OCS Report
BOEM 2019-038

Environmental Setting of the Southern California OCS Planning Area

US Department of the Interior
Bureau of Ocean Energy Management
Pacific OCS Region

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NOTATION

The following is a list of acronyms, abbreviations, and units of measure used in this document. Some acronyms used only in tables may be defined only in those tables.

GENERAL ACRONYMS AND ABBREVIATIONS

APHA	Archeological and Historic Preservation Act
ARPA	Archeological Resource Protection Act
BCC	bird of conservation concern
BMC	bird of management concern
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAQS	California Ambient Air Quality Standards
CARB	California Air Resources Board
CalCOFI	California Cooperative Fisheries Investigation
CCAA	California Clean Air Act
CCS	California Coastal Stock
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CMLPAI	California Marine Life Protection Act Initiative
CNEL	community noise level equivalent
COA	corresponding onshore area
COWOS	California/Oregon/Washington offshore stock
CWA	Clean Water Act
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DMR	Discharge Monitoring Report
DNL	day-night average sound level
DPM	diesel particulate matter
DPS	distinct population segment
EEZ	exclusive economic zone
EFH	essential fish habitat
E.O.	Executive Order
EPA	U.S. Environmental Protection Agency

ESA	Endangered Species Act of 1972
ESU	evolutionarily significant unit
FCMA	Fishery Conservation and Management Act of 1976
FMP	Fishery Management Plan
GHG	greenhouse gas
GIS	geographic information system
GWP	global warming potential
GWPC	Ground Water Protection Council
HAB	Hazardous Algal Bloom
HAPC	habitat area of particular concern
MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MPA	Marine Protected Area
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American and Graves Protection and Repatriation Act
NCDC	National Climatic Data Center
NCEI	National Centers for Environmental Information
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERR	national estuarine research reserve
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NP	National Park
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	*National Register of Historic Places*
NWR	National Wildlife Refuge
O&G	oil and gas
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OGR	*Olivella* grooved rectangular
PFMC	Pacific Fishery Management Council
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	fine particulates less than 2.5 microns in diameter
POCS	Pacific Outer Continental Shelf

POTW	publicly owned treatment works
PSD	prevention of significant deterioration
PXP	Plains Exploration and Development Company
ROG	reactive organic gas
SBCAPCD	Santa Barbara County Air Pollution Control District
SCAQMD	South Coast Air Quality Management District
SCB	Southern California Bight
SCS	southern California steelhead
SCSN	Southern California Seismic Network
SEL	asound exposure level
SMCA	state marine conservation area
SMR	state marine reserve
SPL	sound pressure level
spp.	species
ULSD	ultra-low-sulfur diesel
UME	unusual mortality event
U.S.C.	*United States Code*
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCAPCD	Ventura County Air Pollution and Control District
VOC	volatile organic compound
WA	wilderness area
YOY	young-of-year

CHEMICALS

BTEX	benzene, toluene, ethylbenzene, and xylene
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
H_2S	hydrogen sulfide
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides

O_3	ozone
OC	organic carbon
PAH	polyaromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
SO_2	sulfur dioxide
SO_x	sulfur oxides

UNITS OF MEASURE

μPa	micropascal(s)
ac	acre
Bbbl	billion barrels
bbl	barrel(s)
C	Celsius
cm	centimeter(s)
dB	decibel(s)
dBa	a-weighted decibel(s)
F	Fahrenheit
ft	foot (feet)
g	gram(s)
gal	gallon(s)
hp	horsepower
hr	hour(s)
Hz	hertz
in.	inch(es)
km	kilometer(s)
km^2	square kilometer(s)
kHz	kilohertz
L	liter(s)
lb	pound
m	meter(s)
m^3	cubic meter(s)
mcf	million cubic feet
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
min	minute(s)
mm	millimeter(s)
MMT	million metric ton(s)
mph	mile(s) per hour
mt	metric ton(s)
ppb	part(s) per billion
ppm	part(s) per million
rms	root-mean-square
s	second(s)
Tcf	trillion cubic feet
tpy	ton(s) per year
yr	year(s)

1 INTRODUCTION

The leasing and development of oil and gas on the Pacific Outer Continental Shelf (POCS) is regulated by the Department of Interior and delegated to the Pacific Region of the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement. Federal waters of the POCS are divided into planning areas. The only POCS planning area that has oil and gas leases and development is the Southern California OCS Planning Area (Figure 1-1). There are currently 38 existing Federal leases and 23 constructed platforms in the Southern California OCS Planning Area. Among these lease areas, 14 oil and gas fields are currently being produced by 21 platforms (20 producing platforms and one platform used for processing only); 13 platforms are located offshore of Santa Barbara County, four platforms offshore of Ventura County, and four platforms offshore Long Beach, near the boundary of Los Angeles County and Orange County (Aspen Environmental Group 2005). Descriptions of the platforms are presented in Table 1-1. The 23 platforms on the OCS occur in water depths ranging from about 95 to 1,200 ft (29 to 366 m), and they are about 3.7 to 10.5 mi (6 to 17 km) from shore.

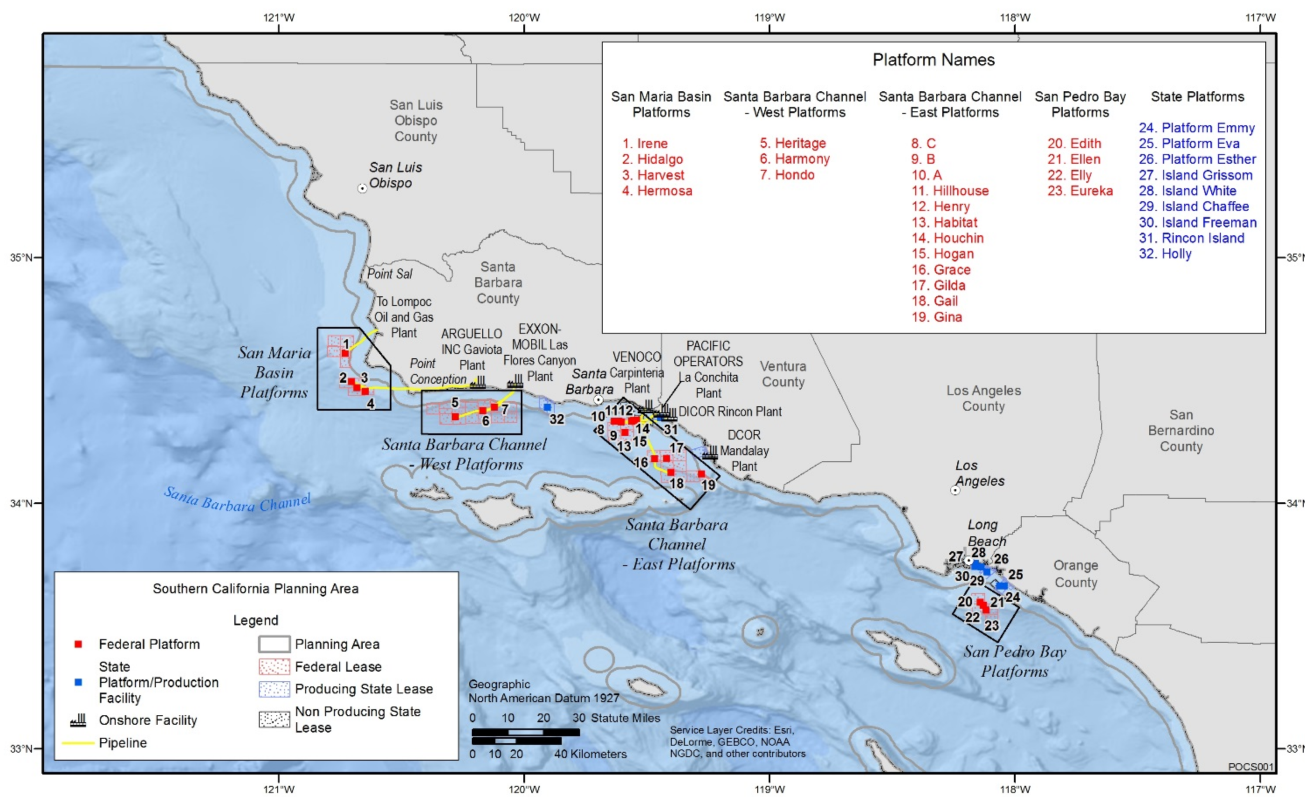

FIGURE 1-1 Locations of Current Lease Areas, Platforms, and Pipelines of the Southern California OCS Planning Area (Also shown are platforms and production facilities in offshore State waters adjacent to the Federal OCS. Platforms in Federal waters are shown in red, and those in State waters are shown in blue.)

