and restrictive long-term stock-building plans (CMLPA 2009). Salmon fishing quotas diminished following the listing of five California salmon population types under the federal Endangered Species Act (ESA). Tuna landings have fallen with the relocation of the fishery to less costly venues in Samoa and Puerto Rico. And decreasing abalone stocks led to the total commercial fishing ban of abalone south of San Francisco in 1997.

When reviewing the commercial fish landings in very recent years (Calendar Year 2020 forward), it must be put into context with the recent and ongoing coronavirus pandemic. With restaurants and supply chains disrupted due to the pandemic commercial fish landings were severely reduced. Sales of fishing gear was down as much as 95% as many commercial boats have simply stayed dockside (Rutgers University 2020, Reiley 2020).

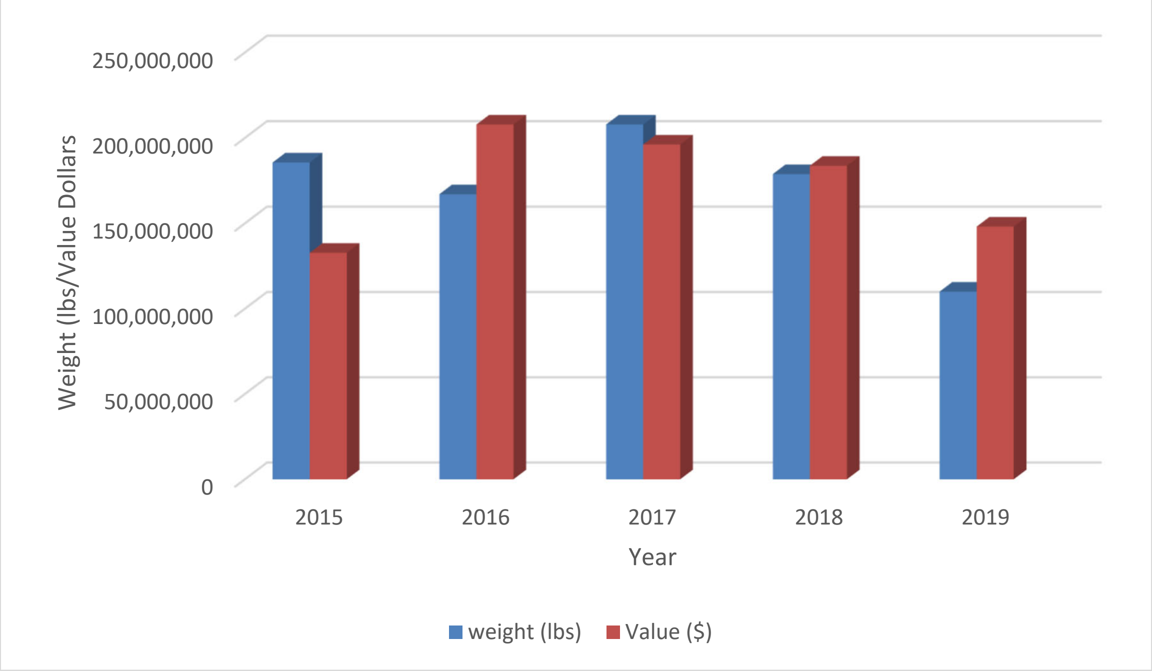
Increasing regulation will likely reduce fisheries catch and landings in the future. The California Marine Life Management Act (MLMA) resulted in permit suspensions in the nearshore fishery and further access restrictions were imposed by the squid management plan (California Department of Fish and Wildlife (CDFW) 2014e). The CMLPA authorized new protections for ocean habitats and wildlife. It created a network of marine protected (fishing-restricted) areas along the coast to help revive depleted fish stocks (National Ocean Economics Program (NOEP) 2005, 2009). The increasing use of waterfront property for recreational boating, tourism, and housing limits the availability of shore-side space for commercial fishing support facilities.

Despite the general decline of landings in California, some fisheries have been relatively resilient. For example, increased international demand for squid has enhanced landings during non-El Niño years, attracting participation from former salmon fishermen. Specialized fisheries for sea urchin, sea cucumber, Pacific herring, and live rockfish have grown in recent years as well (NOEP 2009, Hackett et al. 2009).

Even though the commercial fishing industry in San Diego has contracted, local landings continue to be important to the regional economy. There have been more than 130 commercial fishermen in San Diego whose catch includes lobster, sea urchin, swordfish, spot prawn, white sea bass, rockfish, rock crab, shark, and tuna. In 2009, the Port of San Diego developed and began implementing a Commercial Fisheries Revitalization Plan to address the economic opportunities and potential constraints facing the local commercial fishing industry (Port of San Diego 2009).

From 2015 through 2019, California commercial fisheries landings continue to be 100 to over 200 million pounds per year (Figure J-4). The value of the California commercial fisheries catch varied during the period from $130 million to nearly $200 million (Figure J-4). The value is ex-vessel, that is, whole fish at wholesale price. The overall economic contribution of the product may be as much as three to four times higher as it passes through the economy (NOEP 2005, 2009, Hackett et al. 2009). Variations in the species caught and total pounds landed can be influenced by episodic changes in large scale ocean conditions such as warming events (California Office of Environmental Health Hazard Assessment (OEHHA) 2020, Parnell et al 2019). Additionally, market demand can impact the number of active commercial fisherman, thereby lowering the landings, such as the severe negative impact the COVID-19 pandemic had on commercial fishing (Rutgers 2020, Reiley 2020).

Figure J-4:
California Commercial Fisheries Landings and Value 2015 - 2019



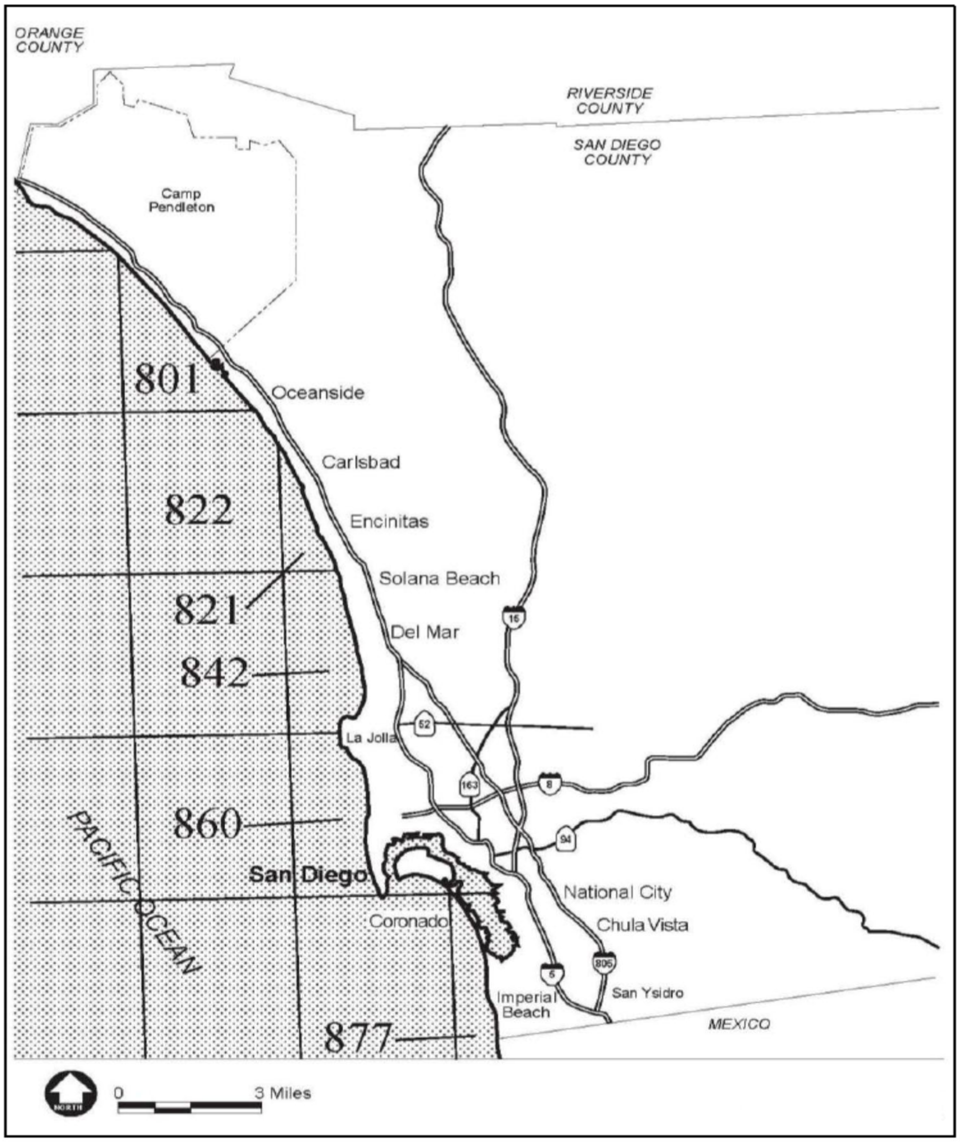
The major commercial fisheries of the Southern California Bight, their seasons, and harvest gear are listed in Table J-1.

Table J-1:
Commercial Fisheries Groups, Seasons, and Harvest Methods

Fishery	Season	Harvest Methods
Coastal Pelagic Species		
Anchovy, mackerels, sardine, squid	Year round, seasonal by species, some with harvest guidelines	Purse seine, drum seine, gillnet, dip net, some line gear (mackerel)
Highly Migratory Species		
Tunas, sharks, billfish, swordfish, dolphin	Year round, seasonal by species and region	Gillnet, purse seine, set net, drift net, troll, hook and line, harpoon (swordfish)
Groundfish Species		
Flatfish, rockfish, thorneyheads, roundfish, scorpionfish, skates, sharks, chimeras	Year round, seasonal by species and region	Trap, troll, gillnet, set net, hook and line
Other Finfish		
CA halibut, CA sheephead, white seabass	Year round, seasonal by species	Set gillnet, drift nets, trap, hook and line
Invertebrates		
Lobster, urchin, prawn, crab, shrimp	Year round, seasonal by species	Trap and diver

Fishery catch statistics are reported for large fishery blocks, providing sufficient ambiguity to protect commercial fishers' "secret spots." Additionally, reported landings can be redacted by CDFW in accordance with confidentiality requirements in California Fish and Game Code §8022. Fish blocks are 9- by 11-mi rectangles. Figure J-5 depicts CDFW nearshore fish blocks in the San Diego area

Figure J-5:
San Diego Nearshore Fish Blocks



From catch data supplied by commercial fishermen, CDFW accumulates the weight and dollar value of commercial fish landed by species in California. The fish block off Point Loma is block 860. Historically sea urchin, market squid and lobster have dominated the catch by weight in block 860. An example of fish catch for block 860 for 2019 is presented in Table J-2.

Table J-2:
Yearly Fisheries Catch Reported from Fish Block 860 (lb)

Species	2015	2016	2017	2018	2019
Bonito, Pacific	26	453			511
Cabezon	153	33	152	208	
Crab, armed box				92	
Crab, box				126	33
Crab, rock	37,242	9,991	14,762	76,541	41,358
Crab, spider	7,233	7,805	8,039	14,250	12,111
Dolphinfish	451		171		
Eel, moray	168				
Halibut, CA	1,274	4,296	14,843	12,217	6,632
Lingcod	36	52	36	145	136
Lobster, CA	119,201	96,253	117,798	111,890	90,155
Mackerel, Jack					252
Mackerel, Pacific	218		350	1241	2,857
Mackerel unspecified				320	
Octopus	351	1,113	203	377	219
Rockfish, all	3,254	1,177	1,128	1,090	3,805
Sablefish	75	306			
Scorpionfish, CA	29		9		
Sea cucumber			10,567	9,945	9,403
Seabass, white	1,428	7,284	3,799	3,974	6,739
Shark, Pacific angel				360	

Species	2015	2016	2017	2018	2019
Shark, shortfin mako	751	1,277		2,598	
Shark, soupfin					415
Shark, thresher	1,883	3,126			214
Sheephead	19,165	9,728	10,657	16,039	13,395
Snail, top		334			157
Surfperch				129	237
Swordfish				9,977	4,335
Tuna, bluefin	1,649	6,249	3,014	2,828	5,998
Tuna, yellowfin	1,827		93		663
Urchin, purple			5480		
Urchin, red	311,235	189,981	87,168	85,634	347,151
Whelk, Kellet	3,306	9,879	5,623	17,284	19,230
Whitefish, ocean	235	54	108	679	1,346
Yellowtail	11,762	9,596	4,897	2,487	2,500

Source data: CDFW 2021
Note: Some species/data may be absent from the table due to redactions by CDFW in accordance with confidentially requirements set by Fish and Game Code 8022. As such areas in the table may be left empty.

Other catch reported as taken by commercial fisherman during 2015-2019 in block 860; but not shown in Table J-2 because the total weight of the catch may have been redacted include: Mackerel (unspecified), jack Mackerel, Jacksmelt, leopard Shark, soupfin Shark, bat Ray, shouvelnose Guitarfish, Jacksmelt, speckled Sanddab, Sanddab, Rockfish (unspecified and several other species), Thornyheads, Triggerfish, Opah, Opaleye, Blacksmith, black Surfperch, rubberlip Surfperch, top Snail, spot Prawn, and California Barracuda.

Many commercially important fisheries species are taken in block 860. Not all fish caught from block 860 are brought to port (landed) in San Diego. For example, historically market squid from block 860, as well as other areas off the San Diego coast, has been taken by Los Angeles area fishing vessels that return to ports in that area to offload their catch. So, the proportion of the catch from block 860 that contributes to San Diego's economy cannot be completely quantified. However, landing data are collected at the two harbors adjacent to Point Loma: Mission Bay and San Diego Bay. Landings at these locations include block 860 and other adjacent locations off the San Diego coast. This data provides an estimate of the economic contribution of the local fisheries to the local economy.

The annual dollar value for the top 6 commercial fisheries species landed at Mission Bay and San Diego Bay from 2015 to 2019 is presented in Table J-3.

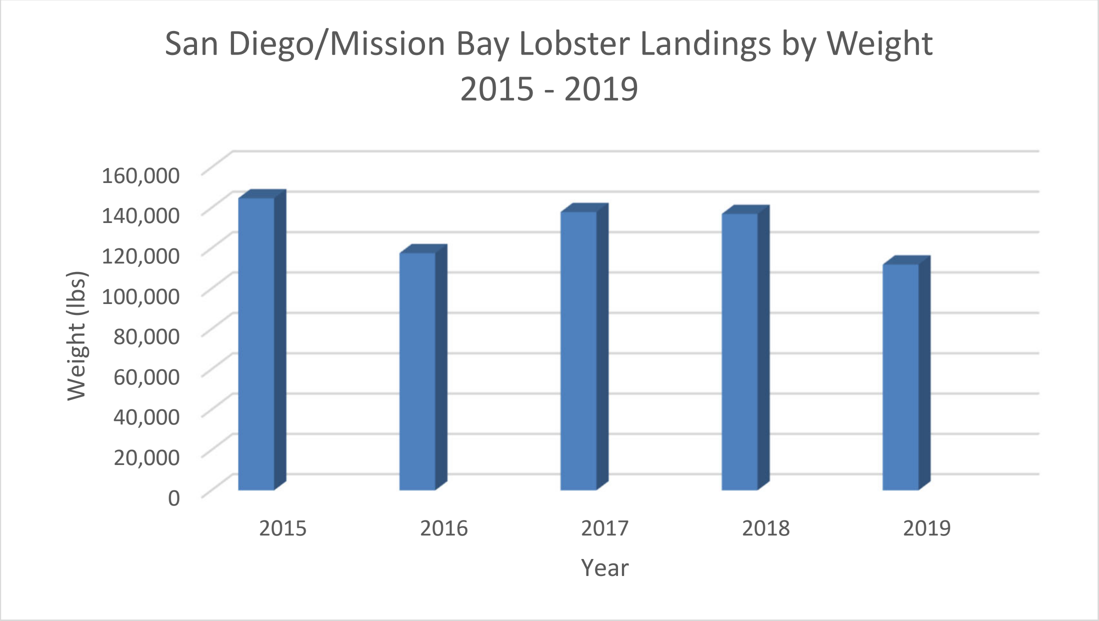
Table J-3:
Top 6 Fisheries Species Value at Mission Bay/San Diego Bay 2015 - 2019

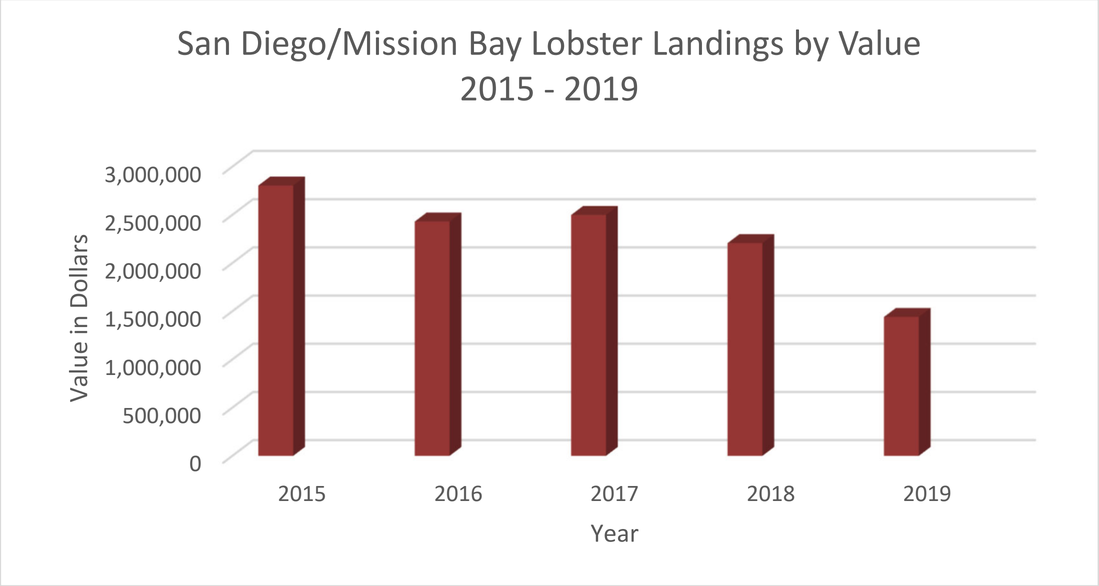
Species	2015	2016	2017	2018	2019
Lobster	$2,804,978	$2,431,036	$2,499,424	$2,207,285	$1,441,296
Tuna, Bigeye	$1,715,853	$2,002,529	$2,007,305	$2,704,457	$3,475,039
Urchin	$549,172	$305,114	$187,979	$222,592	$813,155
Spot Prawn	$473,774	$1,032,791	$921,480	$1,011,066	$741,451
Swordfish	$330,962	$874,290	$706,135	$838,031	$766,890
Opah	$385,881	$475,907	$350,589	$475,907	$565,132

Source data: CDFW 2021

California spiny lobster has historically been a premier commercial catch in San Diego. Figure J-6 shows the weight and value of lobster landed at Mission Bay and San Diego Bay from 2015-2019.

**Figure J-6:
San Diego/Mission Bay Lobster Landings by Weight and Value 2015 - 2019**





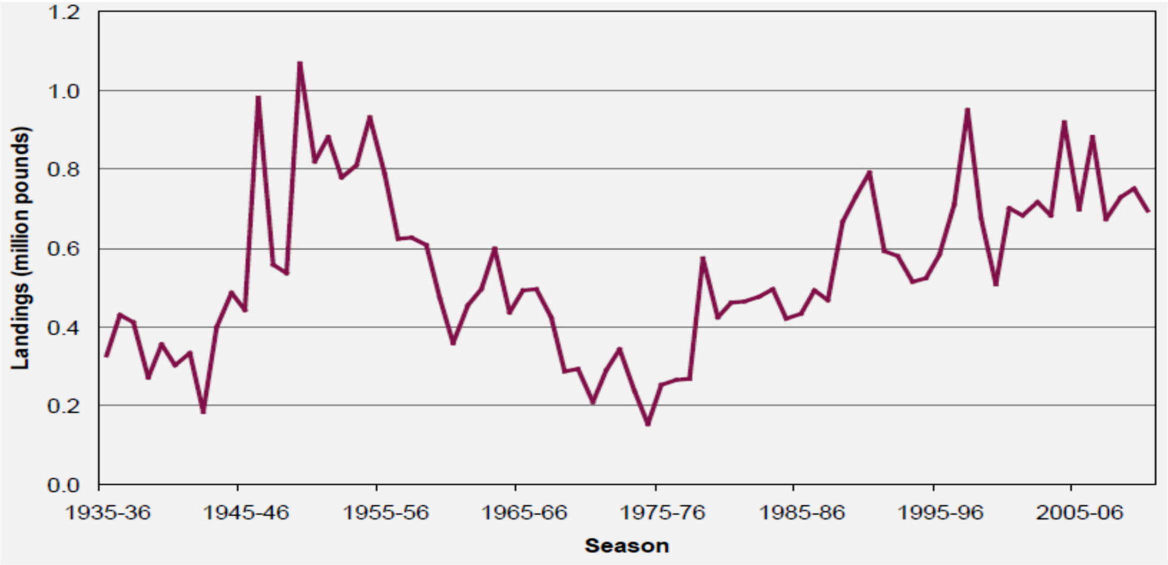
Source data: CDFW 2021

The wholesale value of lobster landed at Mission Bay and San Diego Bay averaged about $2.3 million per year during the period 2015-2019. This represented a large percentage of the total value of all commercial species landed in San Diego County.

The California spiny lobster (*Panulirus interruptus*) ranges from Monterey, California south to Magdelena Bay, Baja California (Mai and Hovel 2007). They occur from the intertidal zone to a depth of about 200 ft (60 m) and are usually associated with eel grass and kelp beds in rocky areas (Leet et al. 2001). Spiny lobster are a major predator of benthic invertebrates including mussels and sea urchins and act as a keystone species along rocky shores and in kelp forests. Primary predators of lobster include sheephead and black sea bass (Neilson 2011). Lobster are nocturnally-active, sheltering under rocks and in crevices during the day and foraging at night. The females migrate to shallow water during spring and summer to spawn; in fall they move to deeper water to mate.

Lobster have been fished commercially in California since the late 1800s. They are caught in traps set along the inner, middle, and outer edges of kelp beds, and over hard-bottom, mostly in depths of 30 to 120 ft (9 to 36 m) (CDFW 2014f). Open season runs from the first Wednesday in October to the first Wednesday after March 15. Early in the season traps are set from just outside the surf line to the inner edge of kelp beds. As winter storms approach, traps are moved farther offshore into the kelp bed and along their outer edge. Figure J-7 presents California Spiny Lobster Commercial Landings from 1936-2011.

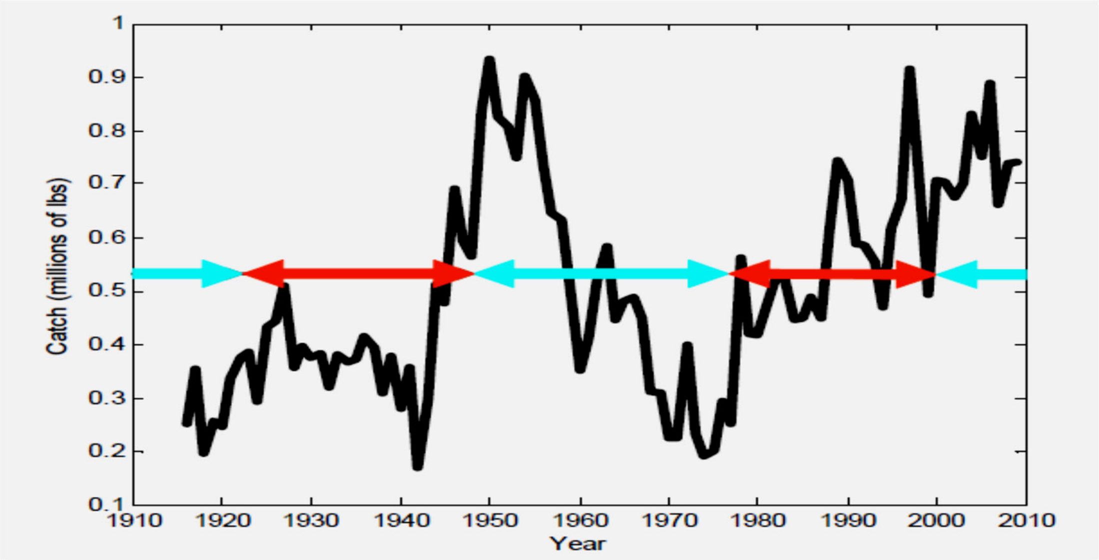
Figure J-7:
California Spiny Lobster Commercial Landings from 1936-2011



Source: CDFW 2013a

The lobster catch in California is influenced by the prevailing oceanographic regime. Figure J-8, from Neilson 2011, contrasts periods of warm and cold water associated with the PDO with lobster landings from 1916 to the 2010.

Figure J-8:
Warm and Cold Water Regimes and Historical Lobster Catch

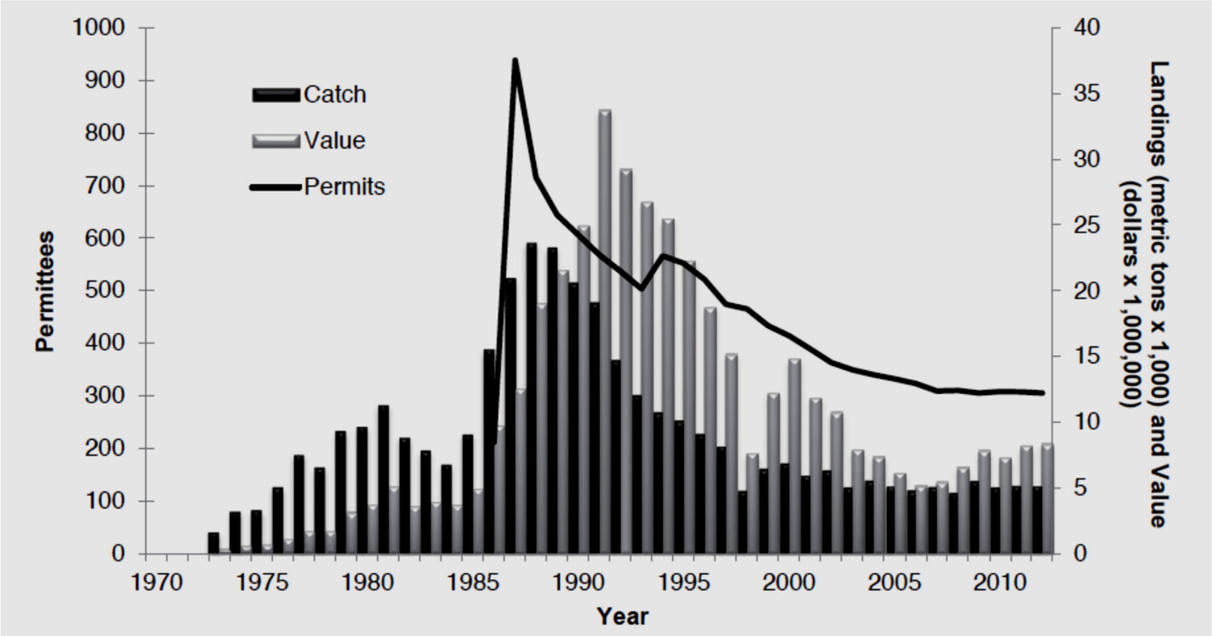


Source: Neilson, 2011

Another historically valuable marine organism landed at Mission Bay and San Diego Bay is sea urchin (Table J-3). Sea urchin are harvested for their roe, which is known as “uni”. Harvesting is done by divers, usually in or around kelp bed, at depths of 30-70 ft (9-21 m) using a hookah breathing system connected to a surface vessel or platform.

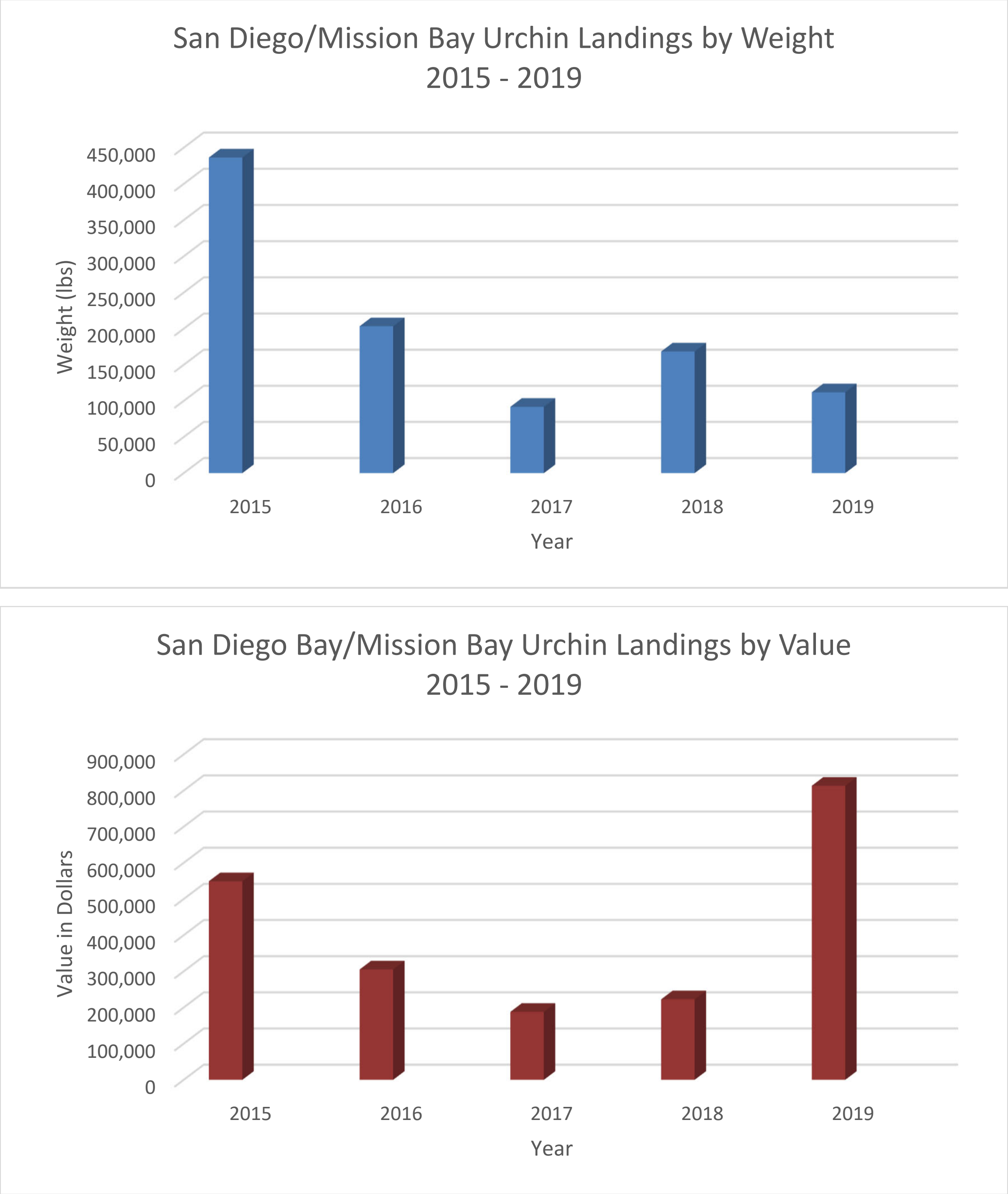
The overall California catch of sea urchin has varied considerably during the past 40 years (Figure J-9, from California Cooperative Oceanic Fisheries Investigations (CalCOFI) 2013). Variations are due to a number of factors including limited development of the fishery prior to the mid-1980s, a strong 1982-1983 El Niño, a rush into the unrestricted fishery precipitated by a rapidly developing Japanese market for “uni” during the late 1980s and early 1990s, subsequent limited access permitting in response to resource depletion combined with weak El Niños in 1987 and 1992, and additional catch restrictions. The continued diminished urchin harvests in 1997-1998 were a result of the loss of kelp, their primary food source, during the prevailing strong El Niño (Wolfson and Glinski 2000). Recently the urchin population off San Diego was decimated following the warm water period of 2014-2016 due primarily to lack of kelp as their food source. The warming ocean waters, due to an episodic change in currents, had severely damage the kelp forests in the area by 2016. They have since begun to recover and as a result Urchin recruitment appears to be strong (Parnell et al 2019). Figure J-10 shows San Diego Bay/Mission Bay urchin landings by weight and value from 2015-2019.

Figure J-9:
California State Urchin Catch 1970-2012



Source: CalCOFI, 2013

Figure J-10:
San Diego Mission Bay Urchin Landings by Weight and Value 2015 - 2019



Source data: CDFW 2021

Both the lobster and urchin fisheries occur near or in the kelp beds, which are limited to maximum depths of about 90 ft (18 m) over consolidated bottom (out to about 1 mi (1.6 km) from shore). Thus, these fisheries take place at a distance of 3.5 mi (5.6 km) or greater from the PLOO.

Swordfish has been another valuable seafood commodity landed at Mission Bay and San Diego Bay during the 5-year period from 2015-2019. Swordfish (*Xiphias gladius*) are found in tropical and temperate ocean waters (Leet et al. 2001, NOAA 2021h). They migrate north from Baja California into California coastal waters in springtime then move south in the fall to spawn and over-winter. Swordfish grow to 1,200 lbs (544 kg) and 14 ft (4.3 m) in length. Adult swordfish eat squid and pelagic fish. They are caught near the surface, mostly at night.

Swordfish are taken well off Point Loma every year. Prior to the early 1980s harpooning swordfish at the surface was the primary harvest method. Only a few boats still use harpoons. West coast longliners are prohibited from fishing in the Exclusive Economic Zone, or anywhere for swordfish using this method.

Spot prawn consistently rank as a valuable seafood landed at ports adjacent to Point Loma from 2015-2019. Spot prawn (*Pandalus platyceros*) are shrimp. They have four bright white spots, hence the name. As of 1 April 2003 the use of trawl nets to take spot prawn has been prohibited. The season for spot prawn south of Point Arguello, Santa Barbara is closed November 1 through January 31. Today, most spot prawn are caught in traps set on the sea floor at depths of 600-1,200 ft (183-366 m). Much of the spot prawn catch off Point Loma goes to supply restaurants featuring live display.

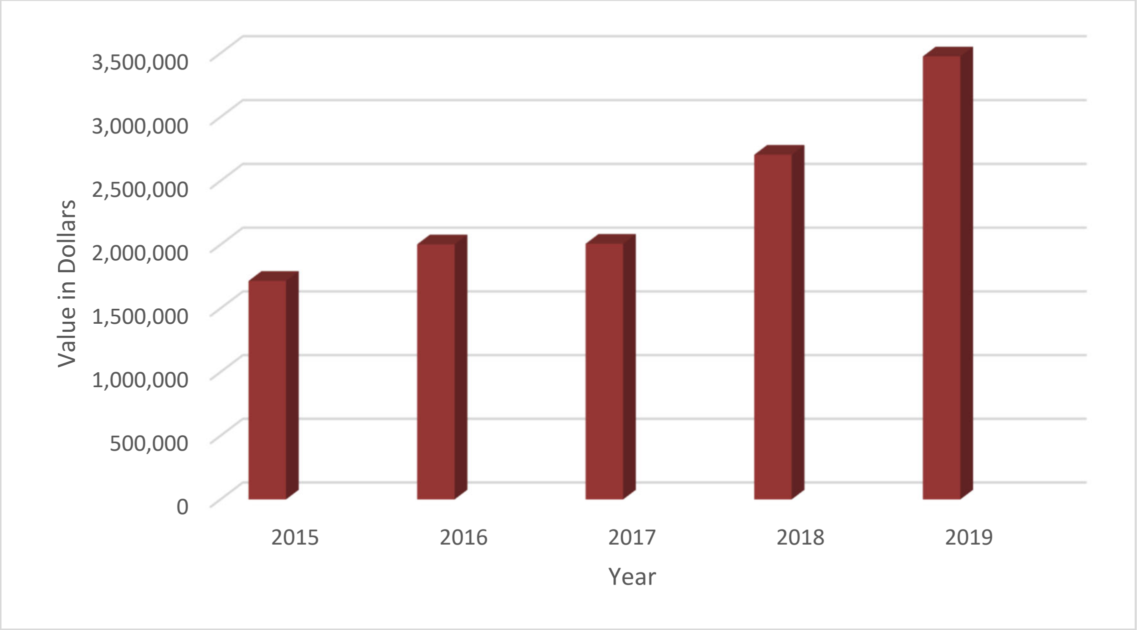
Over the past 25 years there has been a steady increase in demand for "live" finfish. This began primarily to serve members of the Asian community and has since grown to include many markets and Asian restaurants. The "live" finfish industry has grown as an alternate, off-season opportunity for many in the lobster fishery and increased in 1994 with the gillnet closure within 3 nautical miles (nm) (5.6 km) of shore. Traps will catch practically any species willing to enter a small space for food. The primary target species generally weigh 1-3 pounds (lb) (0.5-1.4 kg) and include sheephead, halibut, scorpionfish, cabezon, lingcod, and several members of the genus *Sebastes* (rockfish). These live fish, presented in salt water aquaria for individual selection, bring several times the value of their filleted colleagues. A "Nearshore Finfish Trap Endorsement" is required to catch finfish in baited traps for the "live" market.

Sheephead have historically been a valuable commercial catch landed at Mission Bay and San Diego Bay. The California sheephead, *Semicossyphus pulcher*, is a large, colorful wrasse. Male sheephead reach a length of 3 ft (0.9 m), a weight of 36 lb (16 kg), and have a white chin, black head, and pinkish to red body. Females are smaller, with a brownish red to rose-colored body. California sheephead begin life as a female with older, larger females developing into secondary males. Female sexual maturity may occur in 3 to 6 years and fish may remain female for up to 15 years. Timing of the transformation to males involves population sex ratio as well as size of available males and sometimes does not occur at all (Leet et al. 2001). California sheephead show high site fidelity and a small home range, but increase their movement range with warmer seasonal waters (Topping et al. 2006). Populations of California sheephead off southern California have declined because of fishing pressure. Large males are now rare because they are sought by recreational spear fishermen. Sheephead are taken commercially by traps and kept alive for display in restaurant aquaria where patrons select a specific fish for preparation. Although most commercially landed sheephead are caught by trap some are taken by hook-and-line, and also as bycatch in the gill net fishery. The red color and soft, delicate flesh are especially prized in Asian cuisine.

During 2015 – 2019 two other species became among the top value landings at ports in the San Diego Area: Bigeye tuna and Opah.

Bigeye tuna (*Thunnus obesus*) occur in tropical waters in both the Western and Eastern Pacific. They can be found offshore, as well as inshore rocky reef areas. Whereas they can be found off California, episodic changes warm ocean water currents most likely resulted in their appearance in greater numbers near San Diego in recent years. They are considered a good seafood choice because they are sustainably managed and harvested under U.S. regulations. They are taken by hook and line, pelagic long line, troll gear and purse seine. Populations in the eastern Pacific hit a low in around 2004; but have now recovered and are above its target population level (NOAA 2021f). Although not always seen in large numbers in previous years, during 2015 – 2019 they were the number two fish in value landed at Mission Bay/San Diego Bay (Table J-3, Figure J-11).

Figure J-11:
Mission Bay/San Diego Bay Bigeye Tuna Landings by Value 2015 - 2019



Source: CDFW 2021

Opah (*Lampris guttatus*) are also known as moonfish. They also are considered a good seafood of choice. Also preferring warm waters it is assumed that the increase in their landings in the San Diego area are also a result of episodic current changes. Although they have never been assessed there is no evidence that populations are in decline or that fishing rates are too high. Despite the opah's value to commercial and recreational fishermen, little research on the basic biology and ecology of opah has been conducted. To begin to fill some of the data gaps, NOAA's Southwest Fisheries Science Center began collecting biological samples from opah in 2009 and initiated an electronic tagging program in 2011. Scientists hope to continue tagging opah to learn about their movements and range. This research will provide the basic life history information necessary for future population assessments and management. While there is no directed fishery for opah, they are harvested in small but significant quantities. U.S. fishermen catch them incidentally in tuna and swordfish fisheries around the U.S. Pacific Islands and off southern California (NOAA 2021g).

Other notable commercial fisheries in San Diego marine waters include rock crabs, sea cucumbers, Kellet's Whelk, rockfish, thornyheads, white seabass, California halibut, albacore, thresher shark, sablefish, hagfish, market squid, sardines, anchovies, mackerel, and mariculture.

Rock crabs off Point Loma are mostly caught in traps at depths out to 300 ft (90m). The predominant species taken is the yellow rock crab, *Cancer anthonyi*. They range from Magdalena Bay, Baja California to Humbolt Bay, California, but are abundant only as far north as Point Conception. In southern California, rock crab are most common on rocky bottoms at depths of 30-145 ft (9-44 m), but are also found on open sandy bottoms where they partially bury themselves when inactive. Over sand, adults feed on live benthic prey and scavenge dead organisms that fall to the bottom.

Two species of sea cucumbers are taken in the commercial fishery: the California sea cucumber (*Parastichopus californicus*), also known as the giant red sea cucumber, and the warty sea cucumber (*P. parvimensis*). They inhabit the low intertidal to 300 ft (90 m) deep. Sea cucumbers feed on organic detritus, sea stars and other small invertebrates. The warty sea cucumber is fished almost exclusively by divers, and populations at fished sites have declined due to fishing mortality (Schroeter et al. 2011). The California sea cucumber is caught principally by trawling in southern California. A special permit to commercially fish for sea cucumbers was required beginning with the 1992-1993 fishing season. There is no significant sport fishery for sea cucumbers in California and sport fishing regulations forbid their take in nearshore areas in depths less than 20 ft (6 m) (Leet et al. 2001).

Kellet's Whelk (*Kelletia kelletii*) is a large subtidal snail that occurs intertidally to 230 ft (70 m) on rocky reefs, gravel bottoms, kelp beds, and sand from Baja California, Mexico to Monterey Bay (Leet et al. 2001). The Kellet's whelk fishery is growing rapidly. They cannot be taken within 1,000 ft (305 m) from the shore, except incidentally by lobster and/or rock crab traps.

Rockfish are non-migratory, and many species of rockfish are caught in the offshore area of Point Loma. Numerous rockfish stocks in both northern and southern California are considered depleted, and in an effort to better regulate the stocks, rockfish were divided into nearshore, shelf and slope groups in 2001. The shelf group is comprised of 32 fish of the genus *Sebastes*. They are most commonly caught by trap and hook and line over the continental shelf from depths of 120-900 ft (36-274 m). Live catches bring top prices and are often sold live to Asian restaurants.

Shortspine thornyheads (*Sebastolobus alascanus)* are found off California in waters ranging from 100-5,000 ft (30-1524 m) deep. They migrate to deeper water as they grow and are closely associated with the bottom. They are usually fished from bottom waters 1,200-4,200 ft (366-1,280 m) deep with peak abundance generally in the 1,800-3,000 ft (547-914 m) range. Like rockfish, they are members of the family Scorpaenidae and are primarily exported to

Japan for sushi.

White seabass (*Atractoscion nobilis*) are the largest members of the croaker family (Sciaenidae) in California. They can grow to 90 lb (41 kg), although fish over 60 lb (27 kg) are rare. Adults school over rocky areas or near and within kelp beds. They can be caught at the surface and to depths of nearly 400 ft (122 m). Other common names for white seabass are king croaker, weakfish and sea trout (juveniles).

California halibut (*Paralichthys californicus*), a regular component of the fisheries catch off Point Loma, are a prized, non-schooling flatfish. Known as the left-eyed-flounders, about 40% are actually right-eyed. They range from Baja California to British Columbia. Halibut feed almost exclusively on anchovies and other small fish. They spawn in shallow waters from April to July. In the San Diego area, they are caught in depths to about 300 ft (91 m) by hook and line, directed longline, and set gill nets in federal waters (>3 nm (5.6 km)). The best catches are usually in springtime over sandy bottom. The fishing season is mid-June to mid-March. California halibut range in size up to a maximum of about 70 lb (32 kg), although most are much smaller.

Albacore (*Thunnus alalunga*) are found worldwide in temperate waters; in the eastern Pacific they range from south of Guadalupe Island, Baja California to southeast Alaska (Eschmeyer et al. 1985). Their food varies but consists mostly of small fish, and sometimes squid and crustaceans. In southern California albacore are usually found 20-100 mi (32-160 km) offshore. Normal catch size is 20-40 lb (9-18 kg). Albacore is the most abundant tuna caught in commercial fisheries and recreational fisheries in California and along the West Coast. In the commercial fishery albacore are caught primarily using hook and line gear (jigs, bait, or trolling), but they are also taken in drift gill nets or round haul gear.

Thresher shark (*Alopias vulpinus*) is the most common and valuable shark taken in California commercial fisheries. Commercially-caught thresher shark are principally taken in offshore gill net fisheries.

Sablefish (*Anoplopoma fimbria*) are caught by trawls, nets, trap, and hook and line. Different regulations apply for each method. Sablefish are found in depths of 900-4,200 ft (274-1,280 m), with greatest densities in the 1,200-1,800 ft (366-549 m) range. Sablefish can live 50 years and can weigh up to 126 lb (57 kg). They enter the fishery as early as 1 year of age and most are taken by the trawl fishery by years 4 - 6, at a weight of less than 25 lb (11 kg). Traps and long-line hook fisheries generally catch the older, larger fish. Most of the catch is exported to Japan where it is served as sushi. In the U.S., sablefish are often marketed as black cod, the smaller ones are often filleted and sold as butterfish.

The Pacific hagfish (*Eptatretus stoutii*) is the target of an emerging commercial fishery in California (Bell 2009). Hagfish are unlike any other saltwater finfish. They have four hearts and up to 16 pairs of gill pores along their body. Hagfish feed on dead and dying fish and marine mammals, burrowing into their prey by making a hole with their rasping teeth, or entering through an existing opening (e.g., mouth or gills). They consume prey from the inside, leaving only skin and bones when finished. Moving with a snakelike motion, using their paddle-shaped tails, hagfish resembles an eel, but are not related. The hagfish produces large quantities of slime when agitated, giving it the common name "slime eel." Hagfish occur at depths ranging from 30-5,600 ft (9-1,707 m), but are more common at depths exceeding 300 ft (90 m). The California fishery began in 1982, when Koreans were looking for outside sources of hagfish due to local depletions. Prior to this, California fishermen had only considered hagfish a nuisance because they would eat and destroy their bait and catch. Commercial fishermen usually fish for hagfish at depths of 300-1,800 ft (90-589 m) using strings of baited traps.

The California market squid (*Loligo opalescens*) has been harvested since the 1860s and can be the largest fishery in California in terms of tonnage and dollars since 1993 (Zeidberg et al. 2006). They are sensitive to warm water temperatures and the catch declines with warm water events. Squid landings decreased substantially following the large El Niño events in 1982-1983 and 1997-1998, but not the smaller El Niño events of 1987 and 1992. Market squid are small (6 inch mantle length). They occupy the middle trophic level in California waters, and can be found both inshore and in offshore pelagic waters. They may be the state's most important marine forage species. They are short-lived (about 10 months). Market squid are primary prey for at least 19 species of fish, 13 species of birds, and six species of mammals (Morejohn et al. 1978).

Since the decline of the anchovy fishery, market squid is occasionally the largest biomass of any single marketable species in the coastal environment of California. The majority of squid landings occur around the California Channel Islands, from Point Dume to the Santa Monica Bay, and in the southern portion of the Monterey Bay (Zeidberg et al. 2006). The fishery has varied through the years due to El Niño events and rapid fluctuations in market value. El Niño events have traditionally depleted the market squid fishery and driven up the value due to poor landings (Leet et al. 2001). They are generally caught near the surface, but can be found to depths of 800 ft (244 m). During the 1990s, purse seines became the dominant gear used to harvest market squid. They are considered a good seafood choice because they are sustainably managed and responsibility harvested under U.S. regulations. Most all market squid caught off San Diego are taken to ports in the Los Angeles.

Sardines (*Sardinops sagax*) are small, pelagic, schooling fish that are members of the herring family. The California fishery peaked in 1936-1937 and vanished from southern California during the 1950s. Fishing pressure was first suspected as the cause, but it was subsequently determined that cooling ocean temperatures contributed to the decline. The late 1990s warm water cycle has brought the sardine back to southern California, where the purse seine fishing season for sardines now runs year-round.

Northern anchovy (*Engraulis mordax*) are small, short-lived pelagic fish found throughout the eastern Pacific Ocean. They are active filter feeders, and consume various types of plankton. Anchovies are ecologically important as prey for many species of birds, mammals, and fish. Historically in California, anchovy supplied a large reduction fishery, which produced fish meal, oil, and soluble protein. They are currently utilized for human consumption, bait, and pet food. Large-scale anchovy landings were first seen in the early 1900s during times of low sardine availability. Commercial landings have been low since the 1980s due to market constraints rather than biological factors.

Pacific mackerel (*Scomber japonicus*) are a schooling seasonal species in the San Diego area. In the eastern Pacific they range from Chile to the Gulf of Alaska. They feed on larval, juvenile and small fish, and, occasionally on squid and crustaceans. Dense schools of Pacific mackerel are caught in surface waters by the purse seine fleet. Most Pacific mackerel caught off California weigh less than 3 lb (1.4 kg). This fish is known as a "wet fish" because it requires minimal processing prior to canning. The catch is mainly targeted for human consumption and for use as pet food. A small amount is sold at fresh seafood markets.

Giant kelp (*Macrocystis pyrifera*) has been harvested from the Point Loma kelp bed since 1929 by cutter barges that harvest the upper kelp canopy down to a depth of about 4 ft (1.2 m) below the water surface. During the 1980s and 1990s it was the single most valuable fishery in the vicinity of Point Loma because of the high value of products created from it. Algin, extracted from kelp, is used as a binder, stabilizer, and, emulsifier in pharmaceutical products, in cosmetics and soaps, and in a wide variety of food, drink, and industrial products (McPeak and Glantz 1984). Some of the statewide kelp harvest is also used to feed abalone in mariculture operations (MBC 2012).

The Point Loma kelp bed, the largest kelp bed in San Diego County, was particularly important because of its proximity to the kelp processing plant in San Diego Bay. Although the poundage and landed value was proprietary, Wolfson and Glinski (2000) estimated a commercial value of \$5-\$10 million per year for the Point Loma kelp bed. In 2005, after 76 years of operation, the San Diego kelp harvesting and processing operation was shut down and moved to Scotland.

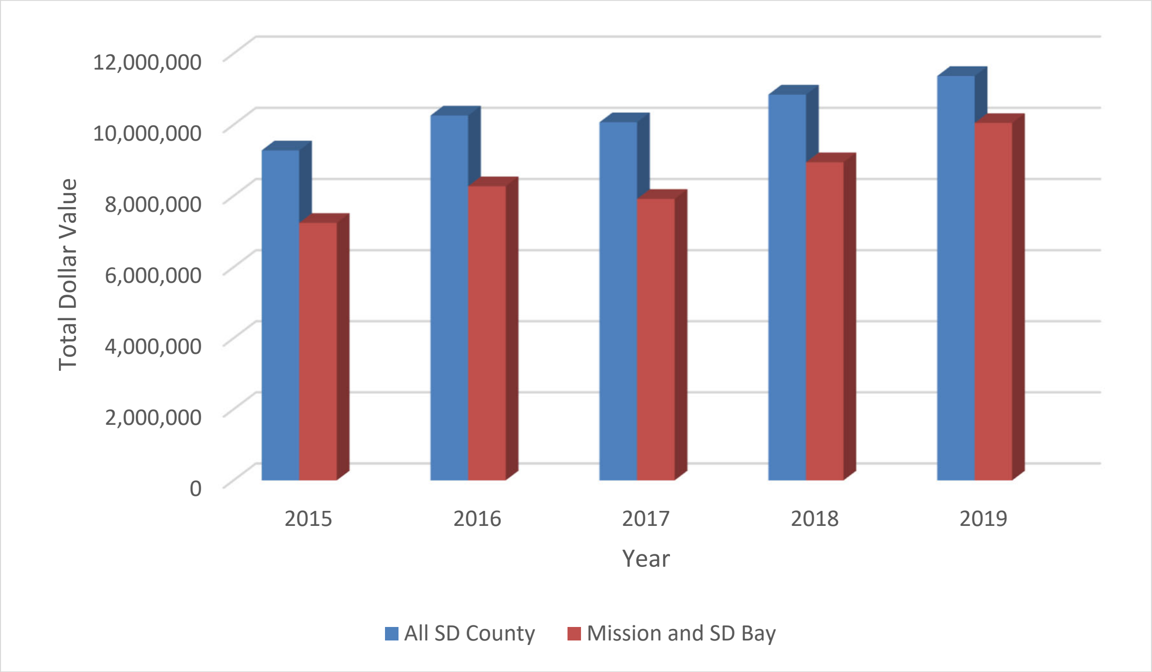
Kelp harvesting in California is regulated by the CDFW. As a result of restrictions on harvesting activities, commercial kelp harvest decreased by 96% from 2002 to 2007 (U.S. Army Corps of Engineers (USACOE) 2013). Two kelp beds, one located from the California/Mexico International Boundary to southern tip of San Diego Bay, and one located from the southern tip of San Diego Bay to the southern tip of Point Loma, are considered open, which means they may be harvested by anyone with a kelp harvesting license. Kelp beds at Point Loma and Mission Bay are currently available for lease from the state (USACOE 2013).

The CDFW is the principal authority issuing permits for marine aquaculture (mariculture) in California. The California State Lands Commission and various municipal entities may grant tideland leases, but if aquaculture is involved, the operation must be registered with the CDFW.

Recently another entity has proposed a major Aquaculture operation off the San Diego coast. Rose Canyon Fisheries is proposing a sustainable aquaculture project that would use difference types of large cages to raise native species: Yellowtail jack, White seabass and Stripped bass. The current proposed project location is about 7 mi to the north of the Point Loma discharge and a similar distance offshore. This puts it 4.5 mi west of the entrance to Mission Bay. They have assessed the water quality and other factors at that location and found it conducive to an aquaculture project (Marine Research Specialists 2014).

The total annual value of all San Diego County commercial landings from 2015-2019 is shown in Figure J-12. The value of commercial fishing industry landings in San Diego have demonstrated a consistent growth in during this period. Also shown in Figure J-12 is the proportion of San Diego County commercial landings from Mission Bay and San Diego Bay, which made up over 80% of all landed value of commercial fishery species in San Diego County.