TABLE 1-1 Production and Processing Platforms on the Southern California Outer Continental Shelf

Platform	Date Installed	Location	Water Depth (ft)	Distance from Shore (mi)
Tranquillon Ridge Field				
Irene	8-7-1985	Santa Maria Basin	242	4.7
Pt Pedernales Field				
Irene				
Point Arguello Field				
Harvest[a]	6-12-1985	Santa Maria Basin	675	6.7
Hermosa[a]	10-5-85	Santa Maria Basin	603	6.8
Hidalgo[a]	7-2-86	Santa Maria Basin	430	5.9
Hondo Field				
Hondo[b]	6-23-76	Santa Barbara Channel	842	5.1
Harmony[b]	6-21-89	Santa Barbara Channel	1,198	6.4
Pescado Field				
Heritage[d]	10-7-89	Santa Barbara Channel	1,075	8.2
Sacate Field				
Heritage[d]				
Carpinteria Offshore				
Houchin	7-1-1968	Santa Barbara Channel	163	4.1
Hogan	9-1-1967	Santa Barbara Channel	154	3.7
Henry	8-31-1979	Santa Barbara Channel	173	4.3
Dos Cuadras Field				
Hillhouse	11-26-1969	Santa Barbara Channel	190	5.5
A	9-14-1968	Santa Barbara Channel	188	5.8
B	11-8-1968	Santa Barbara Channel	190	5.7
C	2-28-1977	Santa Barbara Channel	192	5.7
Pitas Point Field				
Habitat[e]	10-8-1981	Santa Barbara Channel	290	7.8
Santa Clara Field				
Gilda	1-6-1981	Santa Barbara Channel	205	8.8
Grace[c]	7-30-1979	Santa Barbara Channel	318	10.5
Sockeye Field				
Gail[c]	4-5-1987	Santa Barbara Channel	739	9.9
Hueneme Field				
Gina	12-11-1980	Santa Barbara Channel	95	3.7

TABLE 1-1 Production and Processing Platforms on the Southern California Outer Continental Shelf

Platform	Date Installed	Location	Water Depth (ft)	Distance from Shore (mi)
Beta Field				
Edith	1-12-1984	Offshore Long Beach, CA	161	8.5
Elly	3-12-80	Offshore Long Beach, CA	255	8.6
Ellen	1-15-80	Offshore Long Beach, CA	265	8.6
Eureka	7-8-1984	Offshore Long Beach, CA	700	9.0

[B] Platform Elly is a processing facility.

a These facilities are beginning the decommissioning process.

[D] These facilities are shut-in at this writing due to the 2015 onshore pipeline break.

[e] This facility is shut-in and not producing.

The geographic range of the potential effects from activities in the Southern California Planning Area depend on the resources being examined and ranges from very local to beyond the planning area boundaries. This document compiles information to inform the affected environment in the Southern California Planning Area. BOEM intends to use this document to inform future outreach processes with other federal agencies and tribal governments. This document will also inform future Chapter 3 ("Affected Environment") sections in Environmental Assessments or Environmental Impact Statements prepared under the National Environmental Policy Act (NEPA). Included are descriptions of all areas and natural and human resources potentially subject to either direct or indirect effects from leasing areas for new oil and gas production and/or decommissioning of existing oil and gas platforms in the Southern California Planning Area. Importantly, this document does not replace the NEPA process or obligations to consult; it will only be used as a resource that is more complete and technical than what is commonly possible in public NEPA documents.

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2 GEOLOGY AND SEISMICITY

This chapter describes the geologic setting and the seismic setting and history of the Southern California Planning Area and its five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties).

2.1 Regional Description and Physiography

The portion of the POCS from just north of Point Sal southward to the United States–Mexico border largely coincides with the physiographic region known as the California Continental Borderland (Gorsline and Teng 1989). This region is a complex of basins, ridges, islands, and banks that make up the boundary between the Pacific and North American tectonic plates (Given et al. 2015). These features follow the northwest–southeast trend of the Peninsular Ranges in the south, the east–west trend of the Transverse Range in the Santa Barbara–Ventura Basin and the northwest trending southern Coast Ranges in the northernmost part of the area. Structurally, the region is a sequence of elongated thrust blocks separated by major faults. Numerous offshore basins have been identified in this region, including the offshore Santa Maria, Santa Barbara–Ventura, and San Pedro Basins, where oil and gas well platforms on the Federal OCS are currently in operation (Figure 2-1).

The submerged part of the California Continental Borderland covers an area of about 27,000 mi^2 and has a length of about 560 mi. Its maximum width from shore to the base of the Patton Escarpment (the seaward edge of the continental shelf) is about 155 mi; this occurs at the latitude of the United States–Mexico border (Gorsline and Teng 1989).

2.2 Geology of the Santa Maria Basin

The offshore portion of the Santa Maria Basin, shown in Figure 2-2, lies within the Central California Province (Figure 2-1). It is a northwest-trending basin that extends from about Point Arguello northward to Point Piedras Blancas (Mayerson 1997; BOEM 2014). It is bounded on the east by the Hosgri Fault Zone, on the west by the Santa Lucia Bank Fault, and by structural highs to the north and south. The basin is about 100 mi long and 25 mi wide and covers an area of about 2,500 mi^2. Water depths range from 300 ft near Point Sal to 3,500 ft in the southwestern part of the basin.

The Santa Maria Basin experienced rapid subsidence because of regional extension during the early Miocene. Normal faulting of basement blocks formed sub-basins that are filled with volcanic rocks and biogenic and clastic sediments of Miocene and Pliocene age. In the early Pliocene, uplift and structural inversion of the basin reactivated the normal faults and caused folding of the Miocene and Pliocene strata into anticlines[1] that are traps for much of the oil in the basin (Mayerson 1997).

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[1] An anticline is a geologic structure created by compressional stress and comprised of folded strata, convex up, with the oldest beds at its core.

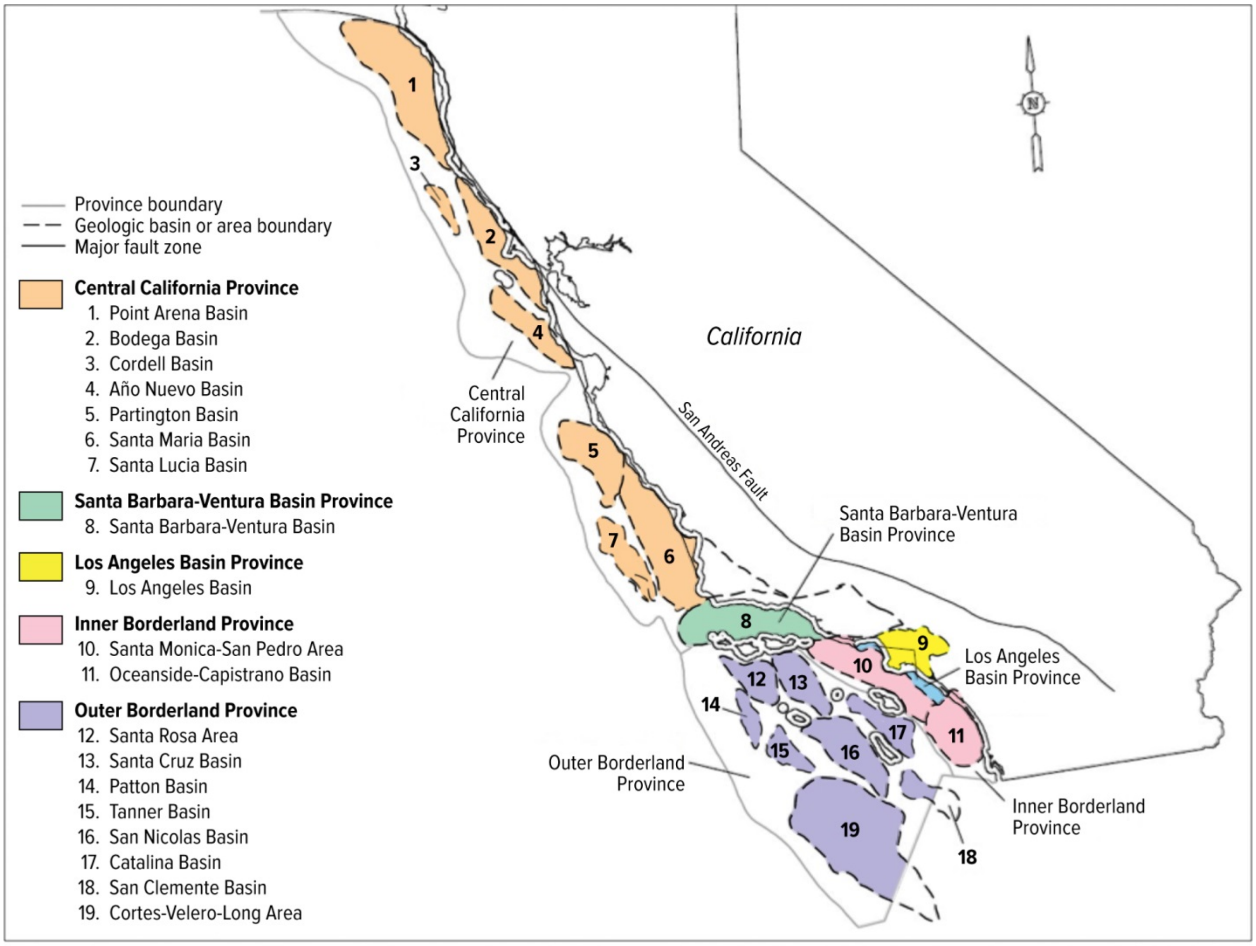

FIGURE 2-1 Map of the California POCS Region Showing the Offshore Geologic Basins (MMS 1997)

The stratigraphy of the Santa Maria Basin is shown in Figure 2-3. Logs of exploratory wells drilled in the southern and central portions of the offshore basin (most bottoming in basement rocks of the Jurassic Franciscan Complex) show Paleogene rocks are missing in most wells.

The first exploratory well was drilled in the offshore Santa Maria Basin in 1964. The well, located about 15 mi northwest of Point Sal, had abundant shows of oil in the Monterey Formation. Since 1980, when the first discovery well was drilled at the Point Arguello field, the Monterey Formation has been the primary exploration target in the basin (Mayerson 1997). Four of the 14 producing fields in the Southern California OCS Planning Area are in the offshore Santa Maria Basin (Point Arguello, Rocky Point, Tranquillon Ridge, and Point Pedernales fields).

Monterey Formation. The vast majority of petroleum production in the offshore Santa Maria Basin comes from the Monterey Formation. The Monterey Formation is most productive where it has been diagenetically altered to highly fracturable quartz, and in shallower areas, opal-CT (crystobalite/tridymite). This play is established both onshore and offshore. The primary source rock for the play is the organic-rich shales and phosphatic rocks of the Monterey Formation itself (Mayerson 1997; Figure 2-3).

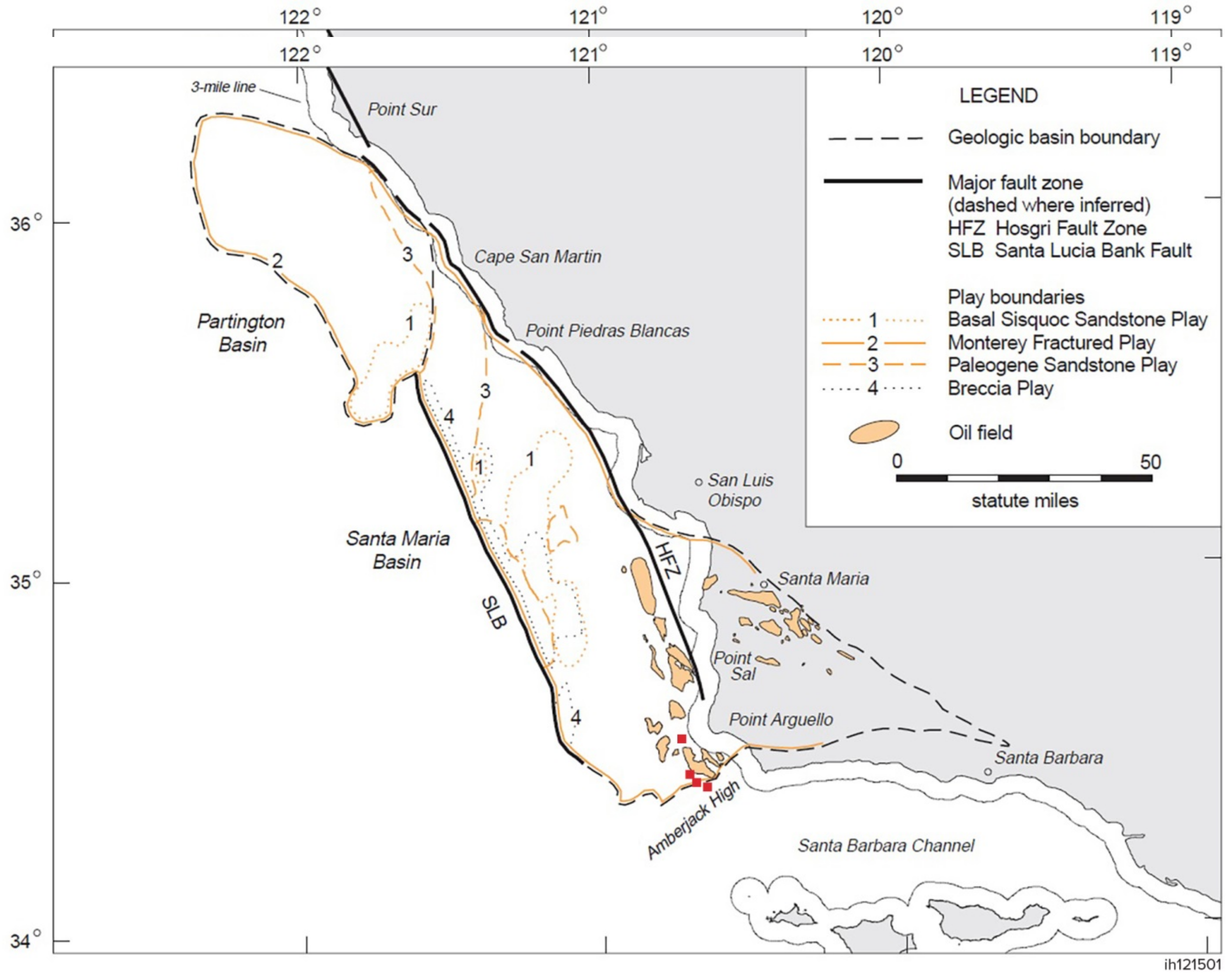

FIGURE 2-2 Location, Geologic Plays, and Oil Fields of the Santa Maria Basin (Platforms in Federal waters are shown in red.) (Modified from Mayerson 1997)

Reservoirs in the Monterey Formation include oil and associated gas accumulations in fractured siliceous and dolomitic rocks of the middle and upper Miocene (Figure 2-3). In the entire offshore Santa Maria Basin, the Monterey Formation covers an area of about 3,800 mi^2 and occurs at burial depths of about 0 (exposed on the seafloor) to 11,000 ft (Figure 2-3). The Monterey Formation is its own source and reservoir rock. Researchers report that total organic carbon content of the formation ranges from 3 to 17%. Minor reservoir rocks also include sandstones of the Point Sal and Lospe Formations (Figure 2-3).

As mentioned above, the quality of the reservoir is thought to be controlled by the diagenetic grade of its siliceous strata, with the best reservoirs having been diagenetically altered from opal-CT) to quartz, because of the increased fracture density associated with quartz-phase strata (Isaacs 1992; Mayerson 1997). This diagenetic boundary has been correlated with a seismic reflector than can be traced throughout much of the offshore basin. Traps in the offshore

Santa Maria Basin producing reservoirs are primarily structural and occur in faulted and/or fault-bounded anticlines. Many of the fields discovered in the central portion of the offshore basin and, therefore, are associated with fault zones, especially along the basin's eastern boundary (Figure 2-2; Mayerson 1997).[2]

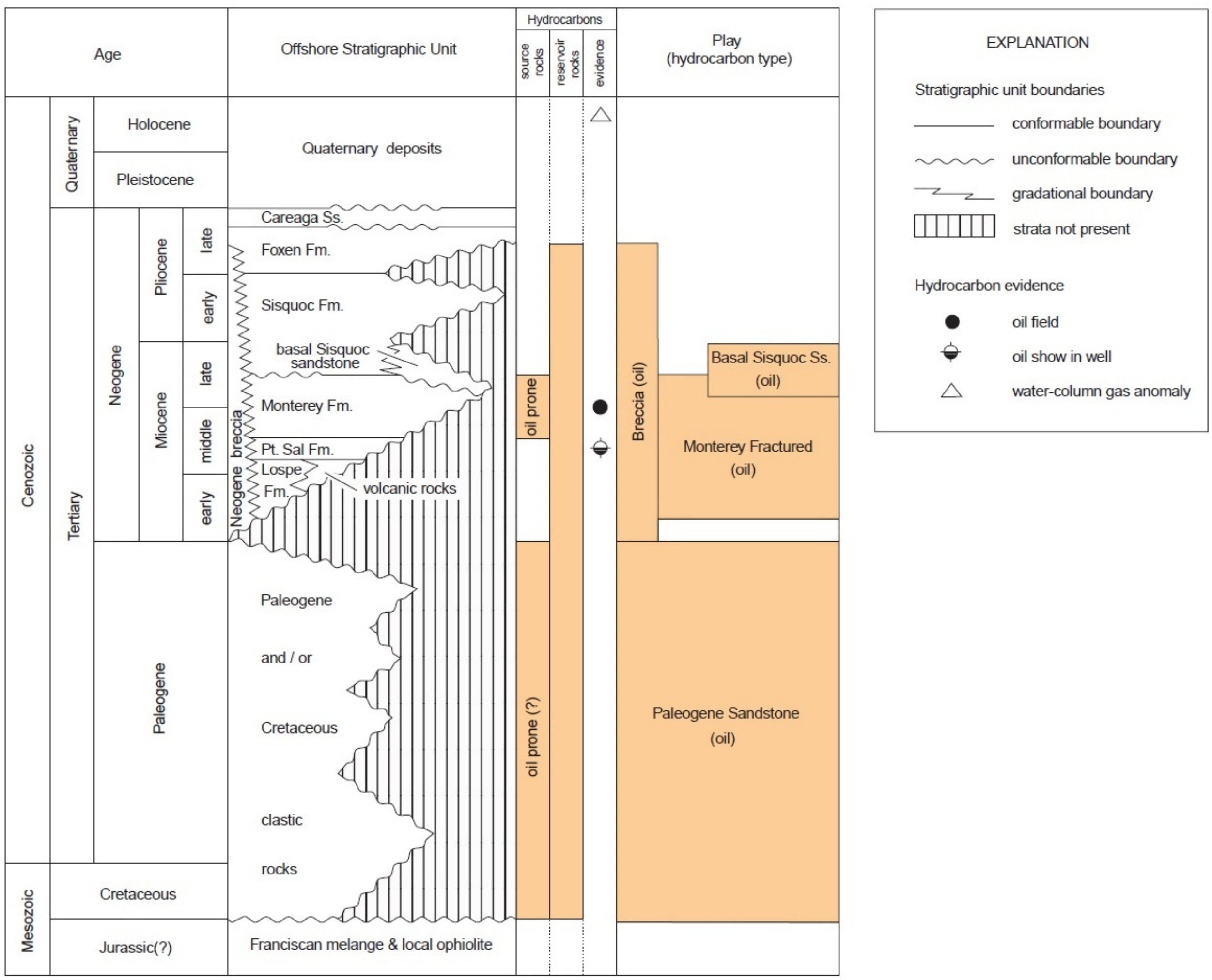

FIGURE 2-3 Stratigraphy of the Santa Maria Basin (Mayerson 1997)

2.3 Geology of the Santa Barbara–Ventura Basin

The Santa Barbara–Ventura Basin is located both onshore and offshore Southern California (Figure 2-4). The depositional basin is bounded to the north by the Santa Ynez and

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2 Although there are only three producing fields in the offshore Santa Maria Basin, many more discoveries have been made and economically viable fields have been delineated. The leases on which these fields are located were the subject of litigation and ultimately bought back by the government.

related faults; to the east by the San Gabriel fault; to the south by a series of thrust faults and lateral faults related to the Malibu Coast-Santa Monica fault zone, the Santa Cruz Island fault, and the Santa Rosa fault; and to the west by the Amberjack High, a poorly defined basement trend that lies between Point Conception and Point Arguello (Figure 2-4). The submerged (offshore) portion of the basin (shown in green in Figure 2-4), designated as the Santa Barbara–Ventura Basin province, is about 9 mi long, 20 mi wide, and covers an area of about 1,800 mi^2. This province is commonly referred to as the Santa Barbara Channel (Galloway 1997; BOEM 2014).