Figure J-12:
San Diego Commercial Fisheries Value 2015 - 2019



J.4 ESSENTIAL FISH HABITAT

The Sustainable Fisheries Act of 1996 (an amendment to the Magnuson-Stevens Fishery Conservation and Management Act) provided a new habitat conservation tool: the EFH mandate (NOAA 2021b). Regional fishery management councils (FMCs) are required to identify EFH for federally managed species (i.e., species covered under FMPs). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 United States Code [U.S.C.] 1802[10]). The term "fish" is defined as "finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds." The NMFS in 2002 further clarified EFH with the following definitions (50 Code of Federal Regulations (CFR) 600.05–600.930): "Waters" include all aquatic areas and their associated biological, chemical, and physical properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "Substrate" includes 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 a species' "full life cycle" (NMFS 2002a).

The Sustainable Fisheries Act requires that EFH be identified and mapped for each federally managed species. The NMFS and regional FMCs determine the species' distributions by life stage and characterize associated habitats, including Habitat Areas of Particular Concern

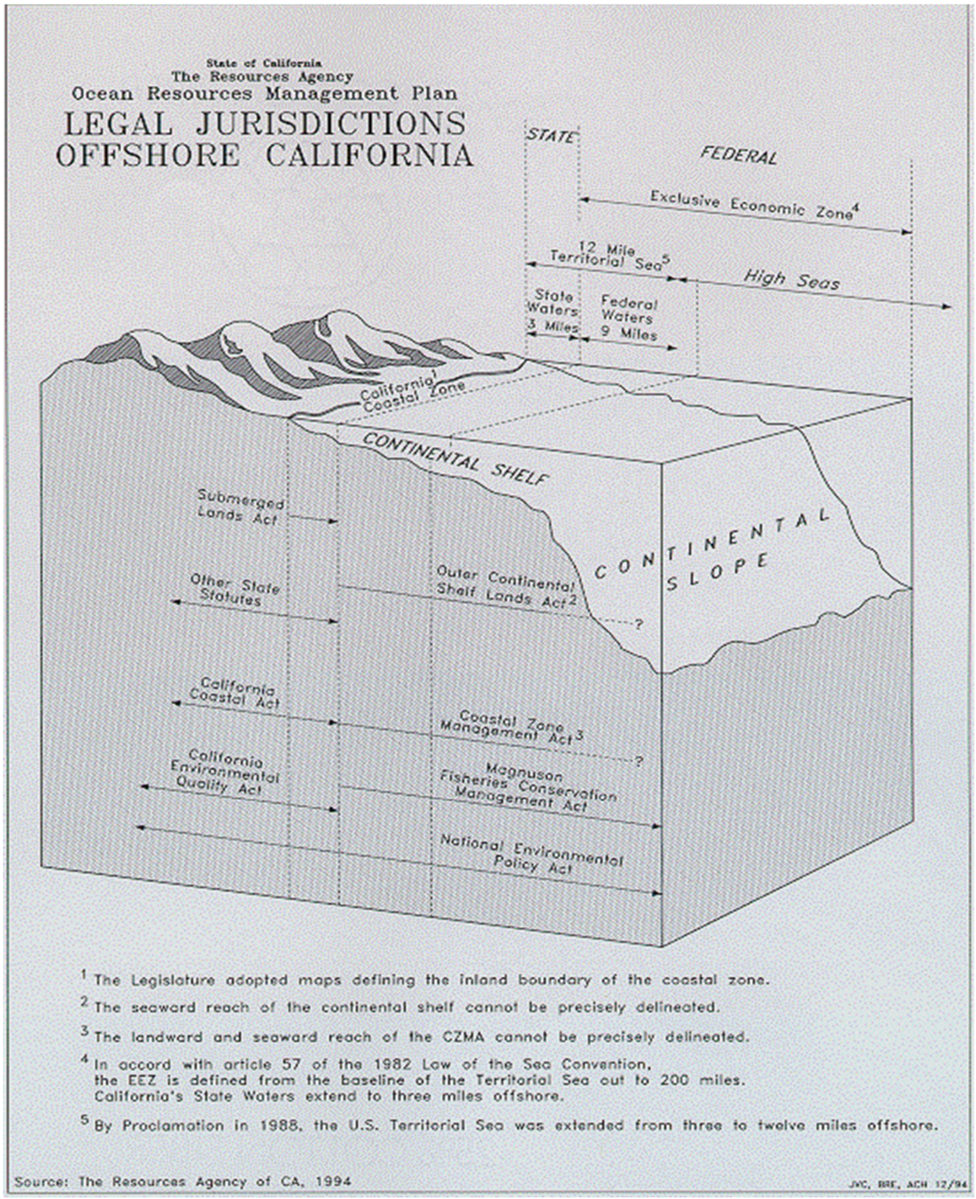
(HAPC). HAPC are discrete areas within EFH that either play especially important ecological roles in the life cycles of managed species or are especially vulnerable to degradation from human-induced activities (50 CFR 600.815[a][8]). The Sustainable Fisheries Act requires federal agencies to consult with the NMFS on activities that may adversely affect EFH. For actions that affect a threatened or endangered species, or its critical habitat, and its EFH, federal agencies must integrate Endangered Species Act (ESA) and EFH consultations.

An Essential Fish Habitat Assessment (EFHA) is a critical review of a proposed project and its potential impacts to EFH. As set forth in the rules (50 CFR 600.920[e][3]), EFHAs must include (1) a description of the proposed action; (2) an analysis of the effects, including cumulative effects, of the action on EFH, the managed species and associated species; (3) the effects of the action on EFH; and (4) proposed mitigation, if applicable. Once the NMFS learns of a federal or state activity that may have adverse effects on designated EFH, the NMFS is required to develop EFH consultation recommendations for the activity. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NOAA 2007).

J.4.1 Regulatory Background

Commercial fisheries are protected and managed by the Magnuson-Stevens Fishery Conservation and Management Act (NOAA 2021b), by State and Inter-State Fisheries Management Plans (e.g., Pacific Fishery Management Council (PFMC)), and by the CDFW, prior to 2013 called the California Department of Fish and Game (CDFG). The Magnuson-Stevens Fishery Conservation and Management Act of 1976 established jurisdiction over marine fishery resources in the 200-nm (370-km) U. S. Exclusive Economic Zone (Figure J-13). The Magnuson-Stevens Fishery Conservation and Management Act was reauthorized and amended by the Sustainable Fisheries Act of 1996 (NOAA 2021b). The Sustainable Fisheries Act requires that regional FMCs develop and implement FMPs to protect managed species included in the plans. FMPs are developed to achieve the goal of no net loss of the productive capacity of habitats that sustain commercial, recreational, and native fisheries. Magnuson-Stevens Fishery Conservation and Management Act was reauthorized in 2007 and is periodically updated and amended most recently in 2018 (NOAA 2021b).

Figure J-13:
Legal Jurisdictions Offshore California (COPC 2021)



[1] The Legislature adopted maps defining the inland boundary of the coastal zone.

[2] The seaward reach of the continental shelf cannot be precisely delineated.

[3] The landward and seaward reach of the CZMA cannot be precisely delineated.

[4] In accord with article 57 of the 1982 Law of the Sea Convention, the EEZ is defined from the baseline of the Territorial Sea out to 200 miles. California's State Waters extend to three miles offshore.

[5] By Proclamation in 1988, the U.S. Territorial Sea was extended from three to twelve miles offshore.

Source: The Resources Agency of CA, 1994

JVC, BRF, ACH 12/94

J.4.2 Fishery Management Plans

The U. S. Exclusive Economic Zone extends from the outer boundary of state waters (3 nm (5.6 km) from shore) to a distance of 200 nm (370 km) from shore. Offshore fisheries in the Southern California Bight are managed by the NMFS (NOAA 2021c) with assistance from the PFMC (PFMC 2021a), and the Southwest Fisheries Science Center (NOAA 2021d). Inshore fisheries (less than 3 nm (5.6 km)) from shore are managed by the CDFW (CDFW 2021a). In practice, state and federal fisheries agencies manage fisheries cooperatively with FMPs generally covering the area from coastal estuaries out to 200 nm (370 km) offshore.

FMPs are extensive documents that are constantly revised and updated. The Pacific Coast Groundfish Fishery Management Plan, for example, originally produced in 1977, has been amended 33 times (PFMC 2021a). FMPs describe the nature, status, and history of the fishery, and, specify management recommendations, yields, quotas, regulations, and harvest guidelines. Associated Environmental Impact Statements address the biological and socioeconomic consequences of management policies. FMCs have websites that present the various elements of their FMPs, current standards and regulations, committee hearings and decisions, research reports, source documents, and links to related sites (e.g., PFMC 2021a). Coverage of the ecology of marine fish, fisheries, and environmental issues in California is presented in reviews by Horn and Allen 1978, Allen et al. 2006, Horn and Stephens 2006, Horn et al. 2006, Love 2006, 2011, Butler et al. 2012, Miller and Schiff 2012, Suntsov et al. 2012, Koslow et al. 2013, Miller and McGowan 2013, and Naval Facilities Engineering Command 2013.

FMPs with managed species that could occur in the vicinity of Point Loma are the Pacific Groundfish FMP (NMFS 2013b, PFMC 2020b), the CPS FMP (PFMC 2020c), and the U. S. West Coast Fisheries for HMS (PFMC 2020d) (Table J-4).

Table J-4:
Federal Fishery Management Species, actively managed under the Pacific Coast Groundfish Management Plan August 2020

Groundfish Management Plan Species

http://www.pcouncil.org/groundfish/fishery-management-plan/

COMMON NAME	**SCIENTIFIC NAME**
Sharks	
Big skate	*Raja binoculata*
California skate	*Raja inornata*
Leopard shark	*Triakis semifasciata*
Longnose skate	*Raja rhina*
Ratfish	
Ratfish	*Hydrolagus colliei*
Morids	
Finescale codling (Pacific flatnose)	*Antimora microlepis*
Grenadiers	
Pacific rattail (Pacific grenadier)	*Coryphaenoides acrolepis*
Roundfish	
Cabezon	*Scorpaenichthys marmoratus*
Kelp greenling	*Hexagrammos decagrammus*

Lingcod	*Ophiodon elongatus*
Pacific cod	*Gadus macrocephalus*
Pacific whiting (hake)	*Merluccius productus*
Sablefish	*Anoplopoma fimbria*
Rockfish	
Aurora rockfish	*Sebastes aurora*
Bank rockfish	*S. rufus*
Black rockfish	*S. melanops*
Black and yellow rockfish	*S. chrysomelas*
Blackgill rockfish	*S. melanostomus*
Blackspotted rockfish	*S. melanostictus*
Blue rockfish	*S. mystinus*
Bocaccio	*S. paucispinis*
Bronzespotted rockfish	*S. gilli*
Brown rockfish	*S. auriculatus*
Calico rockfish	*S. dallii*
California scorpionfish	*Scorpaena gutatta*
Canary rockfish	*Sebastes pinniger*
Chameleon rockfish	*S. phillipsi*
Chilipepper	*S. goodei*
China rockfish	*S. nebulosus*
Copper rockfish	*S. caurinus*
Cowcod	*S. levis*
Darkblotched rockfish	*S. crameri*
Deacon rockfish	*S. diaconus*
Dusky rockfish	*S. ciliatus*
Dwarf-red rockfish	*S. rufinanus*
Flag rockfish	*S. rubrivinctus*
Freckled rockfish	*S lentiginosus*
Gopher rockfish	*S. carnatus*
Grass rockfish	*S. rastrelliger*
Greenblotched rockfish	*S. rosenblatti*
Greenspotted rockfish	*S. chlorostictus*

Greenstriped rockfish	*S. elongatus*
Halfbanded rockfish	*S. semicinctus*
Harlequin rockfish	*S. variegatus*
Honeycomb rockfish	*S. umbrosus*
Kelp rockfish	*S. atrovirens*
Longspine thornyhead	*Sebastolobus altivelis*
Mexican rockfish	*Sebastes macdonaldi*
Olive rockfish	*S. serranoides*
Pink rockfish	*S. eos*
Pinkrose rockfish	*S. simulator*
Pygmy rockfish	*S. wilsoni*
Pacific ocean perch	*S. alutus*
Quillback rockfish	*S. maliger*
Redbanded rockfish	*S. babcocki*
Redstripe rockfish	*S. proriger*
Rosethorn rockfish	*S. helvomaculatus*
Rosy rockfish	*S. rosaceus*
Rougheye rockfish	*S. aleutianus*
Sharpchin rockfish	*S. zacentrus*
Shortbelly rockfish	*S. jordani*
Shortraker rockfish	*S. borealis*
Shortspine thornyhead	*Sebastolobus alascanus*
Silvergray rockfish	*Sebastes brevispinis*
Speckled rockfish	*S. ovalis*
Splitnose rockfish	*S. diploproa*
Squarespot rockfish	*S. hopkinsi*
Starry rockfish	*S. constellatus*
Stripetail rockfish	*S. Saxicola*
Sunset rockfish	*S. crocotulus*
Swordspine rockfish	*S. ensifer*
Tiger rockfish	*S. nigrocinctus*
Treefish	*S. serriceps*
Vermilion rockfish	*S. miniatus*

Widow rockfish	*S. entomelas*
Yelloweye rockfish	*S. ruberrimus*
Yellowmouth rockfish	*S. reedi*
Yellowtail rockfish	*S. flavidus*

Flatfish

Arrowtooth flounder (turbot)	*Atheresthes stomias*
Butter sole	*Isopsetta isolepis*
Curlfin sole	*Pleuronichthys decurrens*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
Flathead sole	*Hippoglossoides elassodon*
Pacific sanddab	*Citharichthys sordidus*
Petrale sole	*Eopsetta jordani*
Rex sole	*Glyptocephalus zachirus*
Rock sole	*Lepidopsetta bilineata*
Sand sole	*Psettichthys melanostictus*
Starry flounder	*Platichthys stellatus*

Coastal Pelagic Management Plan Species through amendment 17, June 2019.

http://www.pcouncil.org/coastal-pelagic-species/fishery-management-plan-and-amendments/

Jack mackerel	*Traxchurus symmetricus*
Krill	*euphausiids*
Pacific mackerel	*Scomber japonicus*
Pacific sardine	*Sardinops sagax*
Market squid	*Loligo opalescens*
Northern anchovy	*Engraulis mordax*

Highly Migratory Management Plan Species through amendment 5, April 2018.

http://www.pcouncil.org/highly-migratory-species/fishery-management-plan-and-amendments/

Sharks

Bigeye thresher shark	*Alopias superciliosus*
Blue shark	*Prionace glauca*
Common thresher shark	*Alopias vulpinus*

Pelagic thresher shark	*Alopias pelagicus*
Shortfin mako shark	*Isurus oxyrinchus*
Tunas	
Albacore tuna	*Thunnus alalunga*
Bigeye tuna	*Thunnus obesus*
Northern bluefin tuna	*Thunnus orientalis*
Skipjack tuna	*Katsuwonus pelamis*
Yellowfin tuna	*Thunnus albacares*
Billfish	
Striped marlin	*Tetrapturus audax*
Swordfish	*Xiphias gladius*
Dolphin-fish	
Dorado (mahi mahi)	*Coryphaena hippurus*

Sources: PFMC 2020b, 2020c, 2020d

The Pacific coast groundfish fishery is the largest, most important fishery managed by the PFMC in terms of landings and value (PFMC 2020b). Groundfish managed species are found throughout the Southern California Bight. More than 90 species of bottom-dwelling marine finfish are included in the federally-managed groundfish fishery. Groundfish species include all rockfishes in the Scorpaenidae family, flatfishes such as Dover sole (*Microstomus pacificus*) and petrale sole (*Eopsetta jordani*), roundfishes such as sablefish (*Anoplopoma fimbria*) and lingcod (*Ophiodon elongatus*), and various sharks and skates. The species managed under the Pacific Groundfish Management Plan are usually found on or near the bottom; rockfish – including widow, yellowtail, canary, shortbelly, and vermilion rockfish; bocaccio, chilipepper, cowcod, yelloweye, thornyheads, and Pacific Ocean perch; roundfish – lingcod, cabezon, kelp greenling, Pacific cod, Pacific whiting (hake), and sablefish; flatfish – including various soles, starry flounder, and sanddab; sharks and skates – leopard shark, soupfin shark, spiny dogfish, big skate, California skate, and longnose skate; and three other species: ratfish, finescale codling, and Pacific rattail grenadier (Table J-4).

The groundfish species managed by the Pacific Groundfish FMP range throughout the Exclusive Economic Zone and occupy diverse habitats at all stages in their life histories. Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish that show strong affinities to a particular location or substrate type.

Rockfish are found from the intertidal zone out to the deepest waters of the Exclusive Economic Zone (Love et al. 2002, 2009, Butler et al. 2012). For management purposes, these species are often placed in three groups defined by depth range and distance offshore: nearshore rockfish, shelf rockfish, and slope rockfish (CDFW 2021a). Table J-5 presents rockfish distribution in the Southern California Bight.

Table J-5:
Rockfish Distribution in the Southern California Bight

Shallow Nearshore Rockfish

black-and-yellow (*S. chrysomelas*)
China (*S. nebulosus*)
gopher (*S. carnatus*)
grass (*S. rastrelliger*)
kelp (*S. atrovirens*)

Deeper Nearshore Rockfish

black (*Sebastes melanops*)
blue (*S. mystinus*)
brown (*S. auriculatus*)
calico (*S. dalli*)
copper (*S. caurinus*)
olive (*S. serranoides*)
quillback (*S. maliger*)
treefish (*S. serriceps*)

Shelf Rockfish

bocaccio (*Sebastes paucispinis*)
bronzespotted (*S. gilli*)
canary (*S. pinniger*)
chameleon (*S. phillipsi*)
chilipepper (*S. goodei*)
cowcod (*S. levis*)
dwarf-red (*S. rufinanus*)
flag (*S. rubrivinctus*)
freckled (*S. lentiginosus*)
greenblotched (*S. rosenblatti*)
greenspotted (*S. chlorostictus*)
greenstriped (*S. elongatus*)
halfbanded (*S. semicinctus*)
honeycomb (*S. umbrosus*)
pinkrose (*S. simulator*)
pygmy (*S. wilsoni*)
redstriped (*S. proriger*)
rosethorn (*S. helvomaculatus*)
rosy (*S. rosaceus*)
silvergrey (*S. brevispinis*)
speckled (*S. ovalis*)
squarespot (*S. hopkinsi*)
starry (*S. constellatus*)
stripetail (*S. saxicola*)
swordspine (*S. ensifer*)
tiger (*S. nigrocinctus*)
vermilion (*S. miniatus*)
widow (*S. entolemas*)

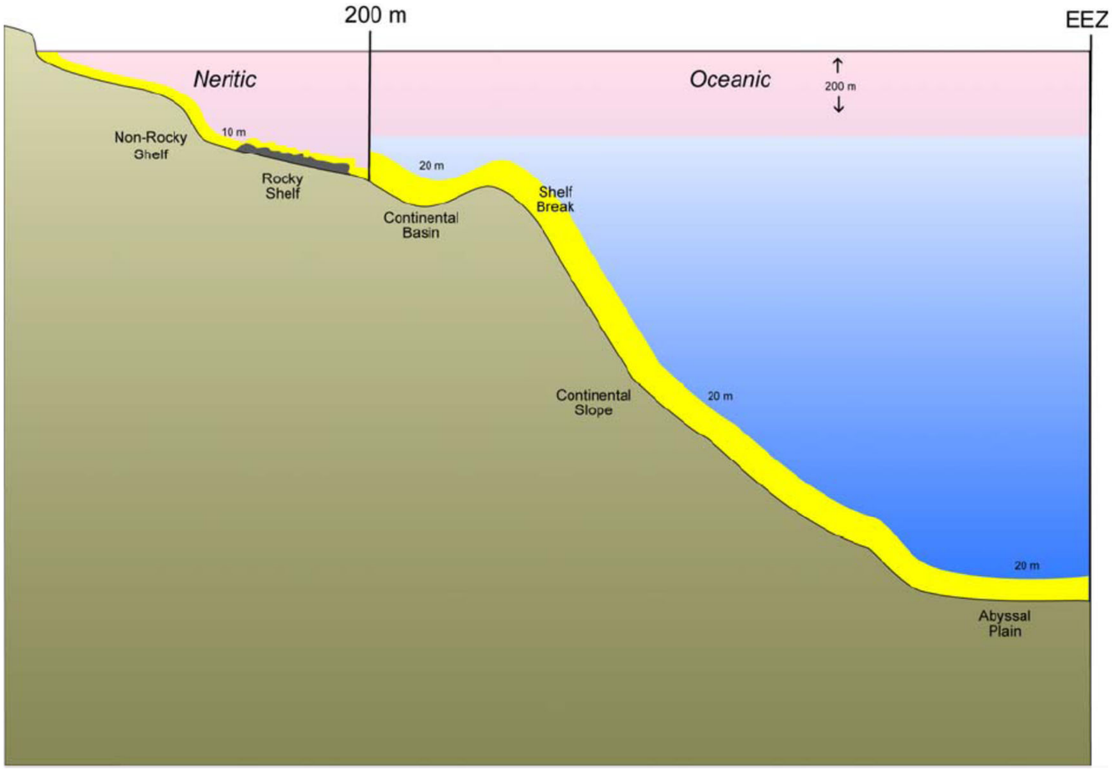
Mexican (*S. macdonaldi*)
pink (*S. eos*)
yelloweye (*S. ruberrimus*)
yellowtail (*S. flavidus*)

Slope Rockfish

aurora (*S. aurora*)
bank (*S. rufus*)
blackgill (*S. melanostomus*)
darkblotched (*S. crameri*)
Pacific ocean perch (*S. alutus*)
redbanded (*S. babcocki*)
rougheye (*S. aleutianus*)
sharpchin (*S. zacentrus*)
shortraker (*S. borealis*)
splitnose (*S. diploproa*)
yellowmouth (*S. reedi*)

The nearshore rockfish spend most of their lives in relatively shallow water. This group is often subdivided into a shallow component and a deeper component. Shelf rockfish are found along the continental shelf (Figure J-14, from USDON 2013). Slope rockfish occur in the deeper waters of the shelf and down the continental slope. The roundfish, flatfish, sharks, and skates covered under the Groundfish FMP are generally concentrated in shallow water while the ratfish, finescale codling, and Pacific rattail are deepsea fish (Eschmeyer et al. 1985, Leet et. al. 2001, Butler et al. 2012, CDFW 2021a).

Figure J-14:
Pacific Coast Groundfish Ranges



The Pacific halibut (*Hippoglossus stenolepis*), a flat groundfish, is regulated by the United States and Canada through a bilateral commission, the International Pacific Halibut Commission (IPHC) (IPHC 2014) and is therefore not in a federal FMP. The normal range of Pacific halibut is from Santa Barbara, California to Nome, Alaska. It would not usually be found in the Point Loma area.

A variety of different fishing gear is used to target groundfish including troll, longline, hook and line, pots, gillnets, and other types of gear (bottom trawls were banned in March 2006 out to a depth of 3,500 m) (Table J-6 (from NMFS 2005b)). The West Coast groundfish fishery has four access components: <u>limited entry</u> – which limits the number of vessels allowed to participate; <u>open access</u> – which allocates a portion of the harvest to fishers without limited entry permits; <u>recreational</u>; and <u>tribal</u> – fishers who have federally recognized treaty rights (PFMC 2021a).

Table J-6:
Gear Types Used in the West Coast Groundfish Fishery

Fishery	Trawl and Other Net	Longline, Pot, Hook and Line	Other
Limited Entry Fishery (commercial)	Mid-water Trawl, Whiting trawl, Scottish Seine	Pot, Longline	-
Open Access Fishery Directed Fishery (commercial)	Set Gillnet, Sculpin Trawl	Pot, Longline, Vertical hook/line, Rod/Reel, Troll/dinglebar, Jig, Drifted (fly gear), Stick	-
Open Access Fishery Incidental Fishery (commercial)	Exempted Trawl (pink shrimp, spot and ridgeback prawn, CA halibut, sea cucumber), Setnet, Driftnet, Purse Seine (Round Haul Net)	Pot (Dungeness crab, CA sheephead, spot prawn) Longline, Rod/Reel Troll	Dive (spear) Dive (with hook and line) Poke Pole
Tribal	as above	as above	as above
Recreational	Dip Net, Throw net (within 3 mi)	Hook and Line methods Pots (within 3 mi) from shore, private boat, commercial passenger vessel	Dive (spear)

Managed jointly by the PFMC and the NMFS under the Coastal Pelagic Species Fisheries Management Plan (CPS FMP), Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), and northern anchovy (*Engraulis mordax*) are included in complex known as the CPS. The Coastal Pelagics FMP also includes two invertebrates, market squid and krill (PFMC 2020c). The CPS inhabit the pelagic realm, i.e., live in the water column, not near the sea floor. They are usually found from the surface to 3,281 ft (1,000 m) deep.

Northern anchovy (*Engraulis mordax*) are small, short-lived fish that typically school near the surface (PFMC 2020c). They occur from British Columbia to Baja California. Northern anchovies are divided into northern, central, and southern sub-populations. The central sub-population has been the focus of large commercial fisheries in the U.S. and Mexico. Most of this sub-population is located in the Southern California Bight between Point Conception, California and Point Descanso, Mexico. Northern anchovy are an important part of the food chain for other species, including other fish, birds, and marine mammals.

Pacific sardine (*Sardinops sagax*), also a small schooling fish, have been the most abundant fish species managed under the Pacific Groundfish FMP. They range from the tip of Baja California to southeastern Alaska. Sardines live up to 13 years, but are usually captured by their fifth year.

Pacific (chub) mackerel (*Scomber japonicus*) are found from southeastern Alaska to Mexico, and are most abundant south of Point Conception, California within 20 mi (32 km) from shore. The "northeastern Pacific" stock of Pacific mackerel is harvested by fishers in the U. S. and Mexico. Like sardines and anchovies, mackerel are schooling fish, often co-occurring with other pelagic species like jack mackerel and sardines. As with other CPS, they are preyed upon by a variety of fish, mammals, and sea birds.

Jack mackerel (*Trachurus symmetricus*) grow to about 2 ft and can live up to 35 years. They are found throughout the northeastern Pacific, often well outside the Exclusive Economic Zone. Small jack mackerel are most abundant in the Southern California Bight, near the mainland coast, around islands, and over shallow rocky banks. Older, larger fish range from Cabo San Lucas, Baja California, to the Gulf of Alaska, offshore into deep water and along the coast to the north of Point Conception. Jack mackerel in southern California usually school over rocky banks, artificial reefs, and shallow rocky reefs.

Market squid (*Loligo opalescens)* range from the southern tip of Baja California to southeastern Alaska (Leet et al. 2001). They are most abundant between Punta Eugenio, Baja California, and Monterey Bay, California. Usually found near the surface, market squid can occur to depths of 2,625 ft (800 m) or more. Squid live less than a year and prefer full-salinity ocean waters. They are important forage foods for fish, birds and marine mammals.

In 2006, the PFMC included krill in the CPS and adopted a complete ban on commercial fishing for all species of krill in West Coast federal waters (PFMC 2006). Krill are small shrimp-like crustaceans that are an important basis of the marine food chain. They are eaten by many managed species, as well as by whales and seabirds.

CPS are harvested directly and incidentally (as bycatch) in other fisheries. Usually targeted with "round-haul" gear including purse seines, drum seines, lampara nets, and dip nets, they are also taken as bycatch in midwater trawls, pelagic trawls, gillnets, trammel nets, trolls, pots, hook-and-line, and jigs. Market squid are fished nocturnally using bright lights to attract the squid to the surface. They are pumped directly from the sea into the hold of the boat or taken with an encircling net (PFMC 2005). Market squid are harvested for human consumption and as bait in recreational fisheries.

Most of the CPS commercial fleet is located in California, mainly in Los Angeles, Santa Barbara-Ventura, and Monterey. About 75% of the market squid and Pacific sardine catch are exported, mainly to China, Australia (where they are used to feed farmed tuna), and Japan (where they are used as bait for longline fisheries).

The U.S. West Coast Fisheries for HMS covers 13 free-ranging species; five tuna - Pacific albacore, yellowfin, bigeye, skipjack, and northern bluefin; five sharks - common thresher, pelagic thresher, bigeye thresher, shortfin mako, and blue shark; two billfish - striped marlin and Pacific swordfish; and dorado (also known as dolphinfish or mahi-mahi) (Table J-2). HMS have a wide geographic distribution, both inside and outside the Exclusive Economic Zone. They are open-ocean, pelagic species, that may spend part of their life cycle in nearshore waters. HMS are harvested by U. S. commercial fishers and by foreign fishing fleets, with only a fraction of the total harvest taken within U.S. waters (PFMC 2020d). HMS are also an important component of the recreational sport fishery, especially in southern California.

Under the HMS FMP, the PFMC monitors other species for informational purposes. In addition, some species-including great white sharks, megamouth sharks, basking sharks, Pacific halibut, and Pacific salmon (PFMC 2014e) - are designated as prohibited catch. If fishers targeting HMS catch these species, they are required to immediately release them.

The federal Shark Conservation Act of 2010 was signed into law January 4, 2011, specifying that no shark is to be landed without fins being naturally attached (CalCOFI 2013). In addition, the State of California passed AB 376 - a bill banning the possession and sale of shark fins, beginning January 1, 2012. While shark fisheries in California are still legal, and those possessing the proper license or permit are allowed to retain shark fins under California law, sales and distribution are prohibited. Restaurants and retailers were allowed to sell stock on hand as of the implementation until July 1, 2013. There is also an exception for taxidermy.

The HMS fishery, with the exception of the swordfish drift gillnet fishery off California, is one of the only remaining open access fisheries on the West Coast. However, the PFMC is currently considering a limited entry program to control excess capacity. The use of entangling nets (set and drift gill nets, and trammel nets) in California state waters (<3 nm (5.6 km) from shore) was banned in 1994 by Proposition 132, the Marine Resources Protection Act of 1990 (Fish and Game Code §8610 et seq.).

Many different gear types are used to catch HMS in California. These include; 1) trolling lines - fishing lines with jigs or live bait deployed from a moving boat, 2) drift gillnets - panels of netting weighted along the bottom and suspended vertically in the water by floats that are attached to a vessel drifting along with the current, 3) harpoon - a small and diminishing fishery mainly targeting swordfish, 4) pelagic longlines - baited hooks on short lines attached to a horizontal line (the HMS FMP now prohibits West Coast longliners from fishing in the Exclusive Economic Zone due to concerns about the take of endangered sea turtles), 5) coastal purse seines - encircling nets closed by synching line threaded through rings on the bottom of the net (usually targeting sardines, anchovies, and, mackerel but also target tuna where available), 6) large purse seines - used in major fisheries in the eastern tropical Pacific and the central and western Pacific (this fishery is monitored by the Inter-American Tropical Tuna Commission, and, in the Exclusive Economic Zone by NMFS); and, 7) recreational fisheries - HMS recreational fishers in California include private vessels and charter vessels using hook-and-line to target tunas, sharks, billfish, and dorado.

As mentioned previously, Pacific halibut (*Hippoglossus stenolepis*) is managed by the IPHC (IPHC 2014). This large species of halibut is mainly encountered well north of the Point Loma area, and, its harvest is prohibited in the area. A smaller relative, the California halibut (*Paralichthys californicus*), is found along the coast of southern California, but is not included in a FMP.

Although FMPs are mandated for federal waters, managed species also occur in state waters. These areas in California (i.e., inshore of 3 nm) are managed under the MLMA (CDFW 2014b). California FMPs have been produced for nearshore finfish (CDFW 2014c), white seabass (CDFWd), market squid (CDFWe), and, a spiny lobster FMP is being developed (CDFWf).

The California Nearshore Fishery Management Plan (NFMP) (CDFW 2014c) covers both commercial nearshore fisheries and recreational fishers. The five goals of the NFMP are to (1) ensure long-term resource conservation and sustainability ,(2) employ science-based decision-making, (3) increase constituent involvement in management, (4) balance and enhance socio-economic benefits, (5) identify implementation costs and sources of funding. Five management approaches form the basis for integrated management strategies to meet the goals and objectives of the NFMP and MLMA. They are: the Fishery Control Rule, Management Measures, Restricted Access, Regional Management, Marine Protected Areas (MPAs), and Allocation (CDFW 2014c). Table J-7 presents key NFMP management goals and objectives.

Table J-7:
Key NFMP Management Goals and Objectives

NFMP Goal or Objective	Fishery Control Rule	Management Measures	Restricted Access	Regional Management	MPAs	Allocation
Conserve ecosystems	Stock assessments completed	-	-	-	-	-
Allow only sustainable uses	Setting TACs based on NFMP fishery control rule; in season monitoring	Size limits on species that survive release; trip limits match capacity; limit gear	-	-	-	-
Adjust catch allowance to reflect uncertainty	TACs based on stock assessments (black & gopher rockfish, cabezon, CA scorpion fish)	Trip limits	-	-	-	-
Match fish harvest capacity to sustainable catch levels	-	-	RA program for NFP species; DNSFP program	-	-	-
Allocate restrictions and benefits fairly and equitably	-	Fish and Game Code guidance to Council for regulation development	-	Regional discussions with constituents on proposed regulation changes	-	Revised as updated information is available
Minimize / limit by catch and mortality	-	Match seasons and depths for co-occurring species	Bycatch permit with trip quota; bimonthly trip limits	-	-	-

NFMP Goal or Objective	Fishery Control Rule	Management Measures	Restricted Access	Regional Management	MPAs	Allocation
Maintain, restore and preserve habitat	-	-	Allowable gear limited to hook & line, traps and dip nets	Identify appropriate habitat for 19 species; NFMP MPA criteria in MLPA Master plan design criteria	-	-
Identify, assess, and enhance habitats	-	-	-	-	Identify appropriate habitat for 19 species	-
Identify and minimize fishing that destroys habitat	-	CA input into Council EFH designations	NFP program gear endorsements	-	-	-
Employ Science based Decision making	OYs/TACs based on stock assessments	-	-	-	-	-
Conduct collaborative research	CRANE	-	-	-	-	-
Collect data on spatial distribution of habitats and organisms	CRANE EFI collection	-	-	Initial focus on southern California and south central regions	-	CRANE & Channel Islands MPA monitoring

The NFMP covers 19 species that frequent kelp beds and reefs generally less than 120 ft (36 m) deep off the coast of California and the near offshore islands (CDFW 2014c), as presented in Table J-8.

Table J-8:
Managed Species - California Nearshore Fisheries Management Plan

Black rockfish - *Sebastes melanops*

Gopher rockfish - *Sebastes carnatus*

Black & yellow rockfish - *Sebastes chrysomelas*

Grass rockfish - *Sebastes rastrelliger*

Blue rockfish - *Sebastes mystinus*

Kelp greenling – *Hexagrammos decagrammus*

Brown rockfish - *Sebastes auriculatus*

Kelp rockfish – *Sebastes atrovirens*

Cabezon - *Scorpaenichthys marmoratus*

Monkeyface prickleback – *Cebidichthys violaceus*

Calico rockfish - *Sebastes dallii*

Olive rockfish - *Sebastes serranoides*

California scorpionfish - *Scorpena guttata*

Quillback rockfish - *Sebastes maliger*

California sheephead – *Semicossyphus pulcher*

Rock greenling - *Hexagrammos lagocephalus*

China rockfish - *Sebastes nebulosus*

Treefish - *Sebastes serriceps*

Copper rockfish - *Sebastes caurinus*

Thirteen of these species are rockfish - all of which are included in the federal Pacific Groundfish FMP. Three of the remaining six species are also covered under the Pacific Groundfish FMP. The three species not covered by the Pacific Groundfish FMP are the California sheephead (*Semicossyphus pulcher*), the rock greenling (*Hexagrammos lagocephalus*), and the monkeyface prickleback (*Cebidichthys violaceus*). These species are actively managed by the CDFW (CDFW 2014c) through catch limits, gear restrictions and monitoring.

The California sheephead is a large, colorful member of the wrasse family (Leet et al. 2001, CDFW 2013a). Male sheephead reach a length of 3 ft, a weight of 36 lbs, and have a white chin, black head, and, a pink to red body. Females are smaller, with a brown-colored body (Eschmeyer et al. 1985). Sheephead populations off southern California have declined because of fishing pressure. Large males are now rare because they are sought by recreational spear fishermen. Sheephead are taken commercially by traps and kept alive for display in restaurant aquaria where patrons select a specific fish for preparation. The rock greenling is a smaller member of the lingcod family. The monkeyface prickleback, also called the monkeyface eel, is more closely related to rockfish than eels. Its elongate shape is an adaptation to living in cracks, crevices, and under boulders.

White seabass (*Atractoscion nobilis*), large members of the croaker family, occur in ocean waters off the west coasts of California and Mexico. This highly-prized species is recovering from reduced population levels in the late 1900s. The current California management strategy of the White Seabass Fishery Management Plan (WSFMP) provides for moderate commercial harvests while protecting young white seabass and spawning adults through seasonal closures, gear provisions, and size and bag limits (CDFW 2014d). The WSFMP also has a recreational fishery component with size and bag limits, and season closures. There is an ongoing white seabass hatchery program in Carlsbad, California operated by the Hubbs-Sea World Research Institute. The hatchery provides juvenile white seabass to other field-rearing systems operated by volunteer fishermen throughout southern California.

Market squid (*Loligo opalescens*), discussed previously under the Coastal Pelagics FMP, is the state's largest fishery by tonnage and economic value (CDFW 2014g). Market squid are also important to the recreational fishery as bait and as forage for fish, marine mammals, birds, and other marine life. Squid belong to the class Cephalopoda of the phylum Mollusca. They have large eyes and strong parrot-like beaks. Using their fins for swimming and jets of water from their funnel they are capable of rapid propulsion forward or backward. The squid's capacity for sustained swimming allows it to migrate long distances.

The Abalone Recovery and Management Plan (CDFW 2014h) establishes a cohesive framework for the recovery of depleted abalone populations in southern California. All of California’s abalone species are included in the plan: red abalone, *Haliotis rufescens*; green abalone, *H. fulgens*; pink abalone, *H. corrugata*; white abalone, *H. sorenseni*; pinto abalone, *H. kamtschatkana* (including *H. assimilis*); black abalone, *H. cracherodii*; and flat abalone, *H. walallensis*. The recovery and management plan for these species implements measures to prevent further population declines throughout California, and to ensure that current and future populations will be sustainable.

The decline of abalone is due to a variety of factors, primarily commercial and recreational fishing, disease, and natural predation. The recovery of a near-extinct abalone predator, the sea otter, has further reduced the possibility for an abalone fishery in most of central California. Withering syndrome, a lethal bacterial infection, has caused widespread decline among black abalone in the Channel Islands and along the central California coast. As nearshore abalone populations became depleted, fishermen traveled to more distant locations, until stocks in most areas collapsed. Advances in diving technology also played a part in stock depletion. The advent of self-contained underwater breathing apparatus in the mid-1900s gave birth to the recreational fishery in southern California, which placed even more pressure on a limited number of fishing areas.

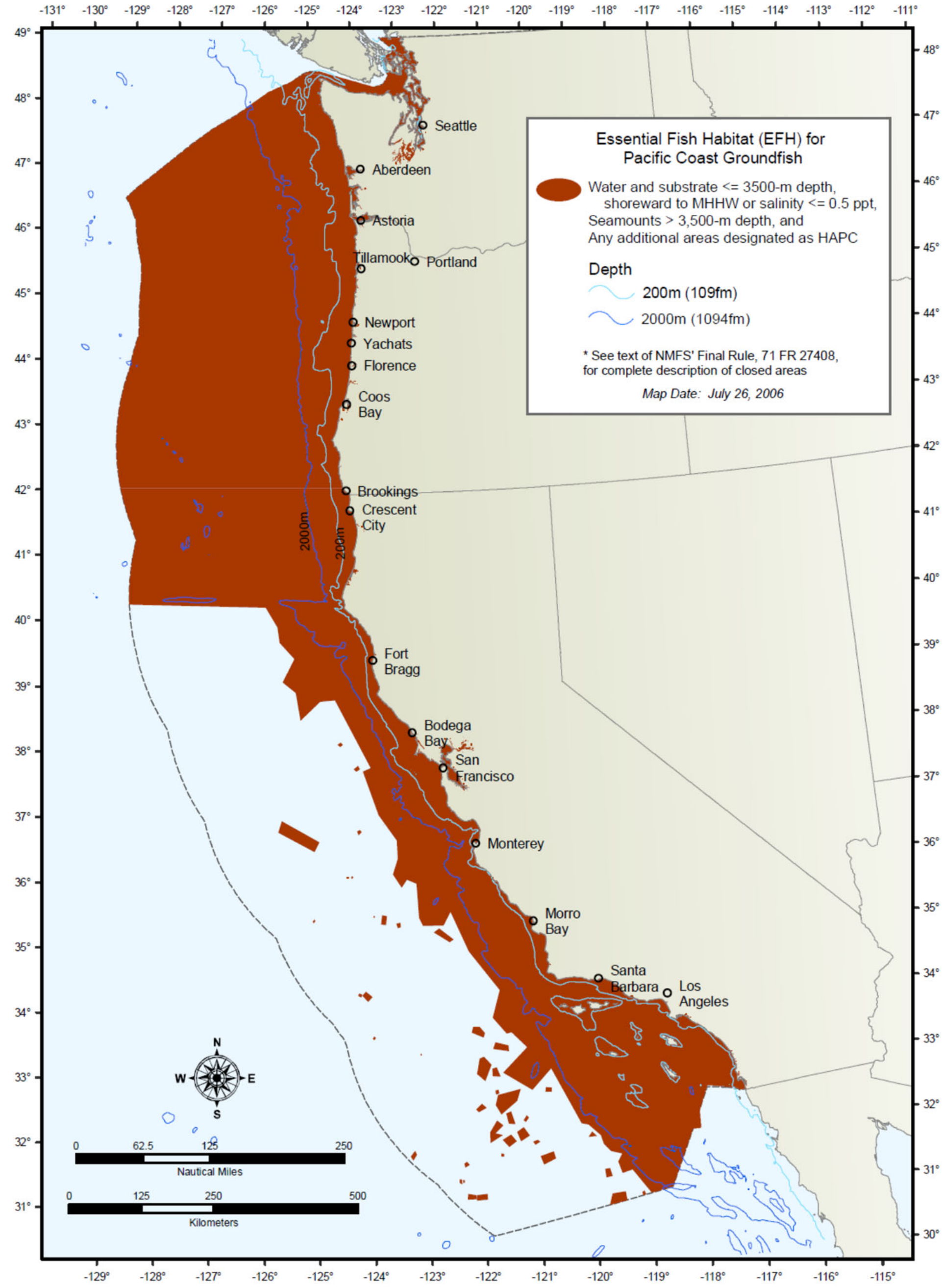
Following stock collapse, the California Fish and Game Commission closed the southern California pink, green, and white abalone fisheries in 1996 and all abalone fishing south of San Francisco in early 1997. The southern abalone fishery was closed indefinitely with the passage of the Thompson bill (AB 663) in 1997. This bill created a moratorium on taking, possessing, or landing abalone for commercial or recreational purposes in ocean waters south of San Francisco, including all offshore islands

J.4.3 Designated Essential Fish Habitat

The NMFS and the PFMC designate EFH and develop FMPs for all fisheries occurring within the Southern California Bight from Point Conception to the U.S./Mexico border. The Sustainable Fisheries Act contains provisions for identifying and protecting habitat essential to federally Managed Species (NOAA 2021e). The FMPs identify EFH, describe EFH impacts (fishing and non-fishing), and suggest measures to conserve and enhance EFH. The FMPs also designate HAPC where one or more of the following criteria are demonstrated: (a) important ecological function; (b) sensitivity to human-induced environmental degradation; (c) development activities stressing the habitat type; or (d) rarity of habitat.

EFH for groundfish managed species includes all waters and substrate from the high tide line or the upriver extent of saltwater intrusion to: 1) depths of 11,483 ft (3,500 m), 2) seamounts in depths greater than 11,483 ft (3,500 m), and 3) areas designated as HAPC not already identified by the above criteria (NMFS 2013b, Figure J-15, from PFMC 2012). With respect to EFH, nearshore areas are considered to be shallower than 120 ft (36 m) with offshore areas beyond that depth. The continental shelf is considered to begin at the 656 ft (200 m) contour.

Figure J-15:
Groundfish Essential Fish Habitat



The Pacific Groundfish FMP divides EFH into seven composite habitats including their waters, substrates, and biological communities: 1) estuaries - coastal bays and lagoons, 2) rocky shelf - on or within 33 ft (10 m) of rocky bottom (excluding canyons) from the high tide line to the continental shelf break, 3) nonrocky shelf - on or within 33 ft (10 m) of unconsolidated bottom (excluding the rocky shelf and canyons) from the high tide line to the continental shelf break, 4) canyon - submarine canyons, 5) continental slope/basin – on or within 66 ft (20 m) of the bottom of the continental slope and basin below the shelf break extending to the westward boundary of the Exclusive Economic Zone, 6) neritic zone – the water column more than 33 ft (10 m) (narrow yellow band above) above the continental shelf, and 7) oceanic zone - the water column more than 66 ft (20 m) (wide yellow band above) above the continental slope and abyssal plain, extending to the westward boundary of the Exclusive Economic Zone (PFMC 2020b, 2012). Table J-9 below presents essential fish habitat for groundfish species.

Table J-9:
Groundfish Species Essential Fish Habitat

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2020b). * = Associated with macrophytes, algae, or seagrass.
Empty cells indicate the habitat is not appropriate for the group/species.

Group/Species	Estuarine	Rocky Shelf	Non-Rocky Shelf	Neritic	Canyon	Continental Slope and Basin	Ocean
Flatfish							
Curlfin Sole			A, SA	E		A, SA	E
Dover Sole			A, SA, J	L, E		A, SA, J	L, E
English Sole	A*, SA, J*, L*, E	A*, SA, J*	A*, SA, J*	L*, E		A*	
Petrale Sole			A, J	L, E		A, SA	L, E
Rex Sole	A		A, SA	E		A, SA	L, E
Rock Sole		A*, SA*, J*, E*	A*, SA*, J*, E*	L		A*, SA*, J*, E*	
Sand Sole			A, SA, J	L, E			
Pacific Sanddab	J, L, E		A*, SA, J	L, E			L, E
Rockfish							
Aurora Rockfish			A, MA, LJ			A, MA, LJ	L
Bank Rockfish		A, J	A, J		A, J	A, J	
Black Rockfish	A*, SJ*	LJ*	LJ*	A*, SJ*			A*
Black-and-yellow Rockfish		A*, MA, LJ*, SJ*, P		L*			
Blackgill Rockfish		LJ		SJ, L		A, LJ	S, LJ
Blue Rockfish		A*, MA, LJ*	LJ*	SJ*, L			
Bocaccio	SJ*, L	A*, LJ*	A*, LJ*	SJ*, L	LJ*	A*, LJ*	
Bronzespotted Rockfish						A	

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2020b). * = Associated with macrophytes, algae, or seagrass.
Empty cells indicate the habitat is not appropriate for the group/species.

Group/Species	Estuarine	Rocky Shelf	Non-Rocky Shelf	Neritic	Canyon	Continental Slope and Basin	Ocean
Brown Rockfish	A*, MA, J*, P	A*, MA, J*, P					
Calico Rockfish	A, J	A, J	A, J				
Canary Rockfish		A, P		SJ*, L		A, P	SJ*, L
Chilipepper		A, LJ, P	A, LJ, P	SJ*, L		A, LJ, P	
China Rockfish		A, J, P		L			
Copper Rockfish	A*, LJ*, SJ*, P	A*, LJ*		SJ*, P			
Cowcod		A, J	J	L			
Darkblotched Rockfish		A, MA, LJ, P	A, MA, LJ, P			A, MA, P	SJ, L
Flag Rockfish		A, P					
Gopher Rockfish		A*, MA, J*, P	A*, A, J*, P				
Grass Rockfish		A*, J*, P					
Greenblotched Rockfish		A, J, P	A, J, P		A, J, P	A, P	
Greenspotted Rockfish		A, J, P	A, J, P				
Greenstriped Rockfish		A, P	A, P				
Honeycomb Rockfish		A, J, P			J		
Kelp Rockfish	SJ*	A*, LJ*, P		SJ*			
Mexican Rockfish		A	A	L			L
Olive Rockfish		A*, J*, P			A*, P		
Pacific Ocean Perch		A, LJ	A, LJ	SJ	A	A, P	SJ, L
Pink Rockfish		A	A			A	
Redbanded Rockfish			A			A	
Redstripe Rockfish		A, P				A, P	
Rosethorn Rockfish		A, P	A, P			A, P	
Rosy Rockfish		A, J, P					
Rougheye Rockfish		A	A			A	
Sharpchin Rockfish		A, P	A, P			A, P	L
Shortbelly Rockfish		A*, P	A*, P		A*, P	A*, P	
Silverygray Rockfish		A*	A*			A*	
Speckled Rockfish		A, J, P			A, P	A, P	
Splitnose Rockfish			A, J*, P			A, P	
Squarespot Rockfish		A, P			A, P		
Starry Rockfish		A, P				A, P	
Stripetail Rockfish			A, P			A, P	
Tiger Rockfish		A				A	
Treefish		A					

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2020b). * = Associated with macrophytes, algae, or seagrass.
Empty cells indicate the habitat is not appropriate for the group/species.

Group/Species	**Estuarine**	**Rocky Shelf**	**Non-Rocky Shelf**	**Neritic**	**Canyon**	**Continental Slope and Basin**	**Ocean**
Vermilion Rockfish		A, J*	J*		A	A	
Widow Rockfish		A, MA, LJ,P	A, MA, LJ, P	SJ*, L	A, MA, LJ, P	A, MA, P	SJ*, L
Yelloweye Rockfish		A, P				A, P	
Yellowtail Rockfish		A, MA, LJ, P	A, MA, LJ, P	SJ*		A, MA, P	SJ*
Scorpionfish							
California Scorpionfish	E	A, SA, J	A, SA, J	E			
Thornyhead							
Longspine Thornyhead						A, SA, J	L, E
Shortspine Thornyhead			A			A, SA	L, E
Roundfish							
Cabezon	A, SA, LJ, SJ*, L, E	A, SA, LJ, E		SJ*, L			SJ*, L
Kelp Greenling	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E		SJ*, L			SJ*, L
Lingcod	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E	A*, LJ*	SJ*, L		A*	
Pacific Cod	A, SA, J, L, E		A, SA, J, E	A, SA, J, L		A, SA, E	A, SA, J, L
Pacific Hake (Whiting)	A, SA, J, L, E			A, SA, J, L, E			A, SA, L, E
Pacific Flatnose					A	A	
Pacific Grenadier			A, SA, J			A, SA, J	L
Sablefish	SJ	A	A, LJ	SJ, L	A, LJ	A, SA	SJ, L, E
Skates/Sharks/Chimeras							
Big Skate			A, MA, J, E			A, MA	
California Skate	A, MA, J, E		A, MA, J, E			A, MA, J, E	
Longnose Skate			A, MA, J, E			A, MA, J, E	
Leopard Shark	A, MA, J, P	A, MA, J, P	A, MA, J, P	A, MA, J, P			
Soupfin Shark	A, MA, J, P	A, MA, J	A, MA, J, P	A, MA, J, P	A, MA, J		A, MA, J
Spiny Dogfish	A, LJ, SJ, P	A, MA, LJ	A, LJ, P	A, LJ, SJ	A	A, MA	A
Spotted Ratfish	A, MA, J	A, MA, J E	A, MA, J E			A, MA, J, E	

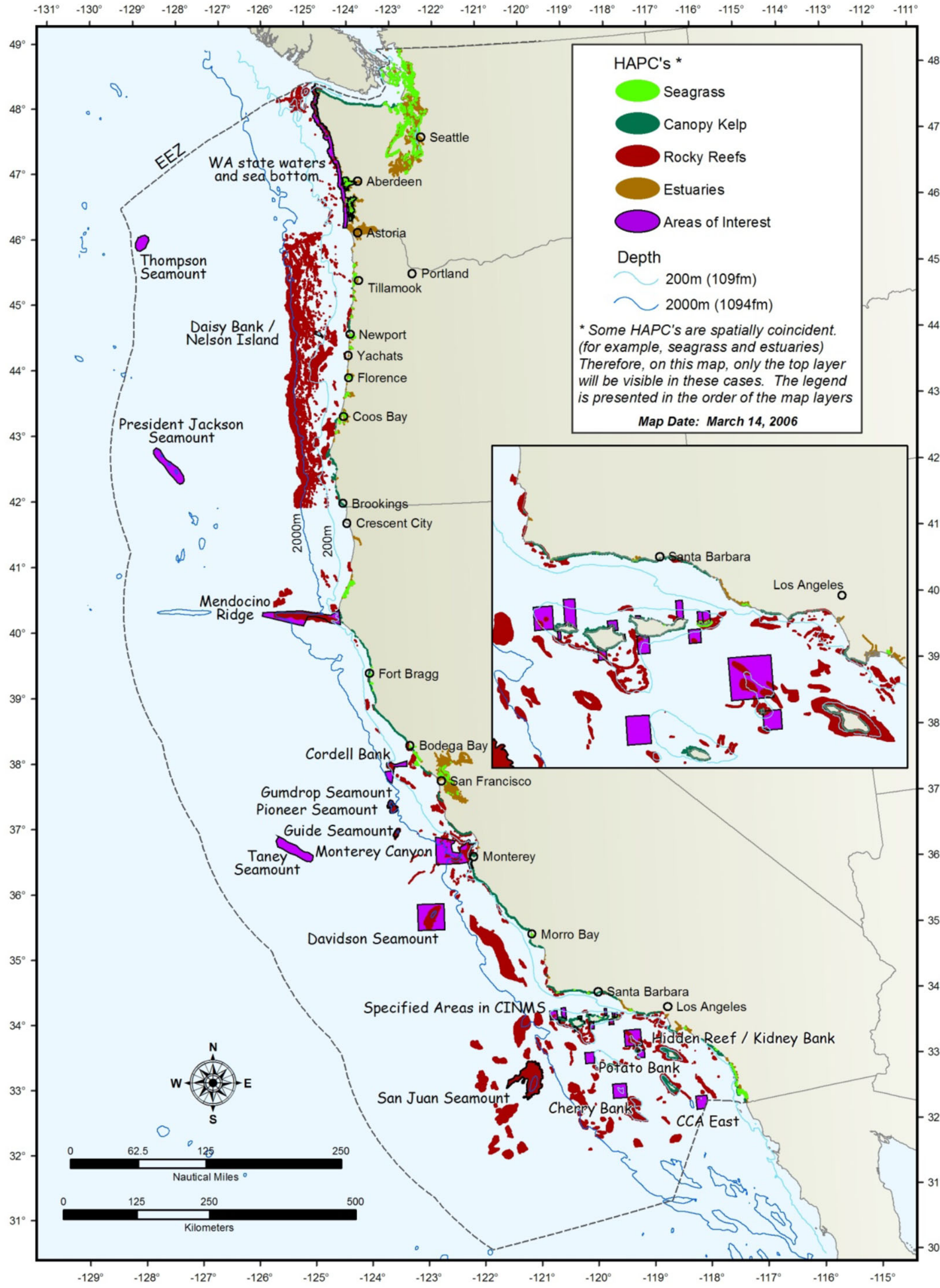
The PFMC has identified six HAPC types. One of these types, certain oil rigs in Southern California waters, was disapproved by NMFS. The current five HAPC types are: estuaries, canopy kelp, seagrass, rocky reefs, and "areas of interest" (e.g., submarine features, such as banks, seamounts, and canyons) (PFMC 2014f). Table J-10 summarizes essential fish habitat and habitat areas of particular concern in the Southern California Bight.