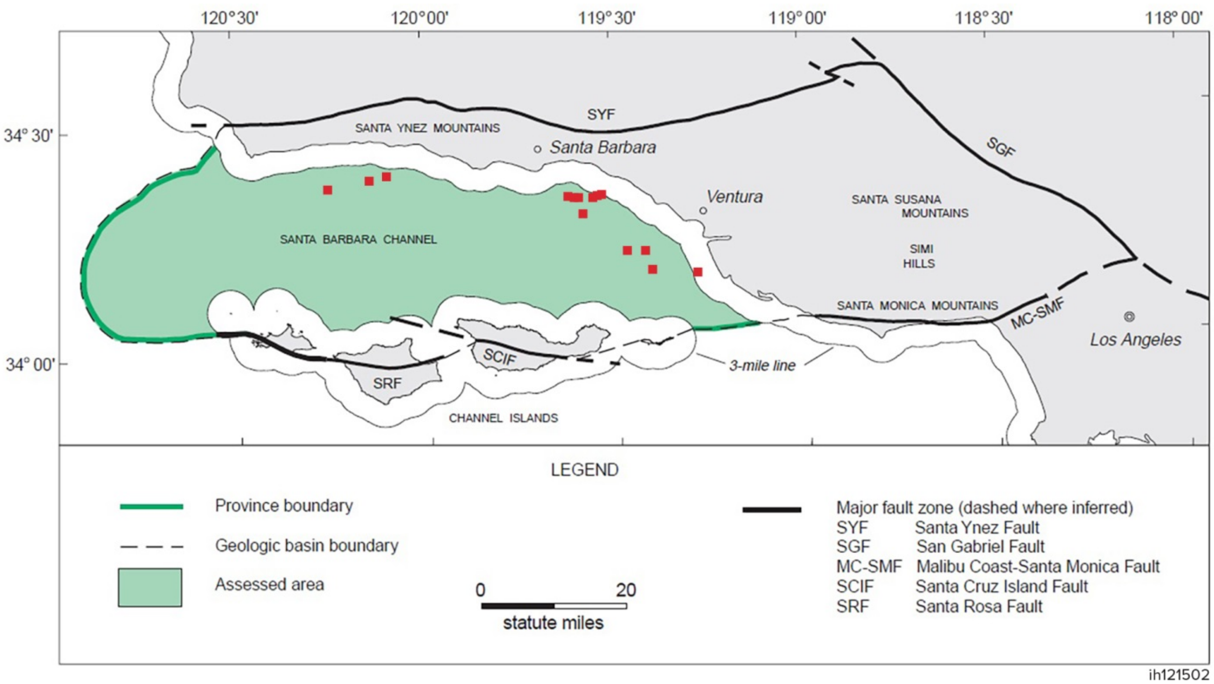

FIGURE 2-4 Location of the Santa Barbara–Ventura Basin (Platforms in Federal waters are shown in red.) (Modified from MMS 1997)

Petroleum seeps in the Santa Barbara Channel have been exploited since prehistoric times. At least 155 oil and gas fields have been discovered since 1861, 33 of which were discovered before 1901. The first offshore oil wells in North America were drilled in the Summerland field in 1894; the first Federal lease in the channel was issued in 1966 (Galloway 1997). Currently, nine fields (Hondo, Hueneme, Pescado, Pitas Point, Sacate, Dos Cuadras, Carpinteria, Sockeye, and Santa Clara) are in production. Together, these fields are estimated to contain reserves of almost 220 million bbl of oil and 500 billion ft^3 of gas.

Oil and gas reservoirs have been identified in nearly every formation in the Santa Barbara Channel. The major producing reservoirs in the Santa Barbara–Ventura Basin are listed in Table 2-1 along with the fields in which they produce.

Pico-Repetto Sandstone. The Pico-Repetto Sandstone is an established oil and gas play that includes known and prospective oil and gas accumulations in Pliocene and early Pleistocene reservoirs. Although Pliocene strata are distributed throughout the basin, the Federal offshore portion of the play is limited to the eastern part of the basin where reservoir sandstones are abundant and depositional thickness is greater than 2,000 ft. Where this formation occurs in the Santa Barbara–Ventura Basin, it covers an area of about 400 mi^2. Reservoir rocks are mainly sandstones of the Repetto and Pico Formations (Figure 2-5); these compose over 50% of the rock volume in parts of the play. The Repetto Formation is reaches thicknesses in excess of 4,000 ft in parts of the basin and the Pico Formation has a maximum thickness exceeding 10,000 ft.

TABLE 2-1 Major Producing Formations and Associated Fields on the Southern California OCS Planning Area

Formation	OCS Field
Pico	Carpinteria
Repetto	Carpinteria, Dos Cuadras, Pitas Point, Santa Clara
Monterey	Hondo, Pescado, Sacate, Santa Clara, Sockeye
Topanga	Sockeye
Hueneme	Hueneme, Sockeye
Vaqueros	Hondo
Sespe	Hueneme, Santa Clara, Sockeye

The Monterey Formation is the likely source rock for oil and gas in the Pico-Repetto play; deeply buried lower Pliocene claystones and mudstones may be another source (although whether the Pliocene section is thermally mature is uncertain). Traps are predominantly structural (anticlines, faulted anticlines, and fault blocks), with less common stratigraphic traps also occurring along unconformities on the flanks of folds and permeability barriers.

Monterey Formation. The Monterey Formation is an established play that includes known and prospective oil accumulations in middle to late Miocene reservoirs. The Monterey Formation is distributed throughout the basin. Reservoir rocks of the play are fractured zones formed by silica diagenesis (which causes the rock mass to become increasingly brittle) and late Neogene compressional tectonics. The Monterey Formation is its own source rock. Traps within the play are predominantly complexly faulted anticlines but also include normal- and thrust-faulted blocks.

Topanga Sandstone. The Topanga Sandstone is an established play that includes known and prospective oil and associated gas accumulations in early to middle Miocene reservoirs. Reservoir rocks of the play are primarily sandstones with good porosity (20–30%) and good permeability (400 to 600 millidarcies). Sandy zones may be thicker than 1,000 ft. Source rocks are the Monterey Formation and, locally, the clay shales of the Rincon Formation. Traps are predominantly structural (faulted anticlines), but may also contain important stratigraphic elements (e.g., channel sandstones). The Sespe, Hueneme, and Vaqueros sandstones are an established play that include known and prospective accumulations of oil and associated as