Table J-10:
EFH and HAPC in the Southern California Bight

Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) (PFMC 2014f)		
Group/Species	**EFH**	**HAPC**
Pacific Groundfish	Marine and estuarine waters less than or equal to 11,483 ft (3,500 m) to mean higher high water level or the upwater extent of seawater intrusion, seamounts in depths greater than 3,500 m, and areas designated as HAPC not identified by the above criteria.	Estuaries, canopy kelp, sea grass, rocky reefs, and other areas of interest.
Coastal Pelagic Species	All marine and estuarine waters above the thermocline from the shoreline offshore to 200 nm offshore.	No HAPC designated.
Highly Migratory Species	All marine waters from the shoreline offshore to 200 nm offshore.	No HAPC designated.
Pacific Coast Salmon	North of project area.	North of project area.

Figure J-16 on the following page presents groundfish habitat areas of particular concern for the western coast of the United States, including the Southern California Bight.

Figure J-16:
Groundfish Habitat Areas of Particular Concern



EFH identified for managed CPS is wide-ranging. It includes the geographical range where they are currently found, have been found in the past, and may be in the future. In the Southern California Bight, the CPS EFH constitutes all marine and estuarine waters above the thermocline from the shoreline offshore to the limits of the Exclusive Economic Zone with no HAPC designated. The thermocline is an area in the water column where water temperature changes rapidly, usually from colder at the bottom to warmer on top. The CPS live near the surface primarily above the thermocline, and within a few hundred miles of the coast, so their designated EFH (Table J-11) is less complex than for Groundfish Managed Species. The PFMC is presently considering identifying EFH and possibly HAPC for two individual krill species, *Euphausia pacifica* and *Thysanoessa spinifera*, and for other species of krill (PFMC 2008).

Table J-11:
Coastal Pelagic Species Essential Fish Habitat

Coastal Pelagic Species and Lifestages Associated with EFH designations. A = Adults, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2020c). Empty cells indicate that the habitat is not appropriate for the Group/Species.

Group/Species	Coastal epipelagic	Coastal mesopelagic	Coastal benthic
Krill	E, L, J, A	-	-
Northern anchovy	E, L, J, A	-	-
Mackerels	E, L, J, A	-	-
Sardine	E, L, J, A	-	-
Market Squid	L, J, A	-	E

Only market squid are significantly associated with benthic environments; the females lay their eggs in sheaths on sandy bottom in 33-165 ft (10-50 m) depths. The CPS are found in shallow waters and within bays and even brackish waters, but are not considered dependent upon these habitats. They prefer temperatures in the 50 to 82.4 °F (10 to 28 °C) range with successful spawning and reproduction occurring from 57 to 61 °F (14 to 16 °C). Larger, older individuals are generally found farther offshore and farther north than younger, smaller individuals. All lifestages of CPS species are found in the Southern California Bight.

EFH for HMS (PFMC 2020d, Table J-12) such as tuna, sharks and billfish is even more extensive than for CPS. HMS range widely in the ocean, in area and depth. They are usually not associated with the features typically considered fish habitat (estuaries, seagrass beds, rocky bottoms). Their habitat selection appears to be less related to physical features and more to temperature ranges, salinity levels, oxygen levels, and currents. For the U.S. West Coast Fisheries for HMS, EFH occurs throughout the Southern California Bight. The PFMC has currently identified no HAPC for HMS.

Table J-12:
Highly Migratory Species Essential Fish Habitat

Highly Migratory Species and Lifestages Associated with EFH Designations. A = Adults, SA = Sub-Adults, LJ = Late Juveniles, N= Neonate, EJ = Early Juveniles, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2020d). Empty cells indicate that the habitat is not appropriate for the group/Species.

Group/Species	Coastal epi-pelagic	Coastal meso-pelagic	Oceanic epi-pelagic	Oceanic meso-pelagic
<u>Sharks</u>				
Blue Shark	–	–	N, EJ, LJ, SA, A	–
Shortfin Mako	–	–	N, EJ, LJ, SJ, A	–
Thresher Sharks	LJ, SA, A	LJ, SA, A	LJ, SA, A	LJ, SA, A
<u>Tunas</u>				
Albacore	–	–	J, A	–
Bigeye Tuna	–	–	J, A	J, A
Northern Bluefin	–	–	J	–
Skipjack	–	–	A	–
Yellowfin	–	–	J	–
<u>Billfish</u>				
Striped Marlin	–	–	A	–
<u>Swordfish</u>				
Broadbill Swordfish	–	–	J, A	J, A
<u>Dolphinfish</u>				
Dorado	–	–	J, SA, A	–

Rockfish Conservation Areas, closed to fishing, have been established to protect sensitive Pacific coast groundfish habitat (Figure J-17). Bottom trawling was prohibited in March 2006 in these areas out to depths of 11,482 ft (3,500 m). In Cowcod Conservation Areas (Figure J-18, from PMFC 2012), bottom trawling and other bottom fishing activities are prohibited in waters greater than 120 ft (36 m). Within these conservation areas, cowcod and other "overfished" federal groundfish species, are protected with very low incidental catch limits (*CMLPA 2009*). The conservation areas are expected to remain closed until "overfished" stocks are rebuilt or a new management approach is adopted.

Figure J-17:
Essential Fish Habitat Conservation Areas

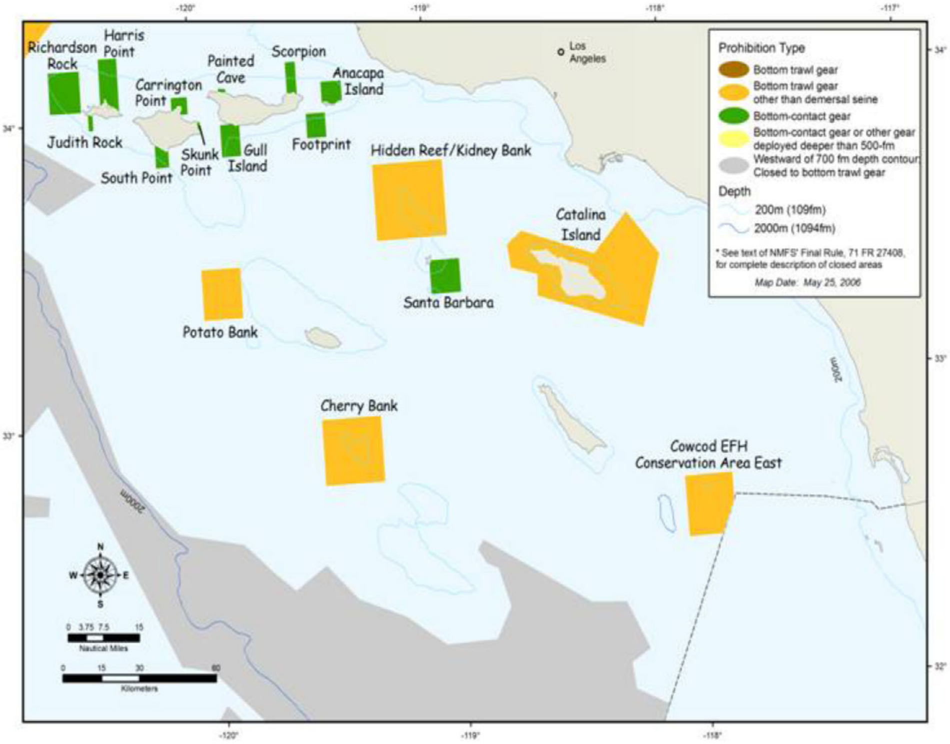
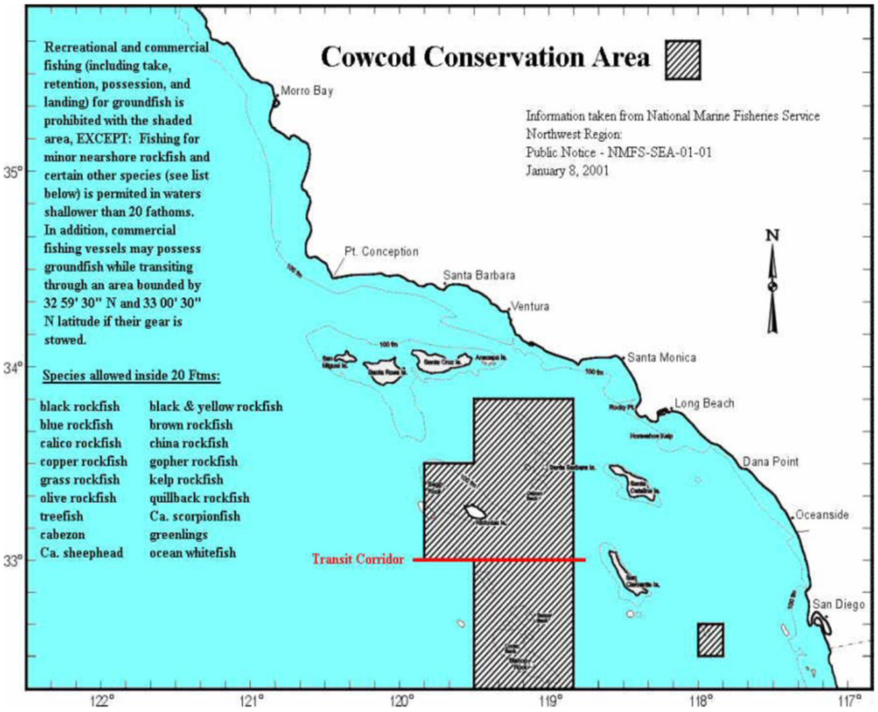


Figure J-18:
Cowcod Conservation Area



Recreational and commercial fishing (including take, retention, possession, and landing) for groundfish is prohibited with the shaded area, EXCEPT: Fishing for minor nearshore rockfish and certain other species (see list below) is permited in waters shallower than 20 fathoms. In addition, commercial fishing vessels may possess groundfish while transiting through an area bounded by 32 59' 30" N and 33 00' 30" N latitude if their gear is stowed.

Species allowed inside 20 Ftms:

black rockfish
blue rockfish
calico rockfish
copper rockfish
grass rockfish
olive rockfish
treefish
cabezon
Ca. sheephead
black & yellow rockfish
brown rockfish
china rockfish
gopher rockfish
kelp rockfish
quillback rockfish
Ca. scorpionfish
greenlings
ocean whitefish

J.4.4 Essential Fish Habitat Impacts

EFH regulations require analysis of potential impacts that could have an adverse effect on EFH and managed species (NMFS 2002a,b). Adverse effect is defined as an impact that reduces the quality and/or quantity of EFH (NMFS 2004a,b). Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

The PLOO could have physical impacts associated with the presence of the pipeline and diffusers on the ocean bottom, and chemical and biological impacts associated with the discharge of treated wastewater.

Physical Impacts

The Point Loma outfall pipeline is buried in a trench through the surf zone out to a distance of about 2,600 ft (792 m) offshore. Over the next 400 ft (123 m) it gradually emerges from the trench and beyond 3,000 ft (914 m) offshore it lies in a bed of ballast rock on the ocean floor. At its terminus, the pipeline connects to the diffuser section with two legs, each 2,500 ft (762 m) long. The outfall pipe and diffusers with their supporting bed of ballast rock form an artificial reef. The pipe and rock, covered with encrusting organisms (tube worms, anemones, barnacles), provide food and shelter to a variety of fish and invertebrates (Wolfson and Glinski 1986). This artificial habitat covers an area of about 22 acres (9 hectares) off Point Loma (assuming a 36-ft (11-m) width of pipe and ballast rock). Catches of rockfish could be enhanced over this area, but would probably be too small to be discernible in recreational or commercial landings.

The pipeline and diffusers represent a potential hazard to commercial fishermen using traps that can snag on the pipe and ballast rock. Lobster, crab, and fish traps are used throughout the area (Parnell et al. 2010). Since the location of the pipeline and diffusers is well-marked on navigation charts and commercial vessels are equipped with accurate positioning systems it is possible to place fishing gear a safe distance away. Nevertheless, commercial trap fishermen target the pipe area, apparently choosing to risk higher gear-loss for a better yield per trap next to the high-relief rocky habitat created by the pipe and ballast rock.

Chemical and Biological Impacts

The PLOO monitoring program provides an extensive database on marine water quality and marine biology beginning with pre-design studies in the late 1950s' (COSD 2008-16,18, 20). The monitoring program at Point Loma was not designed as a research program but was established to determine compliance with local, state, and federal environmental regulations. Even so, the monitoring program has generated data with considerable utility for scientific inquiry and includes many special studies that can contribute to research endeavors. For example, Conversi and McGowan (1992) analyzed 15 years of water transparency data at 7 monitoring stations to evaluate the influence of anthropogenic influences (treated wastewater discharge) and natural oceanographic events. They concluded that anthropogenic activities had not affected transparency, while natural factors such as seasonality and distance from the coast had.

Underwater research has been conducted in the Point Loma kelp bed, 3.5 mi (5.6 km) inshore of the outfall, since the mid 1950s when Wheeler North of the California Institute of Technology and his associates at the Scripps Institution of Oceanography (SIO) began long-term investigations of kelp bed ecology (Neushul 1959, North 1964, North and Hubbs 1968). Professors Paul Dayton and researcher Dr. Ed Parnell and associates at SIO have done ecological surveys at fixed locations in the Point Loma kelp bed since 1971 (e.g., Dayton and Tegner 1984, 1990, Dayton et al. 1992, 2003, Tegner et al. 1995, 1996, 1997, Tegner and Dayton 1987, 1991, Steneck et al. 2002, Graham 2000, 2004, Hewitt et al. 2007, Parnell and Riser 2012, Parnell et al. 2005, 2008, 2010, 2019). Their research has demonstrated that large-scale, low-frequency episodic changes in oceanographic climate control kelp forest community structure. The Point Loma kelp bed has also served as a site for SIO and San Diego State University graduate student research (e.g., Neushul 1959, Gerodette 1971, Deysher 1984, Graham 2000, Mai and Hovel 2007), and for unpublished research on CA spiny lobster movements in the Point Loma kelp bed by Hovel, Lowe, Loflen, and Palaoro.

With the single exception of a temporary break in the pipeline conveying wastewater to the offshore outfall (Tegner et al. 1995), there has been no indication from the extensive research on the Point Loma kelp bed ecosystem of any impact of discharged wastewater. The 2014-2016 marine heat wave did cause massive mortality of giant kelp off San Diego mainly due to nutrient and temperature stress. The kelp forest off San Diego has since begun to recover and future ocean climate conditions are conducive to future recovery (Parnell et al 2019, Appendix E: Kelp Forest Monitoring Off San Diego), nor is there any suggestion in the historical fisheries catch of outfall impacts. The Point Loma outfall ocean monitoring program, as well as other associated studies, provides significant information with which this can be evaluated and nothing has been observed that would indicate any negative impact to the fisheries as a result of the Point Loma discharge (COSD 2020, Appendices C1 -C5). The following section briefly reviews monitoring program results related to the impact on EFH and fisheries species.

The discharge of treated wastewater at Point Loma could affect EFH and fisheries species by altering water or sediment quality. Water quality parameters are monitored at stations around the outfall, in the kelp bed, along the shoreline, and at control stations to the north and south (COSD 2008-2016, 18, 20). Strong local currents and high initial dilution (>200:1) facilitate rapid mixing and dispersion of the discharged effluent.

Unlike dissolved components of the wastewater that are swept away by the currents, particles discharged from the outfall may settle to the ocean floor. This can change the grain size and organic content of the sediments which in turn affects the abundance and diversity of marine organisms living there. Contaminants can also be introduced since many of the potentially harmful chemicals in wastewater are bound to particles.

Alterations in sediment quality in the vicinity of the PLOO are only apparent in areas closer than 1,000 ft (300 m) from the diffusers, where coarser sediments and higher sulfide and biochemical oxygen demand (BOD) levels have been periodically detected (COSD 2008-2016, 18, 20). In general, only sulfide and BOD have shown any change in concentration that appear to be consistent with organic enrichment, and this occurs only immediately adjacent to where the outfall diffusers ejected flow at near zone of initial dilution (ZID) stations (COSD 2020). The change in grain size is likely due to turbulence created as the current flows past the pipe on the bottom, wafting away the finer particles (Diener et al. 1997). The physical presence of large ocean outfalls and associated ballast materials can alter the hydrodynamic regime in surrounding areas, thus affecting sediment movement and transport, and the resident biological communities. Concentrations of anthropogenic Organochlorines (e.g., pesticides, polychlorinated biphenyls (PCBs)) in sediments at Point Loma are generally near or below detection limits at all sampling stations, with the notable exception being dichlorodiphenyldichloroethylene (DDE), a breakdown product of the pesticide dichlorodiphenyltrichloroethane (DDT). DDE, a legacy of historical discharge, is found in sediments throughout southern California (Mearns et al. 1991, Schiff et al. 2011). Levels of DDE at Point Loma are low relative to concentrations elsewhere in the Southern California Bight (COSD 2008-2016, 18, 20, Schiff et al. 2011, Appendix C5). Additionally, there is no consistent pattern of metal concentrations in the sediments as a function of distance from the outfall - the highest levels of iron, aluminum, and copper are found at the northern reference stations. Trace metals are very low compared to available thresholds (COSD 2020).

Sediment toxicity testing was performed from 2016 through 2020 at a number of stations along the San Diego coast, including several that were very close to and bracketed the PLOO discharge point (near ZID). No evidence of toxicity was observed at any station on the shelf off Point Loma. (COSD 2020, Appendix C3).

Changes in sediment quality should also be reflected in the types of species living on and in the sediment. Two elements of the current monitoring program collect this type of information: 1) benthic infauna, and 2) demersal (bottom-dwelling) fish and megabenthic invertebrates. Benthic infauna are collected by collecting grab samples off the ocean floor. Demersal fish and invertebrates are gathered by trawling across the bottom. Living in close association with the sediments, these groups are classic indicators of altered conditions. Also, many important fisheries species live on the bottom and/or feed there.

The infaunal community around the outfall is dominated by an ophiuroid-polychaete assemblage typical of this depth and sediment type in southern California (Ranasinghe et al. 2012). Changes that have occurred in the soft-bottom maroinvertebrate assemblage surrounding the outfall are mainly related to large-scale oceanographic events like El Niño (Zmarzly et al. 1994, Bartlett et al. 2004, Linden et al. 2007, COSD 2008-2016, 18, 20, Appendix C1).

Abundance of the ophiuroid *Amphiodia* which is sensitive to organic enrichment has decreased at near ZID sites but this effect is also being seen regionwide in areas outside the influence of the discharge. Other changes in community structure suggest that the impact may be due to the presence of the outfall structure itself, rather than the influence of discharged wastewater (Posey and Ambrose 1994, Diener et al. 1997). Whatever the reason, infaunal communities near the Point Loma outfall remain similar to those observed prior to discharge and are comparable to natural indigenous communities (COSD 2020). Additionally, using the triad method of evaluating sediment quality (evaluating chemical composition, toxicity and infaunal community structure) indicates no impairments in any sediments near the Point Loma Outfall discharge (Appendix C).

Trawl samples collected at Point Loma are dominated by small flatfish and sea urchins. Though inherently more variable than infaunal data, the trawl data also indicate that normal oceanographic processes control the abundance and diversity of demersal fish and megabenthic invertebrates living around the outfall (COSD 2008-2016, 18, 20, Appendices C1, C4). Patterns in abundance, biomass, and species composition have remained stable since monitoring began. The fish collected by trawling are healthy, with few parasites and a low level or absence of fin rot, tumors, and other physical abnormalities.

One of the most important elements of the Point Loma monitoring program from the EFH and fisheries perspective is the measurement of chemical contaminants in fish tissues. Fish can accumulate pollutants from: 1) absorption of dissolved chemicals in the water, 2) ingestion of contaminated suspended particles or sediment particles, and 3) ingestion of contaminated food (Allen 2006, Newman 2009, Allen et al. 2011, Laws 2013). Incorporation of contaminants into an organism's tissue is called bioaccumulation (Weis 2014, Whitacre 2014). Contaminants can also be concentrated as they are passed through the food web when higher trophic level organisms feed on contaminated prey (Bienfang et al 2013, Daley et al. 2014). Bioaccumulation has potential ecological and human health implications (Klasing and Brodberg 2008, 2011, Walsh et al. 2008, OEHHA 2014a,b).

The PLOO monitoring program targets two types of fish for assessment of contaminant levels: flatfish and rockfish. Samples are collected at various distances from the outfall and at control stations to the north and south. Flatfish and rockfish at Point Loma have concentrations of metals in liver and muscle tissue consistent with values detected throughout the Southern California Bight (Mearns et al. 1991, Allen et al. 2011, COSD 2020). There is no apparent relationship between metal levels and proximity to the outfall (COSD 2020, Appendix C5). Elevated levels of arsenic were found in fish species at both outfall and control stations. The source of this arsenic has historically been attributed to be vents from natural hot springs off the coast of Baja California.

A variety of man-made compounds including DDT (and its derivatives) and PCBs are routinely found in fish tissue throughout the area. These chlorinated hydrocarbons are ubiquitous in southern California, but their concentration in sediments and organisms is steadily decreasing in most areas (Mearns et al. 1991, Allen et al. 2011, Setty et al. 2012, SCCWRP 2021a). Samples collected near the outfall do not have higher levels of DDT and PCBs than samples collected at reference sites COSD 2020). A previous study (Parnell et al 2008) found PCB contamination present in dredged material taken from San Diego Bay and deposited south of Point Loma at the LA-5 disposal site as a source of PCB contamination.

The EPA and the U.S. Food and Drug Administration (FDA) establish limits for the concentration of contaminants like arsenic, DDT and PCBs in seafood sold for human consumption (EPA 2014a, FDA 2014). The California Office of Environmental Health Hazard

Assessment developed a general advisory for all coastal waters of California, excluding enclosed bays and coastal areas with existing advice, because of the level of mercury and PCBs found in coastal fish the length of the state (OEHHA 2020). Coastal state waters are defined as extending 3 nm from the mean low tide line and 3 nm beyond the outermost islands (e.g., the Channel or Farallon islands), including all waters between those islands and the coast, from the Oregon/California border to the United States/Mexico border.

There are no harvest closures or restrictions on seafood taken specifically from the coast off Point Loma that are unique to that area and related to the Point Loma discharge.

In summary, monitoring data show effects of the Point Loma discharge only in deep water near the outfall where minor water and sediment quality alterations have been observed only very close to the outfall. Marine communities in the Point Loma region remain characteristic of natural conditions with no suggestion of environmentally significant changes.

J.4.5 Cumulative Impacts

Cumulative impacts are defined in the National Environmental Protection Act (42 U.S.C. § 4321 *et seq*. and 32 CFR 775 respectively) as: the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7).

In general, the effects of a particular action or group of actions must meet all of the following criteria to be considered cumulative impacts:

- Effects of several actions occur in a common locale or region;
- Effects on a particular resource are similar in nature, such that the same specific element of a resource is affected in the same specific way; and
- Effects are long-term as short-term impacts dissipate over time and cease to contribute to cumulative impacts.

The discharge of treated wastewater from commercial activities, including municipal wastewater treatment plants, power generating stations, industrial plants (e.g., desalination plants), and storm water from drains into open ocean waters, bays, or estuaries can introduce chemical and biological constituents potentially detrimental to estuarine and marine habitats (Perry 2009, Hutchison et al. 2013). These constituents may include pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, and toxic chemical compounds (Stein and Cadien 2009, Setty et al. 2012). Treated wastewater discharges have been regulated under increasingly stringent requirements over the last 50 years and mass emissions of most constituents have been significantly reduced (Lyon and Sutula 2011, SCCWRP 2012, 2021a). Point and nonpoint sources associated with storm water runoff, on the other hand, have not been managed as effectively and continues to be a substantial remaining source of contamination of coastal areas and the ocean (Setty et al. 2012, Howard et al. 2014).

Potential cumulative threats to EFH and fisheries species include degradation of water quality, habitat modification, pollution (chemicals, marine debris, etc.), introduction of exotic species, disease, natural events, and global climate change (Field et al. 2003, Horn and Stevens 2006, O'Shea and Odell 2008, Pinnegar and Engelhard 2008, Crain et al. 2009, Halpern et al. 2009, Hoegh-Guldberg and Bruno 2010, Thrush and Dayton 2010, Doney et al. 2012, Hazen et al. 2012, Howell et al. 2012, SCCWRP 2012, NMFS 2013a, Howard et al. 2014, Maruya et al. 2014). Cumulative impacts could alter the physiology, behavior, growth, and reproduction of individual species, shift patterns of larval dispersal and recruitment, modify the composition of ecological communities, and, change the structure, function, productivity, and resilience of marine ecosystems.

In addition, fishing and non-fishing activities, individually or in combination, can adversely affect EFH and fisheries species (Jackson et al. 2001, 2011, Dayton et al. 2003, Hanson et al. 2003, Chuenpagdee et al. 2003, Jackson 2008, Baum and Worm 2009, Worm et al. 2009, Norse 2010, Hilborn and Hilborn 2012, NMFS 2013b, Laugen et al. 2014). Potential impacts of commercial fishing include over-fishing of targeted species, and bycatch, both of which negatively affect fish stocks (Barnette 2001, NRC 2002, Dieter et al. 2003, PFMC 2004, Hseih et al. 2006, Carretta and Enriquez 2012, PFMC and NMFS 2012). Mobile fishing gears such as bottom trawls (now prohibited to deeper than 3,500 ft) disturb the seafloor and reduce structural complexity (Auster and Langton 1998, Johnson 2002, Lindholm et al. 2011). Indirect effects of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (continued catch by lost or discarded gear), and generation of marine debris (Hamilton 2000, Reeves et al. 2013). Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats (NMFS 2013b). Recreational fishing also poses a threat because of the large number of participants and the intense, concentrated use of specific habitats (Coleman et al. 2004, Ihde et al. 2011, United Nations Food and Agricultural Organization (UNFAO) 2012, Arlinghaus et al. 2013).

Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal (Davidson et al. 2011, Hutchinson et al. 2013, Moore et al. 2013). Natural stresses include storms and climate-based environmental shifts, such as algal blooms and hypoxia (Kim et al. 2009, SCCWRP 2013).

Allen et al. (2005) analyzed fish population trends from 20- to 30-year fish databases (e.g., power generating station fish impingement and trawl monitoring, recreational fishing, and publicly owned treatment works (POTW) trawl monitoring). Combined, these databases provided information on 298 species of fish. A number of long-term environmental databases (e.g., CalCOFI oceanographic data, shoreline temperature, coastal runoff, and POTW effluent contaminant mass emissions) were used to identify influential, independent environmental variables (e.g., PDO; ENSO; offshore temperature; upwelling in the north, Southern California Bight, and south; coastal runoff; and contaminant mass emissions). Most southern California fish had population trends that followed changes in natural oceanic variables not anthropogenic inputs. The most important environmental variables were PDO (positive and negative responses), upwelling in the Southern California Bight, offshore temperature, and

ENSO. The PDO was the dominant influence for most species in these databases, with the presence or absence of upwelling during the warm regime having an important effect on others (Mills and Walsh 2013). Recent analyses of long-term fish population dynamics in the Southern California Bight also indicate that the primary driver of shifting trends in local fish populations is natural climatological change rather than anthropogenic influence (Miller and Schiff 2012, Koslow et al. 2013, Miller and McGowan 2013, Parnell et al 2019).