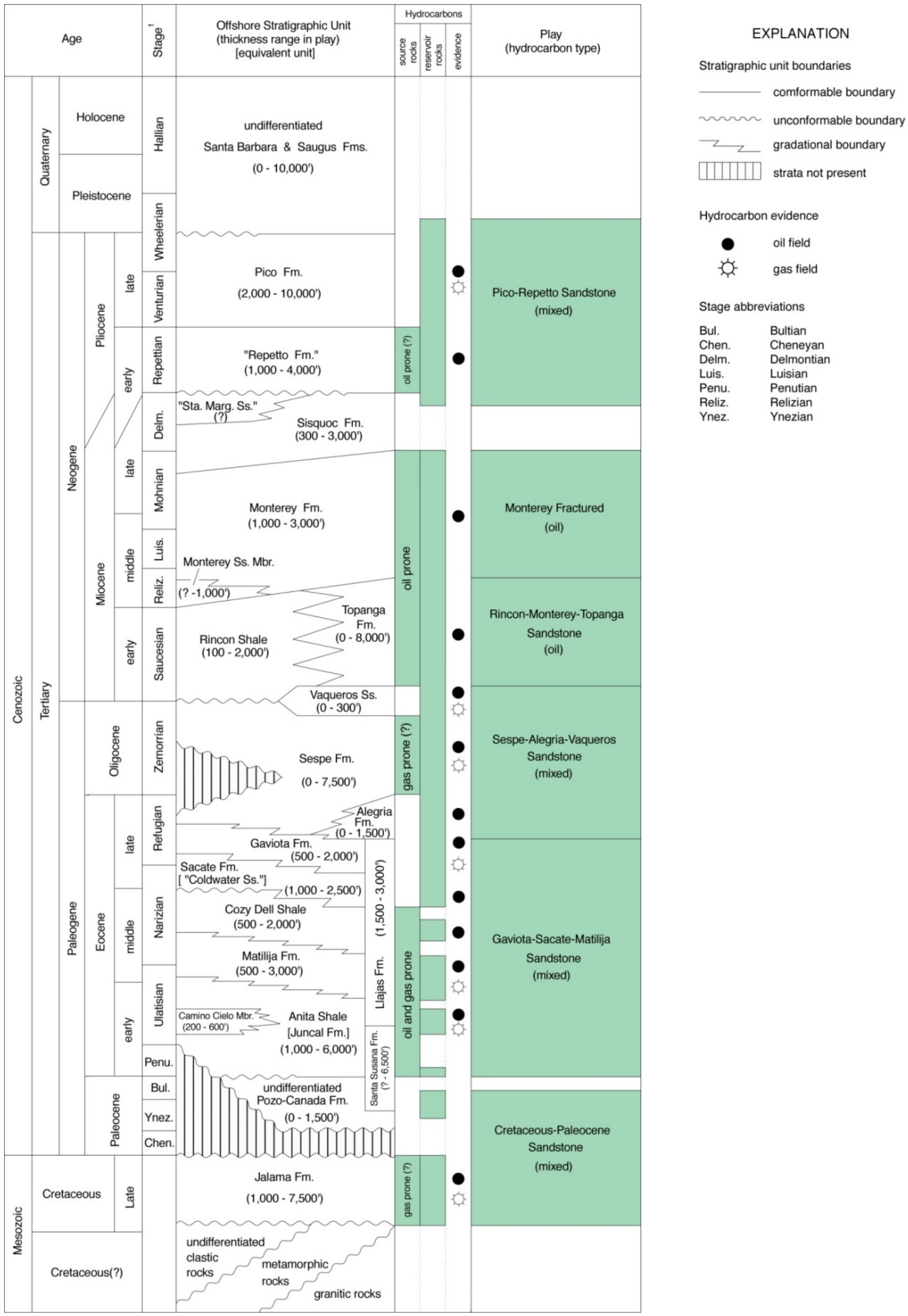

Figure 2-5 Major Producing Formations in the Santa Barbara-Venture Basin (Modified from Galloway 1997)

(and non-associated gas)[3] in reservoirs of late Eocene and Oligocene to early Miocene age. Reservoir rocks are coarse nonmarine and marine clastics of the Sespe Formation and shallow marine sandstones of the coeval Alegria Formation (Figure 2-5). The shallow marine and fan deposits of the Hueneme and Vaqueros sandstones represents a nearshore to shelf deposit and, locally, submarine canyon fill. The Sespe, Hueneme, and Vaqueros section is more than 7,500 ft thick in parts of the basin but averages about 3,000 to 4,000 ft.

Source rocks are likely the Eocene deep-water shales and overlying Miocene formations; traps are most commonly structural (anticlines, faulted anticlines, and fault blocks), but may contain important stratigraphic elements.

2.4 Geology of the Beta Field of the San Pedro Basin

The Beta Field is located in the San Pedro Basin, part of the southernmost extension of the Los Angeles Basin. The San Pedro Basin is structurally bounded by the Palos Verdes (PVF) and Newport-Inglewood fault (NIF) systems. Both faults accommodate a significant amount of regional slip (Wright 1991), and serve as the major hydrocarbon-trapping structures within the San Pedro Basin. Structurally, the Beta Field is located on the sub-thrust section of a broad, northwest-trending anticline bounded by the Palos Verdes Fault (Figure 2-6). The present-day PVF extends for approximately 66 mi southeastward from Santa Monica Bay across the northeast portion of the Palos Verde Peninsula, and offshore across the San Pedro Shelf to Lasuen Knoll.

Within the Beta Field and San Pedro Basin, more than 10,000 ft of Tertiary sedimentary fill overly Cretaceous basement. Local Tertiary strata include the Miocene San Onofre Breccia, the Miocene Monterey Shale, the Miocene/Pliocene Puente Sandstone, the Pliocene Repetto Formation, the Pliocene Pico Formation, and younger Quaternary marine strata (Figure 2-7). Although the adjacent Wilmington, THUMS, Huntington Beach, and other Los Angeles Basin oil fields derive a majority of oil and gas production from the Pico, Repetto, and Monterey Formations, only the Puente Formation is productive within the Beta Field. Several wells were tested for production potential within the Monterey Formation in the Beta Field, but no meaningful oil was recovered. The lack of oil in the Monterey Formation in the Beta Field is probably a consequence of the synchronous deposition of the Monterey Formation along the southwest-dipping Miocene Palos Verdes Fault, which resulted in the majority of the Monterey Formation deposited west of the sub-thrust anticline that forms the structural trap of the Beta Field (Brankman and Shaw 2009).

Puente Formation. The Puente Formation is a fan deposited sandstone interbedded with deep-water marine shales from which the production at the Beta Field takes place. The depth to the Puente ranges from -2500 ft near the Palos Verdes Fault to about –5000 ft on the northeast flank of the Beta structure. Cumulative production through 2013 from the Beta Field is

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3 Non-associated gas is typically a local phenomenon and likely is sourced from land-derived woody or coaly debris deposited in a shallow marine or continental-marine transitional environment.

approximately 100 million bbl of oil and 32 billion ft^3 of gas. Remaining reserves for the Beta Field are estimated at 15 million bbl of oil and a little less than 5 billion ft^3 of gas.

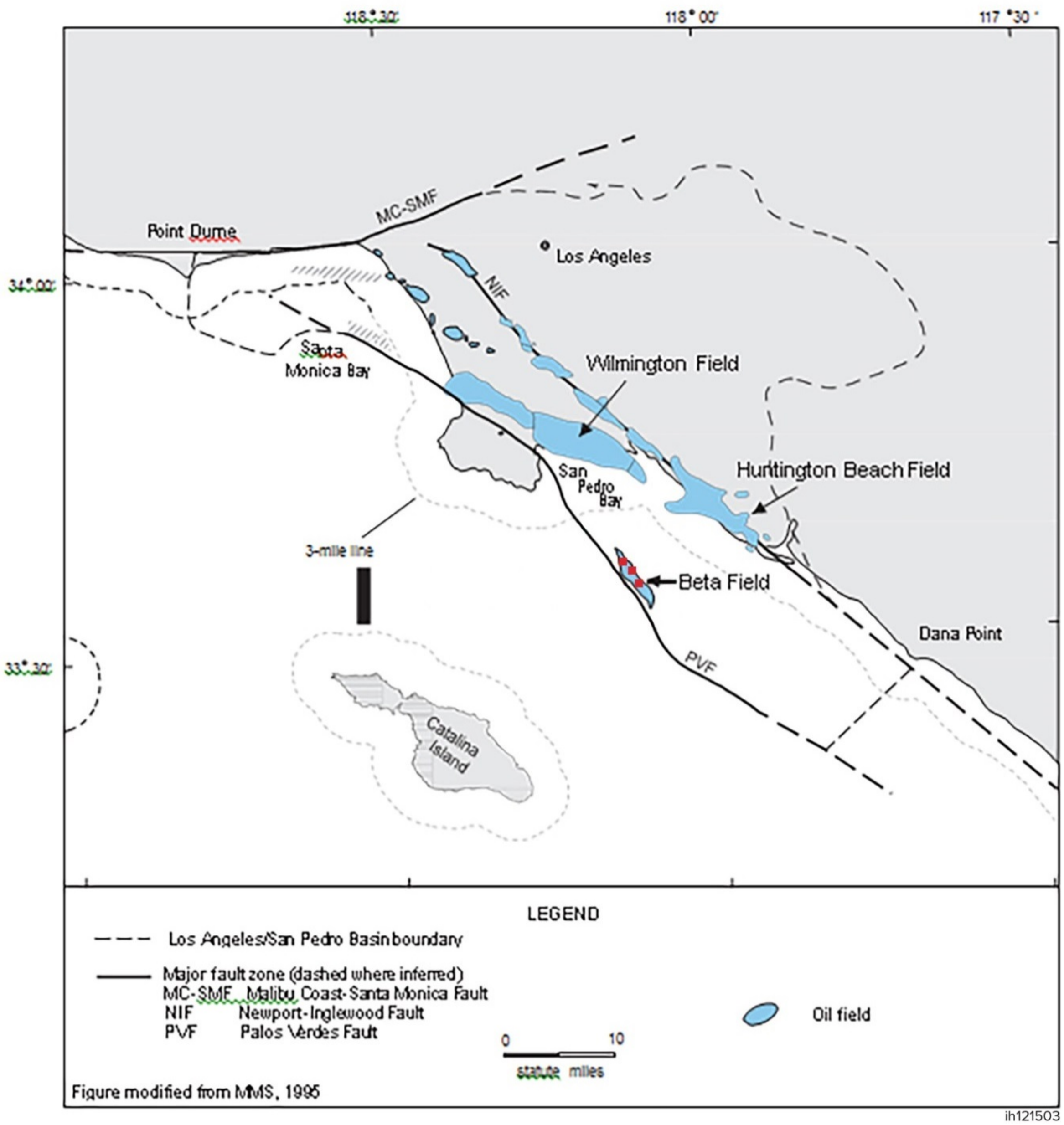

FIGURE 2-6 Location of the San Pedro Shelf and Basin (Platforms on the Southern California OCS are shown in red.) (Modified from Drewry and Victor 1997)

Monterey Formation. Below the Puente Formation is the Mohnian age equivalent of the Monterey Formation. It is a sand and shale sequence of middle Miocene age. Evaluations of the Monterey Formation in the Beta area for potential development have not obtained positive results.

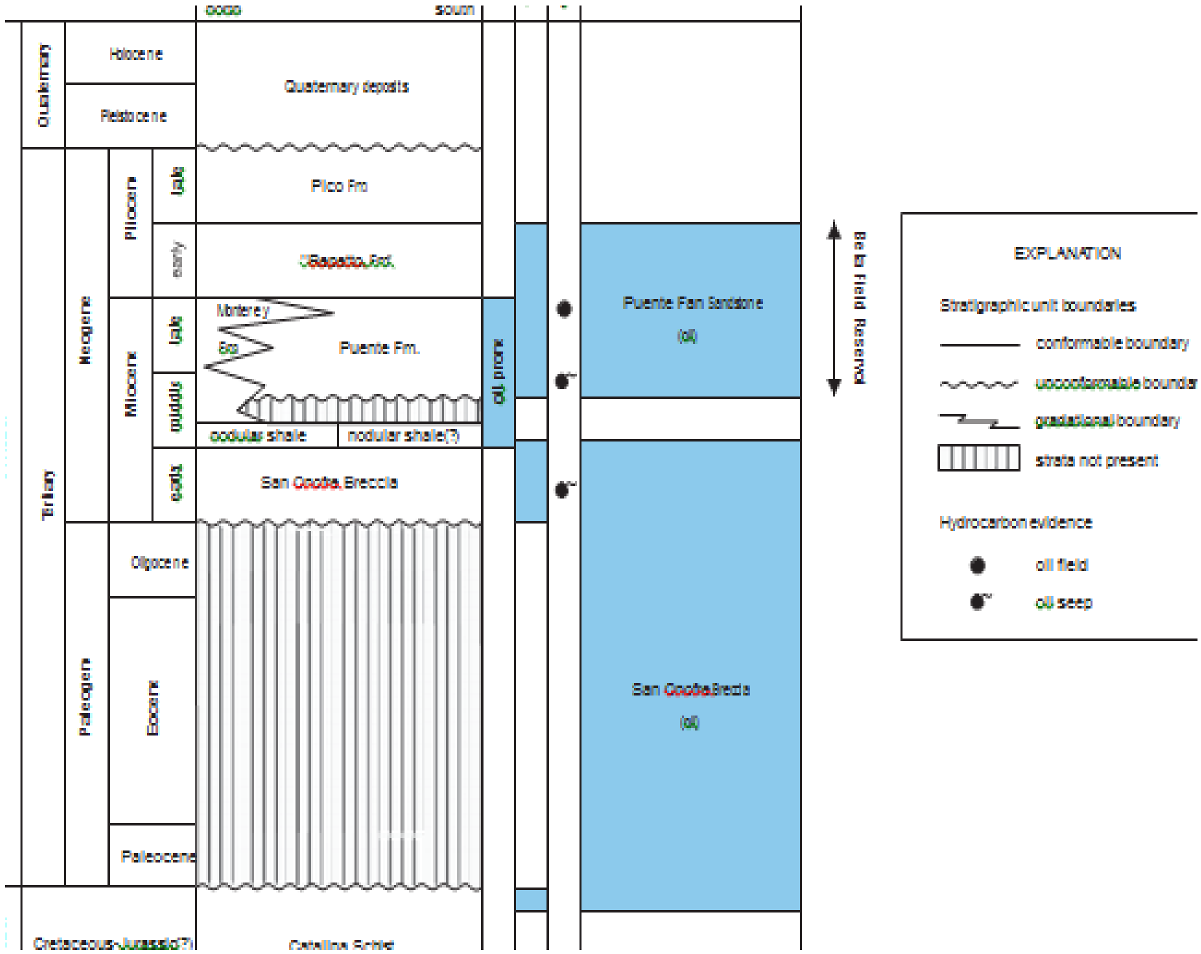

FIGURE 2-7 Stratigraphy of the San Pedro Shelf and Basin Region (Modified from Drewry and Victor [1997])

2.5 Seismicity

The ridges and basins of the California Continental Borderland are bounded by several major active faults that are capable of producing damaging earthquakes (and tsunamis) in close proximity to metropolitan areas of Southern California (Given et al. 2015). Figure 2-8 shows the Quaternary faults[4] of the onshore and offshore California borderland. The major, best-known fault in the region is the San Andreas Fault.

Earthquake activity in the region is monitored by the Southern California Seismic Network (SCSN), an automated seismic network managed by the U.S. Geological Survey (USGS) in cooperation with the California Institute of Technology. Figure 2-9 is a seismicity map of the offshore California borderland showing earthquake events between 1932 and May 2015 in three

4 Quaternary faults are faults that have been observed at the surface and for which there is evidence of movement in the past 1.6 million years, the duration of the Quaternary Period.

magnitude (moment magnitude or Richter scale) categories: (1) 0 to 3; (2) 3.1 to 6.0; and (3) 6.1 to 7.3. Most of the earthquakes are of relatively small magnitude, in the 0 to 3 range. However, several significant earthquakes (Richter magnitude of 6 or greater or Modified Mercali intensity scale VIII or greater) have occurred in historic times on the San Pedro Shelf just offshore of Long Beach, to the southeast of the Santa Barbara Channel. The last significant onshore earthquake in the Santa Barbara and Ventura county area occurred in 1857. This quake, known as the "Fort Tejon" quake, has been estimated to have had a magnitude at 7.9 on the Richter scale (USGS 2015b). The earthquake epicenters shown on Figure 2-9 generally follow a northwest–southeast trend because they occur along the many transform faults in the offshore and nearshore areas.

2.6 References

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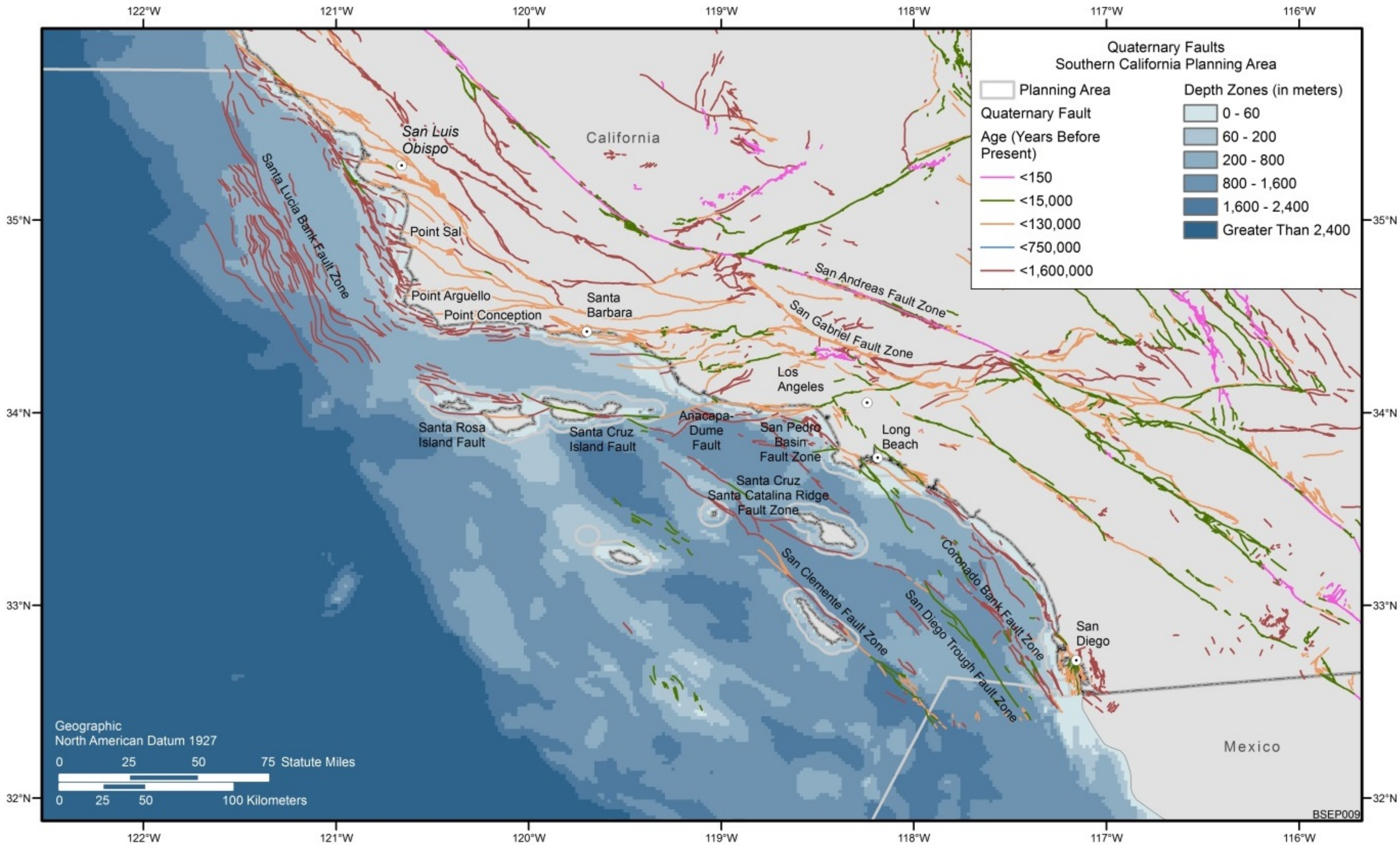