Removal of fish by fishing can profoundly influence individual populations, their survival, and the composition of the community in which they live (Jackson 2008, Jackson et al. 2011, Hilborn and Hilborn 2012). In a seminal study of retrospective data, Jackson et al. (2001) analyzed paleoecological records of marine sediments from 125,000 years ago to present, archaeological records spanning 10,000 years, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer-term data and information, they concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems including pollution, degradation of water quality, and anthropogenic climatic change.

Underwater research has been conducted in the Point Loma kelp bed, 3.5 mi (5.6 km) inshore of the outfall, since the mid 1950s when Wheeler North of the California Institute of Technology and his associates at the SIO began long-term investigations of kelp bed ecology (Neushul 1959, North 1964, North and Hubbs 1968). Professors Paul Dayton, researcher Dr. Ed Parnell and associates at SIO have done ecological surveys at fixed locations in the Point Loma kelp bed since 1971 (e.g., Dayton and Tegner 1984, 1990, Dayton et al. 1992, 2003, Tegner et al. 1995, 1996, 1997, Tegner and Dayton 1987, 1991, Steneck et al. 2002, Graham 2000, 2004, Hewitt et al. 2007, Parnell and Riser 2012, Parnell et al. 2005, 2008, 2010, 2019). Their research has established a long-term database unique in the world, demonstrating that large-scale, low-frequency episodic changes in oceanographic climate control kelp forest community structure. With the single exception of a temporary break in the pipeline conveying wastewater to the offshore outfall (Tegner et al. 1995), there has been no indication in the scientific studies of any impact of the discharged wastewater at Point Loma on the kelp bed ecosystem.

A number of factors influence water quality and biological conditions in the Point Loma area. Potential influences on water quality include ocean upwelling, regional non-point source discharges such as local river outflows, and other local point and non-point sources such as harbors, marinas, storm drains, and urban runoff as well as the PLOO discharge (Bartlett et al. 2004, Parnell et al. 2008, Parnell and Riser 2012).

The PLOO discharges at a depth of approximately 100 m, which inhibits wastewater from reaching surface waters due to thermal stratification and which typically results in the plume being trapped offshore at depths of 40 to 60 m below the surface (COSD 2018; Rogowski et al., 2012, 2013; Svejkovsky, 2015-2017). During spring and summer months, when algal blooms are most prevalent in the Southern California Bight region (Smith et al., 2018), thermal stratification is strongest and plume trapping depths are greatest (Bartlett et al., 2004). Even during the winter months, when vertical stratification of the water column is weakest, the PLOO plume does not typically rise to the surface (Svejkovsky 2015-2017, Hess 2018-2021). Thus, little probability exists that the PLOO could contribute nitrogen to the upper 60 m of the water column even during the times of year when the highest potential exists for algal blooms to occur. It is unlikely that the PLOO directly drives phytoplankton blooms on a local scale.

The euphotic zone is the layer of the water column close to the surface that receives enough light for photosynthesis to occur. The combination of light and excess nutrients within this zone can result in excess production of phytoplankton and, thus, contribute to an algal bloom. Beneath the euphotic zone lies the disphotic zone, which is so dark that rates of respiration exceed those of photosynthesis. Recent analysis of subsurface Chlorophyll-*a* (a proxy for phytoplankton abundance and primary productivity) in the San Diego region show peaks in concentration at depths of 25 m to 36 m (Nezlin et al., 2018). Although we do not have a direct measure of the euphotic zone specific to the San Diego region, using Chlorophyll-*a* concentrations as a proxy indicates that primary production is largely limited to the surface waters above where the PLOO plume is associated. Thus, through a combination of stratification and dilution at the PLOO, plume nutrients are not likely mixed into the euphotic zone for primary producers to assimilate into their biomass. Furthermore, the PLOO achieves a high level of dilution that amounts to a significant dilution of nutrient concentrations as they are comingled with the receiving water after discharge. Consequently, nutrient concentrations near the PLOO are not detectably different from concentrations in ambient waters (Bartlett et al., 2004). As a result, PLOO effluent nutrients likely have minimal effect on phytoplankton production during much of the year, with regional ocean dynamics being a more significant driver (Mantyla et al., 2008; Nezlin et al., 2012, 2018).

Howard et al. (2014) used a model to generate comparisons of nitrogen contributions from ocean upwelling, local rivers, atmospheric deposition and wastewater treatment plant effluent. The authors suggested that total nitrogen flux from wastewater outfalls was larger than that of upwelling and was almost equivalent to riverine input. Importantly however, the model was only validated for use in nearshore coastal waters, as it failed validation testing for offshore. Thus, it is acknowledged that the location of the PLOO was at the edge of the model's validated boundary, which resulted in "a large amount of uncertainty".

Several researchers have determined that the extent of algal blooms in the Southern California Bight region have increased over the last two decades (Kahru et al., 2012; Nezlin et al., 2012). However, according to reports from Ocean Imaging Inc., there were no red tide events associated with the PLOO (Svejkovsky, 2015-2017, Hess 2018-2021, Appendix F). Red tides have been recorded in the Southern California Bight region for over a century, with a recent severe Harmful Algal Bloom (HAB) occurring in 2020, and yet there is no evidence to indicate a direct correlation with wastewater discharge (Allen, 1933; Hess 2018-2021, Horner et al., 1997; Kim et al., 2009; McGowan et al., 2017; Svejkovsky, 2015-2017; Torrey, 1902). Blooms tend to originate in shallower waters off northern San Diego County and move south, or off southern San Diego and move north (Svejkovsky, 2015-2017, Hess 2018-2021).

In the months leading up to the HAB event in 2020, the southern California coast experienced precipitation levels 200-400% above normal (*NOAA National Weather Service*). According to the Southern California Coastal Ocean Observing System (SCCOOS 2020), as the rains subsided in early April, the algal species *Lingulodinium polyedra* proliferated. The influx of freshwater to coastal waters likely made the surface ocean waters more hospitable to this species, an alga known to thrive in stratified conditions where the surface layer is less saline/dense than the bottom layer. Furthermore, like most phytoplankton, *L. polyedra* grow well when temperatures are warm, a factor which further contributed to the stratification. As the waters warmed in early April, and wind was very low, conditions were perfect for the development of a widespread bloom, which extended from Los Angeles to Baja. SCCOOS suggests that although nutrients from runoff may have sustained active growth of the *L. polyedra* bloom, it initially developed offshore away from the influence of terrestrial inputs (Anderson and Hepner, 2020). Although early modeling work suggests that anthropogenic nutrient inputs may contribute to algal primary production along the coast (unpublished), multiple studies have states that climate change, rainfall events, and upwelling are more likely to be the major contributing factors to the proliferation of algal blooms (Gershunov et al., 2019; Gobler et al., 2017; Messie and Chavez, 2015; Rykaczewski and Dunne, 2010; Patti et al., 2008).

Research is underway to better understand what contributes to HABs (SCCWRP 2021b) and the role of the treated wastewater discharges. San Diego, through its participation in SCCWRP, will continue to participate in these efforts, as well as any other special studies that may be necessary in association with climate change. It is anticipated that in the next permit period the PLOO monitoring program may be modified to align with these efforts by additional monitoring for nutrients. This can provide information specific to the PLOO, as well as contribute valuable information to the HAB research endeavors by others. As always, San Diego will continue to participate in Bight Regional Monitoring efforts.

The effects of the Point Loma discharge on water quality and biological conditions are evident only in deep waters within or near the ZID (COSD 2008-2016, 18, 20, Appendix C). Organic enrichment of the sediments due to the outfall discharge is not occurring beyond the ZID. Contaminant loading of sediments is not evident in the discharge vicinity. Sediment chemistry is comparable to reference areas along southern California's outer continental shelf. Biological conditions do not indicate any environmentally significant changes associated with the discharge. A balanced indigenous population of shellfish, fish and wildlife exist immediately beyond the ZID.

While significant natural variations in fish populations are observed (in response to factors such as water temperature, such as the warm water period in 2014-2016 where sea urchin populations were decimated in the Point Loma kelp beds (Parnell et al 2019)), the Point Loma wastewater discharge is not having any significant effect on demersal fish assemblages off Point Loma. Fish populations are healthy and lack physical abnormalities such as fin erosion or tumors. Levels of trace metals, chlorinated hydrocarbons such as pesticides including PCBs are relatively low, with concentrations within the range found in fish throughout the Southern California Bight. Overall, no outfall-related effects are evident from bioaccumulation data. Contaminants in fish tissues in the Point Loma area are similar to those at reference sites beyond the influence of the discharge (Appendix C5).

The PLOO discharge complies with all federal and state standards including State of California Ocean Plan standards for the water quality, protection of marine aquatic life, protection of human health (noncarcinogens) and protection of human health (carcinogens) (SWRCB 2019).

Based on scientific research and oceanographic monitoring at Point Loma, the impact on EFH from the discharge of treated wastewater is expected to be minimal. There should be no significant cumulative, incremental, or synergistic effects on present or reasonably foreseeable future uses of the Point Loma marine environment.

Very important changes related to the discharge through the PLOO are anticipated to occur during the upcoming permit period. A significant modification in San Diego's wastewater system will be initiated during the period of the renewed permit which will improve the quality of the discharge and reduce the flow through the PLOO.

The City will begin operating new wastewater treatment and water reclamation facilities that will significantly reduce the flow and associated pollutants discharged through the PLOO. By the end of 2027, Phase 1 of Pure Water is expected to be in full operation, diverting on average up to 52 mgd of wastewater away from the PLWTP to produce 30 mgd of water suitable for potable reuse and up to 11.9 mgd of reclaimed water for non-potable reuse (e.g., irrigation, industrial and commercial uses). This diversion will result in a nearly 20% reduction in flow discharged through the PLOO. In addition, tests conducted at the Phase 1 Demonstration Facility have shown a significant portion of the pollutants that would have been released at the PLOO discharge will be eliminated through the use of advanced technologies such as ozonation and biological activated carbon filtration. In addition to a reduction in conventional pollutants such as suspended solids and nutrients, many contaminants of emerging concern (CECs), including persistent organic pollutants, pharmaceutical and personal care products, etc., are completely removed from the system at a greater efficiency than traditional wastewater treatment processes.

The PLOO monitoring program has not included routine analysis for CECs. Generally, this was because of the myriad of these substances in existence, lack of analytical methods and little toxicological information with which to put any monitoring results into context. San Diego has and will continue to participate in regional studies coordinated by the SCCWRP that may include work related to CECs. Additionally, it is anticipated that for the renewed permit period some form of monitoring may be initiated to provide information regarding the prevalence of CECs in the discharge, as well as to contribute to research efforts underway by others to understand the sources, fates and effects of these substances.

Possible modifications to the monitoring program, both for nutrients and CECs, will also allow for an assessment of the anticipated improvement in the PLOO discharge for these substances resulting from the diversion of wastewater away from the PLOO to highly advanced upstream reclamation processes.

J.5 CONCLUSIONS

The proposed operation of the PLOO should not reduce the quality or quantity of EFH. Extensive monitoring and scientific studies indicate little to no alteration of physical, chemical, or biological conditions of the waters or substrates. Impacts on marine organisms, prey species, their habitat, and other ecosystem components are minimal. Wastewater discharged from the outfall makes an insignificant contribution to regional cumulative impacts on EFH or fisheries species. Additionally, improvements in the discharge that are anticipated to occur during the upcoming permit period will continue to prevent degradation of the EFH in the future. Thus, the discharge of treated wastewater from the PLOO should not have an adverse effect on EFH.

REFERENCES

Allen, M. J. 2006. Pollution. The Ecology of Marine Fishes: California and Adjacent Waters. In: L. G. Allen, D. J. Pondella and M. H. Horn (eds). University of California Press. Berkeley, CA.

Allen, L. G. and J. N. Cross. 2006. Surface Water. Chapter 12. pp. 320-341 in: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press: Berkeley, CA. 670 p.

Allen, M. J., S. L. Moore, K. C. Schiff, D. Diener, S. B. Weisberg, J. K. Stull, A. Groce, E. Zeng, J. Mubarak, C. L. Tang, R. Gartman, and C .I. Haydock 1998. Assessment of Demersal Fish and Megabenthic Invertebrate Assemblages on the Mainland Shelf of Southern California in 1994. Southern California Coastal Water Research Project, Westminster, CA.

Allen, L. G., A. M. Findlay, and C. M. Phalen 2002. Structure and Standing Stock of Fish Assemblages of San Diego Bay, California from 1994 to 1999. Bulletin of Southern California Academy of Science 101(2):49-85. Berkeley, California.

Allen, M.J., A.K. Groce, D. Diener, J. Brown, Steinert, G. Deets, J.A. Noblet, S.L. Moore,D. Diehl, E.T. Jarvis, V. Raco-Rands, Thomas, Y. Ralph, R. Gartman, D. Cadien, Weisberg, and T. Mikel. (2002). Southern California Bight 1998 Regional Monitoring Program: V. Demersal Fishes and Megabenthic.

Allen, M. J., R. W. Smith, E. T. Jarvis, V. R. Rands, B. B. Bernstein, and K. T. Herbinson 2005. Temporal Trends in Southern California Coastal Fish Populations Relative to 30-Year Trends in Oceanic Conditions. In: Fish Populations pp. 264-285.

Allen, L. G., D. J. Pondella, II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press, Los Angeles. 670 p.

Allen, M. J., D. Cadien, E. Miller, D. W. Diehl, K. Ritter, S. L. Moore, C. Cash, D. J. Pondella, V. Raco-Rands, C. Thomas, R. Gartman, W. Power, A. K. Latker, J. Williams, J. L. Armstrong, and K. Schiff 2011. Southern California Bight 2008. Regional Monitoring Program: Volume IV. Demersal Fishes and Megabenthic Invertebrates. Southern California Coastal Water Research Project, Costa Mesa, CA.

Allen, M. J., R. W. Smith, E. T. Jarvis, V. R. Rands, B. B. Bernstein, and K. T. Herbinson 2005. Temporal Trends in Southern California Coastal Fish Populations Relative to 30-Year Trends in Oceanic Conditions. In: Fish Populations pp. 264-285.

Allen, M. J., D. Cadien, E. Miller, D. W. Diehl, K. Ritter, S. L. Moore, C. Cash, D. J. Pondella,V. Raco-Rands, C. Thomas, R. Gartman, W. Power, A. K. Latker, J. Williams, J. L. Armstrong, and K. Schiff 2011. Southern California Bight 2008. Regional Monitoring Program: Volume IV. Demersal Fishes and Megabenthic Invertebrates. Southern California Coastal Water Research Project, Costa Mesa, CA.

Arlinghaus, R., S. J. Cooke, and W. Potts 2013. Towards Resilient Recreational Fisheries on a Global Scale through Improved Understanding of Fish and Fisher Behavior. Fisheries Management and Ecology 20:91–98.

Auster, P. J. and R. W. Langton 1998. The Effect of Fishing on Fish Habitat. National Undersea Research Center. Univ. of Connecticut. Groton, CT. 51 p.

Barnette, M. C. 2001. A Review of the Fishing Gear Utilized Within the Southeast Region and their Potential Impacts on Essential Fish Habitat. National Marine Fisheries Service. Southeast Regional Office. St. Petersburg, Fl. 68 p.

Bartlett, D., P. Dayton, P. Frank, L. Levin, E. Parnell, L. Shaffer, and C. Winant 2004. Point Loma Outfall Project Report. Scripps Institution of Oceanography. September 2004. 60 p.

Baum, J. K. and B. Worm 2009. Cascading Top-Down Effects of Changing Oceanic Predator Abundances. Journal of Animal Ecology 2009 doi: 10.1111/j.1365-2656.2009.01531.x. 16 p.

Bell, S. 2009. Hagfish: A Re-emerging Fishery. Marine Management News: May 2009. https://www.dfg.ca.gov/marine/newsletter/0509.asp

Benjamin S. G. and J. A. Carton 1999. Interannual and Decadal Variability in the Tropical and Midlatitude Pacific Ocean. Journal of Climate. Vol.12: Issue 12: 3402-3418.

Bienfang, P. K., H. Trapido-Rosenthal, and E. A. Laws 2103. Bioaccumulation/Biomagnifications in Food Chains. In: Environmental Toxicology. E. A. Laws (ed) 2013. Springer Publications. Print ISBN 978-1-4614-5763-3. Pp. 35-69.

Bjorkstedt, E., Goericke, R., McClatchie, S., Weber, E., Watson, W., Lo, N., Peterson, W., Brodeur, R., Bograd, S., Auth, T., Fisher, J., Morgan, C., Peterson, J., Durazo, R.,Gaxiola-Castro, G., Lavaniegos, B., Chavez, F., Collins, C. A., Hannah, B., Field, J., Sakuma, K., Satterthwaite, W., O'Farrell, M., Sydeman, W., Thompson, S.A., Warzybok, P. Bradley, R., Jahncke, J., Golightly, R., Schneider, S., Largier, J., Kim, S.Y., Melin, S., DeLong, R., and J. Abell 2013. State of the California Current 2011- 2012: Ecosystems Respond to Local Forcing as La Niña Wavers and Wanes, CalCOFI Reports 53, 41-78.

Brown, D. A., R. W. Gossett, G. P. Hershelman, C. G. Word, A. M. Westcott, and J. N. Cross 1986. Municipal Wastewater Contamination in the Southern California Bight: Part I-Metal and Organic Contaminants in Sediments and Organisms. Mar. Environ. Res., 18:291–310.

Butler, J. L., M. S. Love, and T. E. Laidig 2012. A Guide to the Rockfishes, Thornyheads, and Scorpionfishes of the Northeast Pacific. University of California Press. 185 p.

CalCOFI (California Cooperative Oceanic Fisheries Investigations) 2013. Review of Selected California Fisheries for 2012: Coastal Pelagic Finfish, Market Squid, Pacific Herring, Groundfish, Highly Migratory Species, White Seabass, Pacific Halibut, Red Sea Urchin, and Sea Cucumber. California Department of Fish and Wildlife. Fisheries Review. CalCOFI Rep., Vol. 54, 2013. 25 p.

California Fisheries Fund 2014. The California Fisheries Atlas. June 2014. http://www.californiafisheriesfund.org

CDFG (California Department of Fish and Game) 1968. The Marine Environment Offshore from Point Loma, San Diego County. Marine Resources Operations. Fish Bulletin 140.

CDFW (California Department of Fish and Wildlife) 2013a. Status of the Fisheries Report an Update Through 2011. Report to the California Fish and Game Commission. January 2013. 277 p.

CDFW 2013a (California Department of Fish and Wildlife) 2013. Status of the Fisheries Report an Update Through 2011. Report to the California Fish and Game Commission. January 2013. 277 p.

CDFW 2013b. Guide to the Southern California Marine Protected Areas Point Conception to California-Mexico Border. November 2013. 120 p.

CDFW 2014b. California Marine Life Management Act. www.wildlife.ca.gov

CDFW 2014c. California Nearshore Fisheries Management Plan. www.wildlife.ca.gov

CDFW 2014d. White Seabass Fishery Management Plan. www.wildlife.ca.gov/

CDFW 2014e. Market Squid Fishery Management Plan. www.wildlife.ca.gov/

CDFW 2014f. Spiny Lobster Fishery Management Plan. www.wildlife.ca.gov/

CDFW 2014g. Coastal Pelagic Species Landings. www.wildlife.ca.gov/

CDFW 2014h. Abalone Recovery and Management Plan. www.wildlife.ca.gov

CDFW 2021a. California Department of Fish and Wildlife Web Site. www.wildlife.ca.gov/

CDFW 2021d. Marine Protected Areas. www.wildlife.ca.gov/Conservation/Marine/MPAs/Network/Southern-California

CFR (Code of Federal Regulations) 2013. 50 CFR 402.14 - Formal Consultation. Title 50: Wildlife and Fisheries. Subpart B: Consultation Procedures. Tuesday, October 1, 2013. http://www.gpo.gov/fdsys/pkg/CFR-2013-title50-vol11/pdf/CFR-2013-title50-vol11-sec402-14.pdf

Chenillat, F., P. Riviere, X. Capet, P. J. S. Franks, and B. Blanke 2013. California Coastal Upwelling Onset Variability: Cross-Shore and Bottom-Up Propagation in the

Planktonic Ecosystem. PLoS ONE 8(5):e62281.

Chuenpagdee, R., L. E. Morgan, S. M. Maxwell, E. A. Norse, and D. Pauly 2003. Shifting Gears: Assessing Collateral Impacts of Fishing Methods in US Waters. Front. Ecol. Environ. 1(10): 517–524.

CMLPA (California Marine Life Protection Act) 2009. Regional Profile of the MLPA South Coast Study Region (Point Conception to the California-Mexico Border). Second Edition. June 25, 2009. 193 p.

Coleman, F. C., W. F. Figueira, J. S. Ueland, and L. B. Crowder 2004. The Impact of United States Recreational Fisheries on Marine Fish Populations. Science 305: 1958-1960.

COPC 2021. California Ocean Protection Council. Overview of ocean Coastal Laws. www.opc.ca.gov

COSD (City of San Diego) 2000. City of San Diego. (2020). International Wastewater Treatment Plant Final Baseline Ocean Monitoring Report for the South Bay Ocean Outfall (1995–1998). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2008. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2007. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2009. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2008. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2010. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2009. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2011. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2010. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2012. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2011. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2013. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2012. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2014. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2013. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2015. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2014. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2016. Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 20015. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2018. City of San Diego. (2018). Biennial Receiving Waters Monitoring andAssessment Report for the Point Loma and South Bay Ocean Outfalls, 2016–2017 including addenda. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

COSD 2020. City of San Diego. (2020). Biennial Receiving Waters Monitoring andAssessment Report for the Point Loma and South Bay Ocean Outfalls, 2018–2019 including addenda. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Crain, C. M., B. S. Halpern, M.W. Beck, and C. V. Kappel 2009. Understanding and Managing Human Threats to the Coastal Marine Environment. The Year in Ecology and Conservation Biology, 2009: Ann. N.Y. Acad. Sci. 1162:39–62 (2009). doi: 10.1111/j.1749-6632.2009.04496.x _c 2009 New York Academy of Sciences.

CSULB (California State University, Long Beach) 2013. Oceanography of the Southern California Bight. Perspectives on the Pacific Ocean Offshore.

Dailey, M. D., J. W. Anderson, D. J. Reish, and D. S. Gorsline 1993. The California Bight: Background and Setting. In: Dailey, M. D., D. J. Reish, and J. W. Anderson. (eds). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, CA, pp. 1–18.

Daley, J. M., G. Paterson, and K. G. Drouillard 2014. Bioamplification as a Bioaccumulation Mechanism for Persistent Organic Pollutants (POPs) in Wildlife. In: Whitacre, D. M. (ed) 2014. Reviews of Environmental Contamination and Toxicology. Vol. 227:107-155. Springer. New York. Print: ISBN 978-3-319-01326-8. eBook: ISBN 978-3-319-01327-5. Online: http://www.springer.com/environment/environmental+toxicology/book/978-3-319-01326-8.

Davidson, A. D., A. G. Boyer, H. Kim, S. Pompa-Mansilla, M. J. Hamilton, D. P. Costa, G. Ceballos, and J. H. Brown 2011. Drivers and Hotspots of Extinction Risk in Marine Mammals. Proceedings of the National Academy of Sciences. 6 p. http://www.pnas.org/content/109/9/3395

Dayton, P. K. and M. J. Tegner 1984. Catastrophic Storms, El Niño, and Patch Stability in a Southern California Kelp Forest Community. Science 224: 283-285.

Dayton, P. K. and M. J. Tegner 1990. Bottoms beneath Troubled Waters: Benthic Impacts of the 1982-1984 El Niño in the Temperate Zone. In: P. Glenn (ed) Global Ecological Consequences of the 1982-1984 El Niño-Southern Oscillation. Pages 433-472. Elsevier Oceanography Series No. 52. Amsterdam, the Netherlands.

Dayton, P. K., M. J. Tegner, P. E. Parnell, and P. B. Edwards 1992. Temporal and Spatial Patterns of Disturbance and Recovery in a Kelp Forest Community. Ecological Monographs 62(3): 421-445.

Dayton, P. K., S. Thrush, and S. A. Coleman 2003. Ecological Effects of Fishing in Marine Ecosystems of the United States. Prepared for the Pew Ocean Commission. 52 p.

Dayton, P., P. E. Parnell, L. L. Rasmussen, E. J. Terrill, and T. D. Stebbins 2009. Point Loma Ocean Outfall Plume Behavior Study, Scope of Work. Scripps Institution of Oceanography, La Jolla, CA, and City of San Diego, Metropolitan Wastewater Department, San Diego, CA.

Deysher, L. E. 1984. Recruitment Processes in Benthic Marine Algae. Ph.D. Dissertation. University of California, San Diego. 324 p.

Diener, D., B. Riley, G. Robertson, D. Mauer, T. Gerlinger, and I. Haydock 1997. An Ocean Outfall as an Artificial Reef: Impacts to the Benthic Environment and a Balanced Indigenous Population. In: Conf. Proc. Calif. and the World Ocean. 1307-1317.

Dieter, B. E., D. A. Wion, and R. A. McConnaughey 2003. Mobile Fishing Gear Effects on Benthic Habitats: A Bibliography. NOAA Tech. Memo. NMFS-AFSC-135, 206 p.

DOALOS (Division for Ocean Affairs and the Law of the Sea). 2014. Maritime Zones and Delimitation. http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm

Doney S.C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley 2012. Climate Change Impacts on Marine Ecosystems Ann. Rev. Marine. Sci. 2012.4:11-37.

EPA 2014a. Fish Consumption Advisories. https://www.epa.gov/choose-fish-and-shellfish-wisely/fish-and-shellfish-advisories-and-safe-eating-guidelines

Eschmeyer, W. N., E. S. Herald, and H. Hammann 1985. A Field Guide to Pacific Coast Fishes of North America. Houghton Mifflin Company. Boston. 336 p.

FDA (U. S. Food and Drug Administration) 2014. Seafood Safety. http://www.fda.gov/Food/PopularTopics/ucm341987.htm

Field, J. C., D. F. Boesch, D. Scavia, R. Buddemeier, V. R. Burkett, D. Cayan, M. Fogarty, M. Harwell, R. Howarth, C. Mason, L. J. Pietrafesa, D. Reed, T. Roye, A. Sallenger, M. Spranger, and J. G. Titus 2003. Potential Consequences of Climate Variability and Change on Coastal Areas and Marine Resources. In: Climate Change Impacts in the United States. US Global Change Research Program: 461-487. http://www.usgcrp.gov/usgcrp/Library/nationalassessment/foundation.htm.

Gerodette, T. 1971. Ecological Studies of Two Temperate Solitary Corals. Dissertation. University of California, San Diego.

Graham, M. H., 2000. Role of Pre-Settlement Processes in the Population Dynamic of Subtidal Kelp. Ph.D. Thesis. University of California, San Diego.

Graham, M. H. 2004. Effects of Local Deforestation of the Diversity and Structure of Southern California Giant Kelp Forest Food Webs. Ecosystems 7:341-357.

Hackett, D., M. Hansen, and K. King 2009. The Economic Structure of California's Commercial Fisheries. California Department of Fish and Game. 91 p.