FIGURE 2-8 Quaternary Faults in the California Borderland Region (Data source: USGS 2015a)

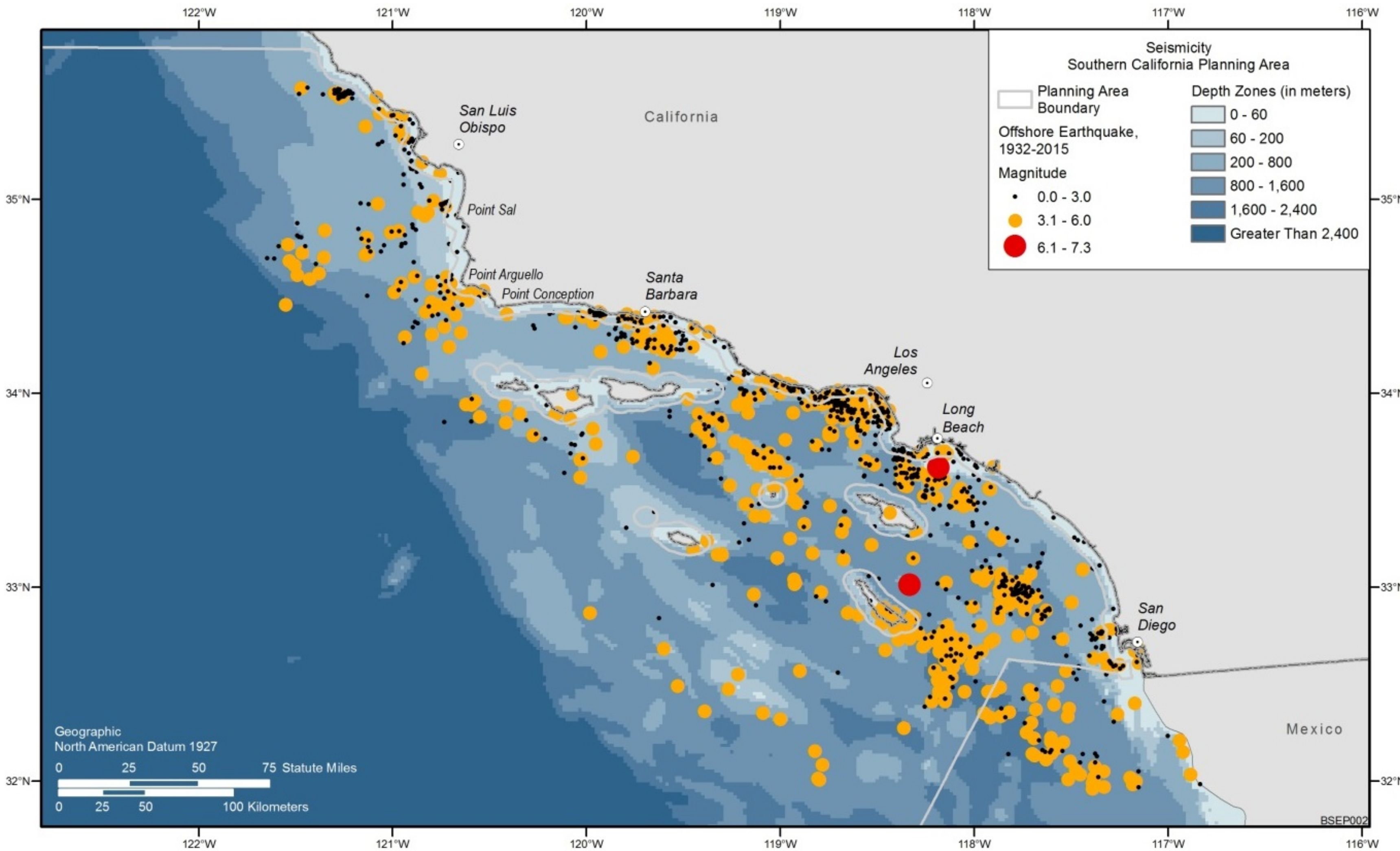

FIGURE 2-9 Seismicity of the Offshore California Borderland Region (Data source: USGS 2015c)

3 METEOROLOGY

This chapter describes the meteorological conditions of the Southern California Planning Area and its five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties).

3.1 Climate

A dominating factor in the weather of California is the semi-permanent high-pressure area referred to as the Pacific High, which plays an important role in seasonal climatic variations (WRCC 2017a). This pressure center moves northward in the summer, holding storm tracks well to the north. As a result, California receives little or no precipitation from this source in summer. In the winter, the Pacific High retreats southward permitting storm centers to swing into and across California, bringing widespread, moderate precipitation to the State.

The temperature and salinity of California waters vary with seasonal variations in upwelling, insolation, and flow. The California Current moves southward along the California coastline bringing in cool waters of the northern Pacific Ocean. In summer, extensive upwelling of colder sub-surface waters occurs, caused by the prevailing northwesterly winds that drive surface waters offshore and draw water up from below. This is what produces California's characteristic and frequent coastal fog and low clouds. As a result, ocean temperatures on the Pacific coast are much cooler than at comparable latitudes on the east coast of the U.S., resulting in cooler summer coastal temperatures. The cool California coastal waters also hinder development of tropical cyclones in the region. Broad-scale climate forcing related to El Niño/La Niña events and the Pacific Decadal Oscillation help determine how much upwelling occurs in a given year.

Associated with the Pacific High, California generally experiences hot, dry summers and mild, wet winters. However, along the western side of the Coastal Range, including along the Southern California OCS Planning Area, the climate is dominated by the Pacific Ocean, characterized by warm winters and cool summers, small daily and seasonal temperature ranges, and high relative humidity (WRCC 2017a).

Around the Channel Islands, the Catalina eddy can bring cooler weather, fog, and better air quality into Southern California by pushing the marine boundary layer further inland. It can stretch across up to 120 mi, last up to a few days, and is most common between April and October, peaking in June (NASA 2017). Several times per year during the non-summer season, a high-pressure area centered on the Great Basin periodically produces strong and extremely dry downslope Santa Ana winds over Southern California (WRCC 2017a).

3.2 Wind

Southern California, the most frequent wind directions are from the northwest, off the San Luis Obispo County, around the Point Arguello, and from the west in the Santa Barbara and Santa Monica Basins, with average wind speeds of 14 mph, and ranging from 8 to 16 mph (NOAA 2017a). Wind patterns are altered depending on coastline orientation, due to local and diurnal sea/land breeze circulation. For example, southeasterly winds occur as often as westerly winds at Santa Barbara, and southerly winds as often as northwesterly winds at Long Beach. Near the coast, average wind speed of 8 mph (ranging from 5 to 17 mph[1]) is far lower than that in open waters. Wind speeds at inland stations along the coastline range from 4 to 9 mph, which is lower than those at buoy stations with lower surface friction.

The California offshore 90-meter (m) height wind map and wind resource potential estimates are shown on Figure 3-1 (NREL 2018). Areas with annual average wind speeds of 7 meters per second (m/s) and greater at 90-m height are generally considered to be suitable for offshore development.

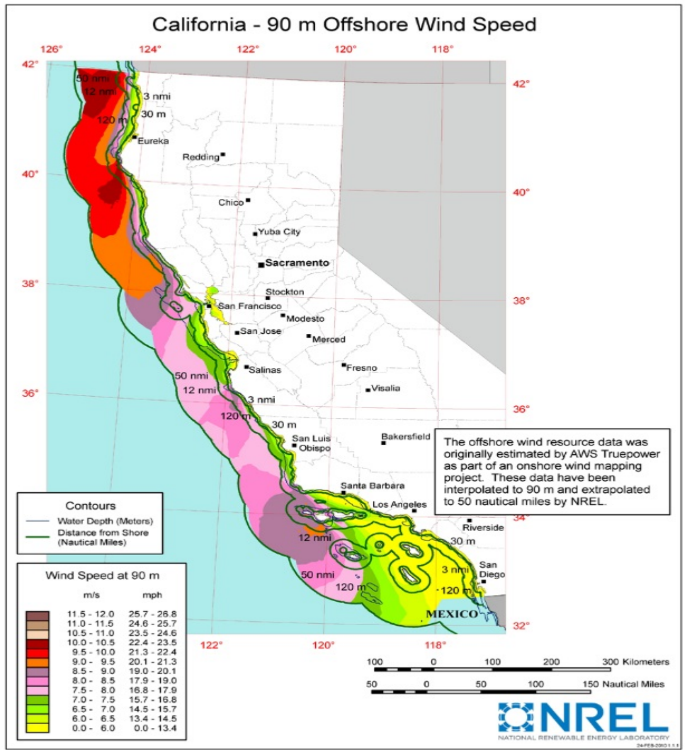

FIGURE 3-1 Map Showing 90-m Height Winds Offshore of California (NREL 2018)

3.3 Temperature

Examination of data from NOAA weather buoys from the Southern California OCS shows annual average temperatures out on open waters off the Southern California coast to range from about 55 to 62°F (average about) 58°F, and near shore from 57 to 65°F (average about 60°F) (NOAA 2019). Due to a moderating influence of the Pacific Ocean, monthly variations in ambient temperatures are relatively small (about 6 to 10°F over open waters and 8 to 13°F near the coast). Minimum monthly temperatures offshore occur December through April, ranging from 52 to 59°F, while maximum offshore monthly temperatures occur in September and October, ranging from 59 to 72°F.