Halpern, B. S. C. V. Kappel, K. A. Selkoe, F. Micheli, C. M. Ebert, C. Kontgis, C. M. Crain, R. G. Martone, C. Shearer, and S. J. Teck 2009. Mapping Cumulative Human Impacts to California Current Marine Ecosystems. Conservation Letters 2:138–148.

Hamilton, Jr., A. N. 2000. Gear Impacts on Essential Fish Habitat in the Southeastern Region. National Marine Fisheries Service. Southeast Fisheries Science Center.

Hanson, J., M. Helvey, and R. Strach (eds) 2003. Non-fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures. National Marine Fisheries Service (NOAA Fisheries). Version 1. Southwest Region, Long, Beach, CA.

Hardy, J. T. 1993. Phytoplankton. In: Dailey, M. D., D. J. Reish, and J. W. Anderson (eds). Ecology of the Southern California Bight. Berkeley: University of California Press. pp. 233-265.

Hess, M. 2018-2021. Satellite & Aerial Coastal Water Quality Monitoring in the San Diego/Tijuana Region Annual Summary Reports 2018-2021. Can be found at: www.sandiego.gov/public-utilities/sustainability/ocean-monitoring/reports

Hazen E. L., I. D. Schroeder, J. Peterson, W. T. Peterson, W. J. Sydeman, S. A. Thompson, B. K. Wells, and S. J. Bograd 2012. Oceanographic and Climatic Drivers and Pressures. CCIEA Phase II Report 2012: Drivers and Pressures – Ocean and Climate. NOAA Fisheries. 60 p.

Hazen, E. L., S. Jorgensen, R. R. Rykaczewski, S. J. Bograd, D. G. Foley, I. D. Jonsen, S. A. Shaffer, J. P. Dunne, D. P. Costa, L. B. Crowder, and B. A. Block 2012. Predicted Habitat Shifts of Pacific Top Predators in a Changing Climate. 13 p. Nature Climate Change Letters. 23 SEPTEMBER 2012. www.nature.com/natureclimatechange

Hewitt, J. E., S. F. Thrush, P. K. Dayton, and Erik Bonsdorff 2007. The Effect of Spatial and Temporal Heterogeneity on the Design and Analysis of Empirical Studies of Scale-Dependent Systems. *The American Naturalist*, volume 169 (2007), pp. 398–408.

Hickey, B. M. 1993. Physical Oceanography. In: M. D. Dailey, D. J. Reish, and J. W. Anderson (eds) 1993. Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press. Berkeley, CA. pp. 19-70.

Hilborn, R. and U. Hilborn 2012. Overfishing: What Everyone Needs to Know. Oxford University Press., New York. 150 p.

Hoegh-Guldberg, O. and J. F. Bruno 2010. The Impact of Climate Change on the World's Marine Ecosystems. Science 328:1523-1528.

Horn, M. H., and L. G. Allen 1978. A Distributional Analysis of California Coastal Marine Fishes. Journal of Biogeography 5:23-42.

Horn, M. H. and J. S. Stephens, Jr. 2006. Climate Change and Overexploitation. P. 621-660. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds) 2006. The Ecology of Marine Fishes: California and Adjacent Waters.

Horn, M. H., L. G. Allen, and R. N. Lea. 2006. Biogeography. Chapter 1. pp. 3-25. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds). 2006. The Ecology of Marine Fishes: California and Adjacent Waters. University of California Press, Berkeley, California.

Howard, M. D. A., G. Robertson, M. Sutula, B. Jones, N. Nezlin, Y. Chao, H. Frenzel, M. Mengel, D.A. Caron, B. Seegers, A. Sengupta, E. Seubert, D. Diehl, and S.B. Weisberg 2012. Southern California Bight 2008 Regional Monitoring Program: Volume VII. Water Quality. Technical Report 710. Southern California Coastal Water Research Project. Costa Mesa, CA.

Howard M. D. A., M. Sutula, D. A. Caron, Y. Chao, J. D. Farrara, H. Frenzel, B. Jones, G. Robertson, K. McLaughlin, and A. Sengupta 2014. Anthropogenic Nutrient Sources Rival Natural Sources on Small Scales in the Coastal Waters of the Southern California Bight. Limnol. Oceanogr. 59(1)285-297.

Howell, E. A., S. J. Bograd, C. Morishige, M. P. Seki, and J. J. Polovina 2012. On North Pacific Circulation and Associated Marine Debris Concentration. Marine Pollution Bulletin, 65(1–3):16-22. http://www.sciencedirect.com/science/article/pii/S0025326X11002372

Hubbs-SeaWorld Research Institute 2021. Aquaculture Program. Ocean Resources Enhancement and Hatchery Program (OREHP) | Home (hswri.org).

Hutchinson, T. H., B. P. Lyons, J. E. Thain, and R. J. Law 2013. Evaluating Legacy Contaminants and Emerging Chemicals in Marine Environments Using Adverse Outcome Pathways and Biological Effects-Directed Analysis. Mar. Pollut. Bull. (2013): http://dx.doi.org/10.1016/j.marpolbul.2013.06.012

Ihde J. F., M. J. Wilberg, D. A. Loewensteiner, D. H. Secor, and T. J. Miller 2011. The Increasing Importance of Marine Recreational Fishing in the US: Challenges for Management. Fisheries Research 108, 268–276.

IPHC (International Pacific Halibut Commission) 2014. http://www.iphc.washington.edu/

Jackson, J. B. C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H, S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S. Steneck, M. J. Tegner, and R. R. Warner 2001. Historical Overfishing and the Recent Collapse of Coastal Ecosystems. Science: 293 (629-638).

Jackson, J. B. C. 2008. Ecological Extinction and Evolution in the Brave New Ocean. PNAS 105: 11458–11465. www.pnas.org.cgi.doi.10.1073.pnas.0802812105

Jackson, J. B. C., E. Sala, and K. E. Alexander (eds) 2011. Shifting Baselines: The Past and the Future of Ocean Fisheries. Island Press. Washington, D. C. 283 p.

Johnson, K. A. 2002. A Review of National and International Literature on the Effects of Fishing on Benthic Habitat. NOAA Tech. Memo. NMFS-F/SPO-57.

Kim, H. J., A. J. Miller. J. McGowan, and M. L. Carter 2009. Coastal Phytoplankton Blooms in the Southern California Bight. Progress in Oceanography. 82:137-147.

Klasing, S. and R. Brodberg 2008. Fish Contaminant Goals and Advisory Tissue Levels for Contaminants in Sport Fish. Pesticide and Environmental Toxicology Branch. Office of Environmental Health Hazard Assessment. California Environmental Protection Agency. June 2008. 122 p.

Klasing, S. and R. Brodberg 2011. Fish Contaminant Goals and Advisory Tissue Levels for Contaminants in Sport Fish: PBDEs. Pesticide and Environmental Toxicology Branch. Office of Environmental Health Hazard Assessment. California Environmental Protection Agency. June 2011. 40 p.

Koslow, A. J, R. Goericke, and W. Watson 2013. Fish Assemblages in the Southern California Current: Relationships with Climate, 1951–2008. Fisheries Oceanography. 22:207–219.

Laugen, A. T., G. H. Engelhard, R. Whitlock, et al. 2014. Evolutionary Impact Assessment: Accounting for Evolutionary Consequences of Fishing in an Ecosystem Approach to Fisheries Management. Fish and Fisheries. Vol. 15, (1): 65-96. http://dx.doi.org/10.1111/faf.12007.

Laws, E. A. (ed) 2013. Environmental Toxicology. Springer Verlag. ISBN-13: 9781461457633. 737 p. http://www.springer.com/978-1-4614-5763-3

Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson 2001. California's Living Marine Resources: A Status Report. California Department of Fish & Game. 592 p.

Linden, P., Shaffer, L., Dayton, P., Parnell, E., Rasmussen, L., Bartlett, D., Dohan, K., and R. Gersberg 2007. Point Loma Oufall Review. Final Report. University of California, San Diego. October 1, 2007. 34 p.

Lindholm, J., M. Gleason, D. Kline, L. Clary, S. Rienecke, and M. Bell 2011. Trawl Impact and Recovery Study: 2009-2010 Summary Report. California Ocean Protection Council. 39 p.

Lluch-Belda, D., D. B. Lluch-Cota, and S. E. Lluch-Cota 2003. Scales of Interannual Variability in the California Current System: Associated Physical Mechanisms and Likely Ecological Impacts. California Cooperative Oceanic Fisheries Investigations Reports 44:76-85.

Love, M. S. 2006. Subsistance, Recreational and Commercial Fisheries. In: Allen, L. G., D. J. Pondella II, and M. H. Horn (eds). 2006. Chapter 22. pp. 567-594.

Love, M.S. 2011. Certainly More Than You Want to Know About the Fishes Pacific Coast – A Postmodern Experience. Really Big Press. Santa Barbara, California.

Love, M. S., M. Yoklavich, and L. Thorsteinson 2002. The Rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.

Love, M. S, M. Yoklavich, and D. M. Schroeder 2009. Demersal Fish Assemblages in the Southern California Bight Based on Visual Surveys in Deep Water. Environ. Biol. Fish 84:55–68.

Lundquist, C. J., L. W. Botsford, L. Morgan, J. M. Diehl, T. Lee, D. R. Lockwood, and E. L. Pearson 2000. Effects of El Niño and La Niña on Local Invertebrate Settlement in Northern California. California Cooperative Oceanic Fisheries Investigations Reports 41:167-176.

Lyon, G. S., and M. A. Sutula 2011. Effluent Discharges to the Southern California Bight from Large Municipal Wastewater Treatment Facilities from 2005 to 2009. In: SCCWRP Annual Report 2011. 14 p.

Mai, T. T. and K. A. Hovel 2007. Influence of Local-Scale and Landscape-Scale Habitat Characteristics on California Spiny Lobster (*Panulirus interruptus*) Abundance and Survival. Marine and Freshwater Research 58(5) 419–428.

Mantyla A.W., Bograd S.J., and Venrick E.L. (2008). Patterns and controls of chlorophyll-a and primary productivity cycles in the southern california bight. Journal of Marine Systems 73:48-60.

Marine Research Specialists. 2014. Rose Canyon Fisheries, Sustainable Aauaculture Project. Final Report.

MBC (Marine Biological Consultants) 2012. Status of the Kelp Beds 2011: San Diego and Orange Counties. Region Nine Kelp Survey Consortium. June 2012. 231 p.

McClatchie, S. 2014. Regional Fisheries Oceanography of the California Current System: The CalCOFI program. Springer. 235 p.

McPeak, R. H. and D. A. Glantz 1984. Harvesting California's Kelp Forests. Oceanus 27(1):19-26.

Mearns, A. J., M. Matta, G. Shigenaka, D. MacDonald, M. Buchman, H. Harris, J. Golas, and G. Lauenstein 1991. Contaminant Trends in the Southern California Bight: Inventory and Assessment. NOAA Technical Memorandum NOS ORCA 62. Seattle, WA.

Miller, A. J. 1996. Recent Advances in California Current Modeling: Decadal and Interannual Thermocline Variations. In: California Cooperative Fisheries Investigations Reports. 37: 69-79.

Miller, K. A. 2005. Seaweeds of Cabrillo National Monument: an annotated list. University Herbarium, University of California, Berkeley, CA, December 2005.

Miller, E. F. and K. Schiff 2012. Descriptive Trends in Southern California Fishes, 1994-2008. SCCWRP Annual Report 2012: 129-144.

Miller, E. F. and J. A. McGowan 2013. Faunal Shift in Southern California’s Coastal Fishes: A New Assemblage and Trophic Structure Takes Hold. Estuarine, Coastal and Shelf Science. Vol. 127:29-36.

Miller A. J., H. Song, and A. C. Subramaniana 2013. The Physical Oceanographic Environment during the CCE Years: Changes in Climate and Concepts. Deep-Sea Research II. Special Issue on the California Current Ecosystem. 27 p.

Mills, C. M. and J. E. Walsh 2013. Seasonal Variation and Spatial Patterns of the Atmospheric Component of the Pacific Decadal Oscillation. J. Climate 26: 1575–1594.

Moore, J. E. and J. P. Barlow 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE 8(1):e52770. doi:10.1371/journal.pone.0052770. 12 p.

Morejohn, G. V., J. T. Harvy, and L. T. Krasnow 1978. The Importance of *Loligo Opalescens* in the Food Web of Marine Vertebrates in Monterey Bay, California. California Department of Fish and Game Fish Bulletin 169:67-98.

NAVFAC (Naval Facilities Engineering Command) 2013. Ecosystem Technical Report for the Hawaii-Southern California Training and Testing EIS/OEIS. NAVFAC Biological Resource Services. Arlington, VA. 66 p.

Neilson, D. J. 2011. The California Spiny Lobster Stock Assessment. California Department of Fish and Game. 138 p.

Neushul, M. 1959. Studies on the Growth and Reproduction of the Giant Kelp, *Macrocystis*. University of California Ph.D. Thesis. 134 p.

Newman, M. C. 2009. Fundamentals of Ecotoxicology. CRC Press. Chelsea, Mi. ISBN-13: 978-1420067040. 571 pages.

Nezlin N.P., Sutula M.A., Stumpf R.P., and Sengupta A. (2012) Phytoplankton blooms detected by SeaWiFS along the central and southern California coast. Journal of Geophysical Research 117: C07004.

Nezlin N.P., McLaughlin K., Booth J.A.T., Cash C.L., Diehl D.W., Davis K.A., Feit A., Goericke R., Gully J.R., and Howard M.D. (2018) Spatial and temporal patterns of chlorophyll concentration in the southern California bight. Journal of Geophysical Research: Oceans 123: 231-245.

NMFS 2002a. The Final Rule for Essential Fish Habitat. Federal Register 67(12):2343-2383.

NMFS 2002b. Considerations for Conducting a Thorough Analysis of Options to Minimize Adverse Effects. NMFS Office of Habitat Conservation. October 2002. 5 p.

NMFS 2004a. Preparing Essential Fish Habitat Assessments: A Guide for Federal Action Agencies. National Oceanic and Atmospheric Administration. February 2004.

NMFS 2004b. Essential Fish Habitat Consultation Guidance (Version 1.1). April 2004. Office of Habitat Conservation. Silver Spring, MD.

NMFS 2005a. Final Groundfish Essential Fish Habitat (EFH) Environmental Impact Statement. National Marine Fisheries Northwest Region. December 2005.

NMFS 2005b. Description of Fishing Gears Used on the U.S. West Coast. Pacific Coast Groundfish Fishery Management Plan. Essential Fish Habitat Designation and Minimization of Adverse Impacts. Final Environmental Impact Statement. December 2005. Volume 2 of 4. Appendix 8 of Appendix A.

NMFS 2007. Magnuson-Stevenson Fishery Conservation and Management Act As Amended Through January 12, 2007. National Marine Fisheries Service. National Oceanic and Atmospheric Administration. 178 p.

NMFS 2011b. Endangered and Threatened Wildlife and Plants: Final Rulemaking To Designate Critical Habitat for Black Abalone. Federal Register 76. No. 208.

NMFS 2012. Southern California Steelhead Recovery Plan. Southwest Region, Protected Resources Division, Long Beach, California. Executive Summary and Two Volumes.

NMFS 2013a. National Marine Fisheries Service Endangered Species Act Section 7 Consultation Biological and Conference Opinion. The U.S. Navy's Training Exercises and Testing Activities in the Southern Hawaii-California raining and Testing Study Area from December 2013 through December 2018. Dec. 13, 2013. 457 p.

NMFS 2013b. Groundfish Essential Fish Habitat Synthesis: A Report to the Pacific Fishery Management Council. NOAA NMFS Northwest Fisheries Service Center, Seattle WA. April 2013. 485p.

NOAA (National Oceanic and Atmospheric Administration) 2007. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT. Public Law 94-265. As amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479). 178p.

NOAA 2021. What is an El Niño. NOAA Fisheries Website. http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html.

NOAA 2021b. NOAA laws and Policies http://www.fisheries.noaa.gov/topic/laws-policiesl

NOAA 2021c. NOAA Fisheries Website. http://www.nmfs.noaa.gov/

NOAA 2021d. Southwest Fisheries Science Center Web Site. http://swfsc.noaa.gov/

NOAA 2021e.EFH http://www.westcoast.fisheries.noaa.gov/habitat/fish_habitat/efh_consultations_go.htm

NOAA 2021f. Pacific Bigeye tuna. https://www:fisheries.noaa.gov/species/pacific-bigeye-tuna

NOAA 2021g. Opah. https://www:fisheries.noaa.gov/species/opah

NOAA 2021h. Swordfish https://www.fisheries.noaa.gov/search?oq=green=sturgeon

Noble, M. A. 2009. Introduction to the Physical Oceanography of the Southern California Bight. Geological Society of America Special Papers. V. 454. 169 p.

NOEP (National Ocean Economics Program) 2005. California's Ocean Economy. Report to the Resource Agency, State of California. Prepared by J. Kildow and C. S. Colgan, July 2005. 167 p.

NOEP 2009. State of the U.S. Ocean and Coastal Economies. By Judith T. Kildow, Charles S. Colgan, and J. Scorse. 60 p. http://www.miis.edu/media/view/8901/original/NOEP_Book_FINAL.pdf

Norse, E. A. 2010. Ecosystem-Based Spatial Planning and Management of Marine Fisheries: Why and How? Bulletin of Marine Science. Volume 86(2)179-195.

North, W. J. (ed) 1964. An Investigation of the Effects of Discharged Wastes on Kelp. Publ. No. 26. The Resources Agency of California. State Water Quality Control Board.

North, W. J. and C. L. Hubbs 1968. Utilization of Kelp Bed Resources in Southern California. California Department of Fish and Game Bulletin No. 139. 264p.

NPS (National Park Service) 2006. Assessment of Coastal Water Resources and Watershed Conditions at Cabrillo National Monument, California: by D. L. Engle and J. Largier. Technical Report NPS/NRWRD/NRTR-2006/355, August 2006.

NRC 2002. Effects of Trawling and Dredging on Seafloor Habitats. National Academy Press. 126 p.

OEHHA 2020. California Office of Environmental Health Hazard Assessment. Water Bodies with Fish Advisories. https://www.oehha.ca.gov/fish/advisories

OEHHA 2014a. Fish. California Office of Environmental Health Hazard Assessment. http://www.oehha.ca.gov/fish/so_cal/index.html

OEHHA 2014b. Water Bodies with Fish Consumption Advisories. http://www.oehha.ca.gov/fish/special_reports/index.html

O'Shea, T. J. and K. K. Odell 2008. Large-scale Marine Ecosystem Change and the Conservation of Marine Mammals. J. Mammalogy 89(3):529-533.

Parnell, E., and K. Riser 2012. Evaluation of Anthropogenic Impacts on the San Diego Coastal Ecosystem. Annual Project Report (2011-2012). Submitted to City of San Diego Public Utilities Department. UCSD Contract OO-19958/H074007. 15 p.

Parnell, P. Ed, P. K. Dayton, C. E. Lennert-Cody, L. L. Rasmussen, and J. J. Leichtera 2005. Marine Reserve Design: Optimal Size, Habitats, Species Affinities, Diversity, and Ocean Microclimate. Ecological Applications: Vol. 16, No. 3, pp. 945–962.

Parnell, P. Ed, A. K. Groce, T. D. Stebbins, and Paul K. Dayton 2008. Discriminating Sources of PCB Contamination in Fish on the Coastal Shelf off San Diego, California (USA). Marine Pollution Bulletin 56 (2008) 1992–2002.

Parnell, P. E., P. K. Dayton, R. A. Fisher, C. C. Loarie, and R. D. Darrow 2010. Spatial Patterns of Fishing Effort off San Diego: Implications for Zonal Management and Ecosystem Function. Ecol. Appl. 20:2203–2222. http://dx.doi.org/10.1890/09-1543.1

Parnell, P. E., E. Miller, C. Lennert-Cody, M. Carter, and T.D. Stebbins 2010. The Response of Giant Kelp (*Macrocystis pyrifera*) in Southern California to Low Frequency Climate Forcing. Limnology and Oceanography 55: 2686-2702.

Parnell, P. E., P.K. Dayton, K. Riser, B. Bylach 2019. Evaluation of Anthropogenic Impacts on the San Diego County Coastal Kelp Forest Ecosystem (Biennal Project Report). Scripps Institution of Oceanography. 2018-2019.

Perry, B., P. M. DiGiacomo, and B. Holt 2007. Oceanography of the Southern California Bight. http://geology.campus.ad.csulb.edu/people/bperry/scbweb/circulation.htm

Perry, B. 2009. Coastal Systems and Human Impacts. CSU Long Beach Department of Geological Sciences Course Web Book. http://geology.campus.ad.csulb.edu/people/bperry/geology303/geol303text.html

PFMC (Pacific Fishery Management Council) 2004. Appendix 10, Pacific Coast Groundfish Essential Fish Habitat, the Effects of Fishing Gears on Habitat: West Coast Perspective. Pacific States Marine Fisheries Commission, Portland, OR.

PFMC 2005. Description and Identification of Essential Fish Habitat for the Coastal Pelagic Species Fishery Management Plan. Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council.

PFMC 2006. Measures to Prohibit Fishing in the EEZ off the West Coast. CPS FMP Amendment 12. Pacific Fishery Management Council. 143 p.

PFMC 2007. Amendment 1 to the Highly Migratory Species Management Plan: Bigeye Tuna. January 2007. http://www.pcouncil.org/hms/hmsfmp.html#amendment

PFMC 2008 Management of Krill as an Essential Component of the California Current Ecosystem. Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council. 118 p.

PFMC 2011e. Cowcod Status Report. 17 p. http://www.pcouncil.org/groundfish/stock-assessments/by-species/cowcod/

PFMC 2012. Pacific Coast Groundfish 5-Year Review of Essential Fish Habitat Phase 1: New Information. Final Report to Pacific Fishery Management Council, September 2012. Portland, OR. 416 p.

PFMC 2020a. Pacific Fishery Management Council Web Site. http://www.pcouncil.org/

PFMC 2020b. The Pacific Coast Groundfish Fishery Management Plan. National Oceanic and Atmospheric Administration. http://www.pcouncil.org/groundfish/fishery-management-plan/

PFMC 2020c. Coastal Pelagic Species: Fishery Management Plan and Amendments. http://www.pcouncil.org/coastal-pelagic-species/fishery-management-plan-and-amendments/

PFMC 2020d. Highly Migratory Species: Fishery Management Plan and Amendments. http://www.pcouncil.org/highly-migratory-species/fishery-management-plan-and-amendments/

PFMC 2014e. Pacific Salmon Fishery Management Plan and Amendments. http://www.pcouncil.org/salmon/fishery-management-plan/adoptedapproved-amendments/

PFMC 2014f. Habitats and Communities. http://www.pcouncil.org/managed-fishery/habitat/

PFMC (Pacific Fishery Management Council) and NMFS (National Marine Fisheries Service) 2021.

Pinnegar, J. K. and G. H. Engelhard 2008. The “Shifting Baseline” Phenomenon: A Global Perspective. Rev. Fish. Biol. Fisheries 18:1–16.

Port of San Diego 2009. Commercial Fisheries Revitalization Plan. Background and Existing Conditions Report. October 2009. 172 p.

Posey, M. H. and W. G. Ambrose Jr. 1994. Effects of Proximity to an Offshore Hard-Bottomed Reef on Infaunal Abundances. Mar. Biol. 118: 745-753.

Ranasinghe, J. A., K. C. Schiff, C. A. Brantley, L .L. Lovell, D .B. Cadien, T. K. Mikel, R. G. Velarde, S. Holt, and S. C. Johnson. 2012. Southern California Bight 2008 Regional

Monitoring Program:VI. Benthic Macrofauna. Technical Report No. 65, Southern California Coastal Water Research Project, Costa Mesa, CA.

Reeves, R. R., K. McClellan, and T. B. Werner 2013. Marine Mammal Bycatch in Gillnet and Other Entangling Net Fisheries, 1990 To 2011. Endangered Species Research 20: 71–97. doi: 10.3354/esr00481.

Reiley 2020. Washington Post. Commercial Fishing Inducstry in Free Fall as restuarants close consumers hunker down and vessels tie up. April 8, 2020.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, S. Y. Kim, P. E. Parnell, and P. Dayton 2012. Final Report: Point Loma Ocean Outfall Plume Behavior Study. Prepared for City of San Diego Public Utilities Department by Scripps Institution of Oceanography, University of California, San Diego. San Diego, CA.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, and W. Middleton 2013. Ocean Outfall Plume Characterization Using an Autonomous Underwater Vehicle. Water Science & Technology, 67(4): 925–933.

Rutgers University 2020. COVID-19 Pandemic had a Big Impact on Commercial Fishing in Northeast. Science news. December 2020.

RWQCB and EPA (San Diego Regional Water Quality Control Board and U. S. Environmental Protection Agency) 2017. Waste Discharge Requirements and National Pollutant Discharge Elimination System Permit for the City of San Diego E.W. Blom Point Loma Metropolitan Wastewater Treatment Plant Discharge to the Pacific Ocean through the Point Loma Ocean Outfall, San Diego County. Order No. R9-2017-0007. NPDES No. CA0107409. http://www.waterboards.ca.gov/sandiego/

SCCWRP (Southern California Coastal Water Research Project) 2012. Southern California Bight 2008 Regional Monitoring Program. January 2012. Coastal Ecology Synthesis Report. Southern California Coastal Water Research Project: Costa Mesa, CA.

SCCWRP 2013. Harmful Algal Blooms in Coastal Waters. http://www.sccwrp.org/ResearchAreas/Nutrients/HarmfulAlgalBloomsHABs.aspx

SCCWRP 2021a. Southern California Bight Regional Monitoring. Bight Program Documents - Southern California Coastal Water Research Project/ www.sccwrp.org

SCCWRP 2021b. http://www.sccwrp.org/about/research-areas/eutrophication/harmful-algal-blooms

Schiff, K. C., M. J. Allen, E. Y. Zeng, and S. M. Bay 2000. Southern California. Mar. Pollution Bull. 41(1): 76-93.

Schiff, K., J. Griffith, and G. Lyon 2005. Microbial Water Quality at Reference Beaches in Southern California during Wet Weather. Southern California Coastal Water Research Project Technical Report # 448. Southern California Coastal Water Research Project, Westminster, CA.

Schiff, K., R. Gossett, K. Ritter, L. Tiefenthaler, N. Dodder, W. Lao, and K. Maruya 2011. Southern California Bight 2008 Regional Monitoring Program: III. Sediment Chemistry. Southern California Coastal Water Research Project, Costa Mesa, CA.

SCOOS 2020. Southern California Coastal Ocean Observing System. Red Tide Bulletin Spring 2020.

Smith J., Connell P., Evans R.H., Gellene A.G., Howard M.D.A., Jones B.H., Kaveggia S., Palmer L., Schnetzer A., Seegers B.N., Seubert E.L., Tatters A.O., and Caron D.A. (2018) A decade and a half of Pseudo-nitzschia spp. and domoic acid along the coast of southern California. Harmful Algae 79: 87-104.

Setty, K., K. Schiff, and S. Weisberg (eds) 2012. Forty Years after the Clean Water Act: A Retrospective Look at the Southern California Coastal Ocean. Southern California Coastal Water Research Project. Costa Mesa, CA. Technical Report 727. 52 p.

Stein, E. D. and D. B. Cadien 2009. Ecosystem Response to Regulatory and Management Actions: The Southern California Experience in Long-Term Monitoring. Marine Pollution Bulletin 59 (4-7):91-100.

Steneck, R. S., M. H. Graham, B. J. Bourque, D. Corbett, J. M. Erlandson, J. A. Estes, and M. J. Tegner 2002. Kelp Forest Ecosystems: Biodiversity, Stability, Resilience, and Future. Environmental Conservation 29 (4):436-459.

Suntsov, A., J. A. Koslow, and W. Watson 2012. The Spatial Structure of Coastal Ichthyoplankton Assemblages off Central and southern California. California Cooperative Oceanic Fisheries Investigations Reports. 53:153-170.

Svejkovsky, J 2015-2017. Satellite & Aerial Coastal Water Quality Monitoring in the San Diego/Tijuana Region. Annual Summaries 2015, 2016, 2017. Can be found at: www.sandiego.gov/public-utilities/sustainability/ocean-monitoring/reports

SWRCB (State Water Resources Control Board) 2019. Water Quality Control Plan, Ocean Waters of California (Ocean Plan). https://www.waterboards.ca.gov/water_issues/programs/ocean/docs/oceanplan2019.pdf

Sydeman, W. J., J. A. Santora, S. A. Thompson, B. Marinovic, and E. D. Lorenzo 2013. Increasing Variance in North Pacific Climate Relates to Unprecedented Ecosystem Variability off California. Global Change Biology 19:1662-1675.

Tegner, M. J. and P. K. Dayton 1987. El Niño Effects on Southern California Kelp Forest Communities. Adv. Ecol. Res. 17: 243-279.

Tegner, M. J. and P. K. Dayton 1991. Sea urchins, El Niños, and the Long Term Stability of Southern California Kelp Forest Communities. Mar. Ecol. Prog. Ser. 77: 49-63.

Tegner M. J., and P. K. Dayton 2000. Ecosystem Effects of Fshing in Kelp Forest Communities. ICES Journal of Marine Science 57: 579–589.

Tegner, M. J., P. K. Dayton, P. B. Edwards, K. L. Riser, D. B. Chadwick, T. A. Dean, and L. Deysher 1995. Effects of a Large Sewage Spill on a Kelp Forest Community: Catastrophe or Disturbance? Mar. Env. Res. 40(2): 181-224.

Tegner, M. J., P. K. Dayton, P. B. Edwards, and K. L. Riser 1996. Is There Evidence for Long-Term Climatic Change in Southern California Kelp Forests? CalCOFI Reports 37:111-126.

Tegner, M. J., P. K. Dayton, P. B. Edwards, and K. L. Riser 1997. Large-scale, Low-Frequency Oceanographic Effects on Kelp Forest Succession: A Tale of Two Cohorts. Mar. Ecol. Prog. Ser. 146: 117-134.

Thrush, S. F. and P. K. Dayton 2010. What Can Ecology Contribute to Ecosystem-Based Management? Annu. Rev. Mar. Sci. 2:419–41.

Topping, D. T., C. G. Lowe, and J. E. Caselle 2006. Site Fidelity and Seasonal Movement Patterns of Adult California Sheephead *Semicossyphus pulcher* (Labridae): An Acoustic Monitoring Study. Arch. Ecol. Prog. Ser. 326:257–267.

UNFAO (United Nations Food and Agricultural Organization) 2012. Recreational Fisheries. Technical Guidelines for Responsible Fisheries. No. 13. Rome, Italy. 176 p.

United States Lifesaving Association 2014. Statistics. http://www.usla.org/

USACOE (U. S. Army Corps of Engineers) 2013. Draft Integrated Feasibility Study & Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Encinitas-Solana Beach Coastal Storm Damage Reduction Project, San Diego County, California. 4 Volumes.

USDON (United States Department of the Navy) 2008. Southern California (SOCAL) Range Complex. Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). December 2008. 2 Volumes. http://www.nmfs.noaa.gov/pr/pdfs/permits/socal_eis_vol1.pdf http://www.nmfs.noaa.gov/pr/pdfs/permits/socal_eis_vol2.pdf

USDON 2013. Hawaii-Southern California Training and Testing Activities. Final Environmental Impact Statement/Overseas Environmental Impact Statement. August 2013. 3 Volumes. http://hstteis.com/DocumentsandReferences/HSTTDocuments/FinalEISOEIS.aspx

Walsh, P. J., S. L. Smith, L. E. Fleming, H. Solo-Gabriele, and W. H. Gerwick (eds)2008. Oceans and Human Health: Risks and Remedies from the Seas, Academic Press, Amsterdam. 644 p.

Weis, J. S. 2014. Bioaccumulation/Storage/Detoxification. In: Weis, J. S. (ed). 2014. Physiological, Developmental and Behavioral Effects of Marine Pollution. Springer Link. Pp. 355-392. Print: ISBN: 978-94-007-6948-9. Online: http://link.springer.com/chapter/10.1007/978-94-007-6949-6_10.

Weis, J. S. (ed) 2014. Physiological, Developmental and Behavioral Effects of Marine Pollution. Springer Link. 452 p. Print: ISBN: 978-94-007-6948-9. Online: http://www.springer.com/environment/environmental+toxicology/book/978-94-007-6948-9

Whitacre, D. M. (ed) 2014. Reviews of Environmental Contamination and Toxicology. Vol. 227. Springer. New York. 171 p. Print: ISBN 978-3-319-01326-8. eBook: ISBN 978-3-319-01327-5. Online: http://www.springer.com/environment/environmental+toxicology/book/978-3-319-01326-8.

Wise, J. P., Sr., R. Payne, S. S. Wise, C. LaCerte, J. Wise, C. Gianios, Jr.,W. D. Thompson, C. Perkins, T. Zheng, C. Zhu, L. Benedict, and I. A. Kerr 2009. A Global Assessment of Chromium Pollution Using Sperm Whales (*Physeter macrocephalus*) as an Indicator Species. Chemosphere 75(11):1461-1467.

Wolfson, A. and T. Glinski 1986. Beneficial Uses of the Ocean at Point Loma. In: Report of Ocean Studies off Point Loma. City of San Diego, Department of Water Utilities. 51 p.

Wolfson, A. and T. Glinski 2000. Beneficial Uses of the Ocean off Point Loma. City of San Diego. Request for Modification of Secondary Treatment Requirements. Appendix G. 25 p.

Zeidberg, L. D., W. M. Hammer, N. P. Nezlin, and A. Henry 2006. The Fishery for California Market Squid, (*Loligo opalescens*) (*Cephalopoda myopsida*), from 1981-2003. Fish. Bull. 104:46-59.

Zmarzly, D. L., T. D. Stebbins, D. Pasko, R. M. Duggan, and K. L. Barwick 1994. Spatial Patterns and Temporal Succession in Soft-Bottom Macroinvertebrate Assemblages Surrounding an Ocean Outfall on the Southern San Diego Shelf: Relation to Anthropogenic and Natural Events. Marine Biology 118: 293-307.

APPENDIX K

PROPOSED
MONITORING PROGRAM

City of San Diego
Public Utilities Department

March 2022

APPENDIX K

Proposed Monitoring Program

Table of Contents

Section **Page**

APPENDIX K

Proposed Monitoring Program

SECTION K-1 | ABSTRACT

Monitoring and Reporting Program No. R9-2017-0007 establishes the current influent monitoring, effluent monitoring, whole effluent toxicity testing, receiving water monitoring, and reporting requirements for the Point Loma Ocean Outfall discharge and surrounding areas. Only a few minor changes are proposed to the core program to bring the PLWTP permit in line with the current SBIWTP and SBWRP permits. The City also proposes to continue full participation in the Southern California Bight regional monitoring programs, as well as several other regional monitoring efforts. Additionally, the City will continue to pursue its enhanced ocean monitoring efforts via special projects that address more specific receiving water quality or other discharge-related issues. Finally, the City will continue to work with the San Diego Regional Water Quality Control Board to further align and improve the Point Loma and South Bay outfall monitoring programs and to address the goals and recommendations of the Board's *A Framework for Monitoring and Assessment in the San Diego Region* (Busse and Posthumus 2012).

SECTION K-2 | INTRODUCTION

The history of changes to the Monitoring and Reporting Program (MRP) for the present deepwater (~100 m) discharge site for the Point Loma Ocean Outfall (PLOO) are detailed in a series of five successive MRPs adopted by the San Diego Regional Water Quality Control Board (Regional Water Board) and United States Environmental Protection Agency (USEPA) associated with the National Pollutant Discharge Elimination System (NPDES) Permit No. CA107409. These include the MRPs in: (1) Order No. 95-106 adopted in 1995, although pre-discharge monitoring began several years earlier in July 1991; (2) Order No. R9-2002-0025 adopted in 2002; (3) Addendum No. 1 to Order No. R9-2002-0025 adopted in 2003; (4) Order No. R9-2009-0001 adopted in 2009; (5) Order No. R9-2017-007 adopted in 2017.

Addendum No. 1 to Order R9-2002-0025 adopted in June 2003 resulted in significant modifications to the PLOO monitoring program in order to incorporate the recommendations of the *Model Monitoring Program for Large Ocean Discharges in Southern California* developed by the Southern California Coastal Water Research Project (SCCWRP) between 1998 and 2001 (Schiff et al. 2002). These changes, along with a few additional minor modifications or administrative corrections implemented with the adoption of the MRP in Order No. R9-2009-

0001 brought the PLOO monitoring program into full alignment with the SCCWRP Model Monitoring Program. Modifications implemented with the adoption of the MRP in Order No. R9-2017-0007 were less significant in nature, and designed to address the regional perspective in the Regional Board's *A Framework for Monitoring and Assessment in the San Diego Region* (Resolution No. R9-2012-0069; adopted December 2012), and the 2012 California Ocean Plan (SWRCB 2012).

The City remains committed to maintaining a comprehensive and robust ocean monitoring and reporting program for the San Diego coastal region, and to working with the Regional Water Board to further improve the program in line with goals and objectives included in the above '*Framework*'. Thus, only minor modifications are proposed to the existing monitoring program for the Point Loma region, all of which are designed to maintain continuity with the current SBIWTP and SBWRP permits.

SECTION K-3 |
BASIS OF THE EXISTING MONITORING PROGRAM

The City of San Diego is a full participant with SCCWRP, federal and state regulators (e.g., Regional Water Board, USEPA), other large ocean dischargers in southern California (e.g., Los Angeles County Sanitation Districts, Orange County Sanitation District, City of Los Angeles), and the local environmental community (e.g., Bay Council) during the development of the *Model Monitoring Program for Large Ocean Discharges in Southern California* (MMP). Although the focus of the MMP was towards large publicly owned treatment works (POTWs), much of the design and framework would also apply to smaller POTWs (see SCCWRP 2007).

In addition to modifying the PLOO monitoring program, the Regional Water Board has implemented the MMP design in NPDES permits issued to other major wastewater dischargers within the San Diego region. These include the permits and associated MRPs for the South Bay Water Reclamation Plant (Order No. R9-2021-0011, NPDES No. CA0109045) and South Bay International Wastewater Treatment Plant (Order No. R9-2021-0001, NPDES No. CA0108928), which together discharge commingled effluent to the Pacific Ocean via the South Bay Ocean Outfall (SBOO).

The MMP design involves three main elements:

1) Core Monitoring, which focuses on assessing effluent and receiving water compliance with applicable state and federal regulations;
2) Regional Monitoring, which focuses on conducting or participating in larger-scale surveys of the San Diego region or the entire Southern California Bight, and that often involve multiple agencies and/or academic organizations;
3) Special Projects (*aka* Strategic Process Studies), which are typically more focused studies designed to address and answer specific questions about some aspect of the ocean environment.

A key aspect of this approach to monitoring is the adaptive nature of the program. The core monitoring program element retains much of the historically-imposed ocean outfall monitoring requirements and provides for specific sampling locations where designated constituents are measured and monitored over time. The core monitoring program is directed toward assessing compliance with federal standards established by USEPA and state-wide standards established within the California Ocean Plan. Additionally, this portion of the program is critical to both assessing long-term temporal changes in local marine environmental conditions and determining whether any such changes may be due to either anthropogenic or natural influences.

Whereas core monitoring remains somewhat static, regional surveys and special projects are dynamic in their ability to adapt and change to address emerging questions and concerns. In this way, the monitoring is flexible to ensure the best uses of resources and to adapt when new information becomes available, while still maintaining the long-term data comparability from the core monitoring. A special project may result in a one-time final report with additional actions necessary or it may generate the need to add a new element to the core program to ensure the issue is fully addressed. At the same time, a special project may result in the reduction or realignment of a part of the core program if the regulatory agencies conclude that the special monitoring information is more valuable (or replaces the need for) core monitoring elements. However, any such changes to the core program would only occur upon concurrence and approval of the Regional Water Board and USEPA.

SECTION K-4 |
STATUS OF THE EXISTING MONITORING PROGRAM

Core Monitoring Program. The details and requirements of the current core PLOO monitoring program are established in Order/MRP No. R9-2017-0007, which was adopted on April 12, 2017 and became effective on October 1, 2017. Only a few minor modifications to this program are proposed (see Section K-5 herein).

Regional Surveys. The City of San Diego has been and will continue to be a full participant in the comprehensive surveys of the Southern California Bight (SCB) that are coordinated by SCCWRP approximately every five years. Six such projects have been successfully completed to date, including the Southern California Bight Pilot Project in 1994 and subsequent Bight'98, Bight'03, Bight'08, Bight'13, and Bight'18 programs in 1998, 2003, 2008, 2013, and 2018, respectively. Final reports for these projects are available from the City or from SCCWRP's website (www.sccwrp.org). The City is currently involved in multiple components of the Bight'18 program and expects to initiate planning for Bight'23 in spring 2022.

In addition to the six bight-wide programs described above, the City regularly participates in several other regional activities. The City participates with other southern California ocean dischargers in an ongoing regional survey of the SCB coastal kelp beds ranging from the

USA/Mexico border to Point Conception (see Appendix E, this application). Additionally, the City jointly funds a remote sensing program of the San Diego/Tijuana coastal region with the International Boundary and Water Commission (see Special Projects below, and Appendix F in this application). Finally, the City has also conducted annual region-wide benthic surveys off the coast of San Diego since 1995 as part of regular South Bay outfall monitoring requirements in order to augment the 5-year SCB surveys. These San Diego "mini" regional surveys were added as a requirement of the MRP in PLWTP Order No. R9-2017-0007.

Special Projects. The City of San Diego has been actively working on, collaborating with other researchers or agencies, or supporting a large number of important special projects or enhanced ocean monitoring studies over the past 15+ years. Many of these projects were identified as the result a scientific review of the City's Ocean Monitoring Program and environmental monitoring needs for the region that was conducted by a team of scientists from the Scripps Institution of Oceanography (SIO) and several other institutions (SIO 2004), as well as in consultation with staff from the Regional Water Board, USEPA, SCCWRP and others. Examples of special projects or enhanced monitoring efforts that have been recently completed, or are presently underway, include:

- San Diego Kelp Forest Ecosystem Monitoring Project: This project represents a continuation of a long-term commitment by the City (e.g., funded since 1992) to support this important research conducted by SIO. Overall, this work is essential to assessing the health of San Diego's kelp forests and to monitoring the effects of wastewater discharge on the local coastal ecosystem relative to other factors. A summary of findings from the final project report for the 2014–2019 contract agreement is included in Appendix E of this application. This report, along with several annual reports, are available online (City of San Diego 2021). Work on the current 5-year agreement through June 2024 is underway.

- Remote Sensing of the San Diego/Tijuana Coastal Region: This project represents a long-term effort funded jointly by the City and International Boundary and Water Commission since 2002 to utilize satellite and aerial imagery observations to better understand regional water quality conditions off San Diego. The project is conducted by Ocean Imaging (Littleton, CO), and is focused on detecting and tracking the dispersion of wastewater plumes from local ocean outfalls and nearshore sediment plumes originating from stormwater runoff or outflows from local bays and rivers. A summary of findings from the 2014–2020 annual coastal remote sensing reports is included in Appendix F of this application, and seven of the most recent annual monitoring reports for this project are available online (City of San Diego 2021).

- Point Loma Ocean Outfall Plume Behavior Study: This project was designed to determine the characteristic fates of the PLOO wastewater plume in the coastal waters off Point Loma using a combination of observational and modeling approaches. The study was successfully completed in 2012 and resulted in several important conclusions and recommendations (Rogowski et al. 2012a, 2012b, 2013). The City is currently in the process of implementing the major recommendations of this study (see next project below).

- Plume Tracking Monitoring Plan (PTMP): This project addresses recommendations that the City should improve monitoring of the fate and behavior of wastewater discharged to the ocean via the SBOO (Terrill et al. 2009) and PLOO (Rogowski et al. 2012a, 2012b, 2013). The project involves the deployment of real-time oceanographic mooring systems (RTOMS) at the terminal ends of the PLOO and SBOO to provide real time data on ocean conditions, and the deployment of a remotely operated towed vehicle (ROTV) in conjunction with the RTOMS to enhance the collection of water quality data in order to provide higher resolution maps of plume dispersion and location via adaptive sampling. Additional details are available in the work plan approved by the Regional Water Board on April 25, 2018 (City of San Diego 2018). The PTMP project is expected to significantly enhance the City's environmental monitoring capabilities in order to address current and emerging issues relevant to the health of San Diego's coastal waters, including plume dispersion, subsurface current patterns, ocean acidification, hypoxia, nutrient sources, and coastal upwelling. Data from the moorings are presented in Appendix B of City of San Diego (2020) and Appendix D of this application.

- Sediment Toxicity Monitoring of the San Diego Ocean Outfall Regions: This project started with a 3-year pilot study implemented as a new joint regulatory requirement for the Point Loma and South Bay outfall regions in 2015. Findings for the 2016–2018 pilot study (City of San Diego 2015b) were summarized in a final project report (City of San Diego 2019) that included recommendations for continued sampling through 2023. All sediment toxicity data collected to date (2016-2020) are presented in Appendix C3 of this application. Further, in an effort to provide a more comprehensive assessment of sediment quality in the San Diego region, Appendix C3 presents sediment toxicity results integrated with other lines of evidence, including sediment chemistry and benthic infauna community structure, following the State of California's sediment quality assessment framework as modified for use in previous Bight programs (SWRCB 2009, Bay et al. 2013, B13CIA 2017).

- San Diego Regional Benthic Condition Assessment Project: This multi-phase study represents an ongoing, long-term project designed to assess the condition of continental shelf and slope habitats throughout the entire San Diego region. The first phase of this project involved analyzing 24 years (1994-2017) of benthic infauna and sediment particle size data from San Diego and Bight regional surveys, along with data from the *Deep Benthic Habitat Assessment Study* designed to assess the condition of deeper (>200 m) continental slope habitats off San Diego (see Appendix C.5 in City of San Diego 2015a), and data from the initial phase of the *San Diego Sediment Mapping Study* (see next project below). Results from this effort were used in Appendix C2 of this application to determine reference conditions for the PLOO core monitoring stations and are presented in full in Parnell et al. (2021). A companion publication, focused just on benthic infauna communities located on the slope, is planned for 2022. The second phase of this project entails examination of temporal trends in benthic infauna communities from PLOO core monitoring stations. Preliminary results from this effort are presented in Appendix C4 of this application, and planned for publication by the end of 2022.

- San Diego Sediment Mapping Study: This represents a two-phased project conducted in collaboration with SCCWRP in which sampling was conducted in 2004 for Phase 1 and in 2012 for Phase 2. Phase 1 was designed to estimate spatial variance in sediment quality and benthic infauna community condition over an area spanning both the PLOO and SBOO monitoring regions (>400 km^2). In contrast, the goal of Phase 2 was to utilize an optimal resolution (spacing) of sample sites derived in part from Phase 1 results to generate a completed map of sediment chemistry conditions within a more restricted 30 km^2 area surrounding the PLOO. The findings for Phase 1 and the preliminary results from Phase 2 were included as a summary report in Appendix C.4 of City of San Diego (2015a). A more comprehensive final project report was delayed by staffing changes within both agencies. However, the City hopes to resume collaboration with SCCWRP by the end of 2021.

In addition to the above, the City is continuing to work with SCCWRP and/or its fellow membership agencies on numerous other projects of regional importance, including detecting and assessing the effects of Contaminants of Emerging Concern (CECs) on coastal ecosystems, developing rapid testing techniques for bacterial analysis, wet weather epidemiological studies in nearshore waters, and expanding and developing new capabilities in advanced molecular technologies such as real-time PCR, DNA sequencing and gene expression.

SECTION K-5 | SUMMARY OF PROPOSED MRP CHANGES

Only a few minor modifications or changes are proposed to the existing requirements established in Order No. R9-2017-0007 (see Attachment K-A). These changes are similar to those adopted recently for the SBOO monitoring program as detailed in: (a) Order No. R9-2021-0011 for the South Bay Water Reclamation Plant; and (b) Order No. R9-2021-0001 for the South Bay International Wastewater Treatment Plant. These recommended changes have been discussed previously with Regional Water Board staff and are consistent with the goals and objectives of the Board's 'Framework' and with changes incorporated in the 2019 California Ocean Plan (see Appendix T, this application).

The requested modifications include:

1) Offshore Water Quality Monitoring: Add quarterly requirement for total alkalinity (TA) and spectrophotometric pH monitoring at designated offshore stations, to be used to calibrate pH results measured by CTD (Conductivity, Temperature, Depth profiler), and to calculate aragonite saturation state, using methods consistent with those described

in *An evaluation of potentiometric pH sensors in coastal monitoring applications* (McLaughlin et al. 2017). The City collected TA/spectrophotometric pH samples quarterly at PLOO offshore water quality stations F13, F15, and F35 at surface, thermocline and bottom depths from spring 2019 through winter 2020 in conjunction with the Bight'18 Ocean Acidification and Hypoxia Component, and has subsequently continued to collect these samples on a voluntary basis. A similar change was recently made to the offshore water quality sampling requirements for the SBOO monitoring program detailed in the Orders referenced above.

2) Station Coordinates in Decimal Degrees: Please update station coordinates listed in either Degrees Minutes Seconds (DMS) or Degrees Decimal Minutes (DDM) formats to Decimal Degrees (DD).

3) Replacing Shoreline Station D8: Shoreline Station D8 (32.736997, -117.255333) is permanently inaccessible and should be replaced with D8-B (32.739448, -117.25499). The last time D8-A (32.73901, -117.25511) was visited, it was under repair; however, D8-B is preferred as it safer and more accessible compared to D8-A.

4) Core Sediment and Fish Tissue Monitoring: Add requirement for the analyses of polybrominated diphenyl ethers (PBDEs or BDEs) to the list of parameters to be chemically analyzed for sediments and fish tissue, to match requirements recently added to the SBOO monitoring program as detailed in the Orders referenced above.

5) California Environmental Data Exchange Network (CEDEN): Do not include a requirement to submit receiving water monitoring results to CEDEN. The City makes all ocean monitoring data freely available via its website and is willing to continue submitting data via CIWQS. However, the submission of data to CEDEN is not only expensive, but it is fraught with errors, which take a significant amount of City staff time to resolve. Furthermore, the usefulness of the CEDEN submitted data is questionable, particularly taxonomic data given that species name changes are not accounted for in the CEDEN database.

SECTION K-6 | LITERATURE CITED

[B13CIA] Bight '13 Contaminant Impact Assessment Planning Committee. (2017). Southern California Bight 2013 Regional Monitoring Program: Volume VIII. Contaminant Impact Assessment Synthesis Report. Technical Report 973. Southern California Coastal Water Research Project. Costa Mesa, CA.

Bay, S.M., D.J. Greenstein, J.A. Ranasinghe, D.W. Diehl, and A.E. Fetscher. (2013). Sediment Quality Assessment Technical Support Manual. Technical Report 777. Southern California Coastal Water Research Project. Costa Mesa, CA.

Busse, L., and B. Posthumus. (2012). A Framework for Monitoring and Assessment in the San

Diego Region. California Regional Water Quality Control Board Staff Report. [November 2012], San Diego, CA. 32 p.

City of San Diego. (2015a). Application for Renewal of NPDES CA0107409 and 301(h) Modified Secondary Treatment Requirements Point Loma Ocean Outfall. Volume V, Appendices C thru D. Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2015b). Sediment Toxicity Monitoring Plan for the South Bay Ocean Outfall and Point Loma Ocean Outfall Monitoring Regions, San Diego, California. Submitted by the City of San Diego Public Utilities Department to the San Diego Water Board and USEPA, Region IX, August 28, 2015 [approved 9/29/2015].

City of San Diego. (2018). Plume Tracking Monitoring Plan for the Point Loma and South Bay Ocean Outfall Regions, San Diego, California. Submitted by the City of San Diego Public Utilities Department to the San Diego Water Board and USEPA, Region IX, March 28, 2018 (approved 4/25/2018).

City of San Diego. (2019). Final Project Report for the Sediment Toxicity Pilot Study for the San Diego Ocean Outfall Monitoring Regions, 2016–2018. Submitted May 30, 2019 by the City of San Diego Public Utilities Department to the San Diego Regional Water Quality Control Board and U.S. Environmental Protection Agency, Region IX. 16 pp.

City of San Diego. (2020). Biennial Receiving Waters Monitoring and Assessment Report for the Point Loma Ocean Outfall and South Bay Ocean Outfall, 2018-2019. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2021). Ocean Monitoring Reports. https://www.sandiego.gov/public-utilities/sustainability/ocean-monitoring/reports.

McLaughlin, K, N.P. Nezlin, S.B. Weisberg, A.G. Dickson, J.A. Booth, C.L. Cash, A. Feit, J.R. Gully, S. Johnson, A. Latker, M.J. Mengel, G.L. Robertson, A. Steele, L. Terriquez. (2017). An evaluation of potentiometric pH sensors in coastal monitoring applications. Limnol. Oceanogr.: Methods 15, 2017, 679–689

Parnell, P.E., A.K. Latker, R.G. Velarde, T.D. Stebbins, and W. Enright. (2021). Macrobenthic communities on the Continental shelf and slope off San Diego County. In prep.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, S.Y. Kim, P.E. Parnell, and P. Dayton. (2012a). Final Report: Point Loma Ocean Outfall Plume Behavior Study. Prepared for City of San Diego Public Utilities Department by Scripps Institution of Oceanography, University of California, San Diego, CA.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, and W. Middleton. (2012b). Mapping ocean outfall plumes and their mixing using Autonomous Underwater Vehicles. Journal of Geophysical Research, 117: C07016.

Rogowski, P., E. Terrill, M. Otero, L. Hazard, and W. Middleton. (2013). Ocean outfall plume characterization using an Autonomous Underwater Vehicle. Water Science & Technology, 67: 925–933.

SCCWRP. (2007). Model Monitoring Program for Small Publicly-Owned Treatment Works in the San Diego Region. Technical Report 518: Southern California Coastal Water Research Project, Costa Mesa, CA.

Schiff, K.C., J.S. Brown, and S.B. Weisberg. (2002). Model Monitoring Program for Large Ocean Discharges in Southern California. Technical Report 357: Southern California Coastal Water Research Project, Westminster, CA.

SIO [Scripps Institution of Oceanography]. (2004). Point Loma Outfall Project, Final Report, September 2004. Scripps Institution of Oceanography, University of California, La Jolla, CA.

[SWRCB] State Water Resources Control Board. (2009). Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality. Resolution Number 2008-0070, State Water Resources Control Board, Sacramento, CA.

[SWRCB] California State Water Resources Control Board. (2012). California Ocean Plan, Water Quality Control Plan, Ocean Waters of California. California Environmental Protection Agency, Sacramento, CA.

Terrill, E., K. Sung Yong, L. Hazard, and M. Otero. (2009). IBWC/Surfrider – Consent Decree Final Report. Coastal Observations and Monitoring in South Bay San Diego. Scripps Institution of Oceanography, University of California, San Diego, CA.