Coastal locations typically experience ambient temperatures that are lower and more moderate than do locations farther inland, but slightly higher than at offshore locations. Along the coast, annual average temperatures range from 57 to 65°F (WRCC 2017b). In general, along the coast January is the coldest month (average minimum temperatures range from 51 to 58°F), and August is the warmest (average maximums ranging from 60 to 80°F).

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1 This wind speed occurs at the Point Arguello station, which is a headland on the Pacific coast and higher anemometer height (32.3 m site elevation plus 9.1 m anemometer height), compared to those at other stations, which are generally lower than 10 m.

3.4 Precipitation

Annual precipitation in the area averages about 15 in., ranging 11–22 in. (WRCC 2017b). On average, about 37 days a year (ranging from 27 to 50 days a year) have measurable precipitation (0.01 in. [0.025 cm] or higher). California seldom receives precipitation from Pacific storms during the summer. About 60% of the annual precipitation occurs during the winter months when the Pacific high decreases in intensity and retreats southward (WRCC 2017a). The presence of the coastal mountains contributes to rainfall in the area, and there has been negligible measurable snowfall in the area.

3.5 Atmospheric Stability

Atmospheric stability plays an important role in dispersing gases or particulates emitted into the atmosphere. Vertical motion and pollution dispersion are enhanced in an unstable atmosphere and are suppressed in a stable atmosphere. For Southern California coastal areas, unstable conditions occur about 20% of the time, while neutral and stable conditions each occur about 40% of the time (Doty et al. 1976). In the project area, the atmosphere over the water area tends to be neutral to slightly unstable.

3.6 Mixing Height

Mixing height provides a measure of the height in the lower atmosphere through which atmospheric pollutants are dispersed. The mixing height depends on the heat flux (rate of warming of the surface layer) and wind speed. Due to steady moderating influences of the Pacific Ocean, diurnal and seasonal variations in mixing heights over water and at coastal stations in the project area are relatively small, compared to those at inland locations.

Over water, the air-sea temperature differences change slowly with time; thus, the mixing heights are relatively constant and low, with a typical marine mixing height of about 1,640 ft over low latitude oceans (LeMone 1978). In contrast, overland there is considerable diurnal variation, with low mixing heights at night and high mixing heights associated with daytime heating. Mixing heights along the coasts of the five counties adjacent to the project area typically range between 1,640 and 3,280 ft, with annual average morning and afternoon mixing heights of 1,800 and 2,790 ft, respectively (Holzworth 1972).

3.7 Severe Weather

Severe weather events have been reported in the National Centers for Environmental Information (NCEI) *Storm Events Database* (NCEI 2017b) for the five coastal counties adjacent to the project area. High or thunderstorm winds, floods, wintery weather, high surf, and wildfires are frequently reported but tornadoes, hail, and tropical storms are reported only on occasion. Except for wildfires and tropical storms, these events occurred in any month of the year but occurred more frequently in colder months, when the Pacific high decreases in intensity and migrates to the south.

Hurricanes and tropical storms formed off the coast of Central America and Mexico dissipate and rarely hit California due to the cold-water current off the California coast, which weakens storms from the south. In addition, the general trend in hurricane motion is to the west-northwest due to the prevailing winds (NOAA 2017) which takes hurricanes away from the California coast. Historically, only three tropical depressions and one extratropical cyclone passed within a 100-mi radius of the project area and no hurricanes or tropical storms have hit north of central California.

3.8 References

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4 AIR QUALITY

This chapter describes the air quality of the Southern California Planning Area and its five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). The following sections briefly discuss California and National ambient air quality standards, natural and anthropogenic sources of pollutant emissions on the OCS as well as the adjacent coastal counties, and the regulatory controls on OCS activities affecting air quality.

4.1 Ambient Air Quality Standards

Under the Clean Air Act (CAA), the U.S. Environmental Protection Agency (EPA) has established the National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment (*Federal Register* 1971). The EPA has set NAAQS for six principal pollutants (known as "criteria" pollutants): ozone (O_3), particulate matter (PM) with an aerodynamic diameter of 10 microns (μm) or less and 2.5 μm or less (PM_{10} and $PM_{2.5}$, respectively), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb) (EPA 2017a). Collectively, the levels of these criteria pollutants are indicators of the overall quality of the ambient air.

The CAA established two types of NAAQS: primary standards (also referred to as "health effects standards") to provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly; and secondary standards (referred to as the "quality of life standards") to provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Many of the NAAQS standards address both short- and long-term exposures (e.g., 1 hr, 8 hr, 24 hr, 30 day, and annual).

The California Air Resources Board (CARB), the clean air agency of the State of California, has established separate ambient air quality standards (California Ambient Air Quality Standards, CAAQS) (CARB 2017a). The CAAQS include the same six criteria pollutants as in the NAAQS, but in contrast with the NAAQS they also include standards for visibility reducing particles, sulfates, hydrogen sulfide, and vinyl chloride. In general, the CAAQS are more stringent than the NAAQS, except for 1-hr NO_2 and SO_2 standards. Table 4-1 presents the current CAAQS and NAAQS.

4.2 Area Designations

The EPA assigns area designations based on how the air quality of an area compares to the NAAQS. Areas with air quality that is as good as or better than NAAQS are designated as "attainment areas" while areas in which air quality is worse than NAAQS are designated as "nonattainment areas." Areas that previously were nonattainment areas but where air quality has improved to meet the NAAQS are redesignated "maintenance areas," and any area that cannot be classified based on available information as meeting or not meeting the NAAQS for any pollutant is defined as an "unclassifiable area." These area designations impose Federal regulations on pollutant emissions and the time periods in which the area must again attain the standard, depending on the severity of the regional air quality problem. The CARB similarly designates areas based on the CAAQS.

TABLE 4-1 California and National Ambient Air Quality Standards

			NAAQS[b]	
Pollutant	Averaging Time	CAAQS[a]	Primary[c]	Secondary[d]
Ozone (O_3)	1 hr	0.09 ppm (180 μg/m^3)	—[e]	—
	8 hr	0.070 ppm (137 μg/m^3)	0.070 ppm	Same as Primary Standard
Respirable particulate matter (PM_{10})	24 hr	50 μg/m^3	150 μg/m^3	Same as Primary Standard
	Annual	20 μg/m^3	—	—
Fine particulate matter ($PM_{2.5}$)	24 hr	—	35 μg/m^3	Same as Primary Standard
	Annual	12 μg/m^3	12 μg/m^3	15 μg/m^3
Carbon monoxide (CO)	1 hr	20 ppm (23 mg/m^3)	35 ppm	—
	8 hr	9.0 ppm (10 mg/m^3)	9 ppm	—
	8 hr (Lake Tahoe)	6 ppm (7 mg/m^3)	—	—
Nitrogen dioxide (NO_2)	1 hr	0.18 ppm (339 μg/m^3)	100 ppb	—
	Annual	0.030 ppm (57 μg/m^3)	53 ppb	Same as Primary Standard
Sulfur dioxide (SO2)	1 hr	0.25 ppm (655 μg/m^3)	75 ppb	—
	3 hr	—	—	0.5 ppm
	24 hr	0.04 ppm (105 μg/m^3)	—	—
Lead (Pb)	30 day	1.5 μg/m^3	—	—
	Rolling 3 month	—	0.15 μg/m^3	Same as Primary Standard
Visibility reducing particles	8 hr	See footnote f	—	—
Sulfates	24 hr	25 μg/m^3	—	—
Hydrogen sulfide	1 hr	0.03 ppm (42 μg/m^3)	—	—
Vinyl chloride	24 hr	0.01 ppm (26 μg/m^3)	—	—

[a] Detailed information on attainment determination criteria for CAAQS and reference method for monitoring is available in CARB (2017a).

[b] Detailed information on attainment determination criteria for NAAQS and reference method for monitoring is available in *Federal Register* (1971) and EPA (2017a).

[c] Primary standards provide public health protection, including protecting the health of “sensitive” populations such as asthmatics, children, and the elderly.

[d] Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

[e] Not applicable.

[f] In 1989, the CARB converted both the general Statewide 10-mi visibility standard and the Lake Tahoe 30-mi visibility standard to instrumental equivalents, which are “extinction of 0.23 per kilometer” and “extinction of 0.07 per kilometer” for the Statewide and Lake Tahoe Air Basin standards, respectively.

Sources: CARB (2017a); EPA (2017a).

Based on the most recent available monitoring data, a summary of the attainment status for the six criteria pollutants in San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange counties is presented in Table 4-2. These counties are designated as either attainment or unclassified areas for all NAAQS criteria pollutants, except: the eastern half of San Luis Obispo County and all of Ventura County are nonattainment areas for O_3; Los Angeles and Orange Counties are both nonattainment areas for both O_3 and $PM_{2.5}$; and part of Los Angeles County is a nonattainment area for lead (CARB 2017a; EPA 2017a). Based on the CAAQS, all five counties are designated as nonattainment areas for O_3 and PM_{10}, and Los Angeles and Orange Counties are nonattainment areas for $PM_{2.5}$ (CARB 2017a). All five counties are in attainment for other the CAAQS criteria pollutants.

TABLE 4-2 Summary of State and Federal Attainment Designation Status[a] for Criteria Pollutants in San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties

	O_3		PM_{10}		$PM_{2.5}$		CO		NO_2		SO_2		Pb	
County	State	Fed.	State	Fed.	State	Fed.	State	Fed.	State	Fed.	State	Fed.	State	Fed.
San Luis Obispo	N	NP	N	U	A	A/U	A	A/U	A	A/U	A	U	A	A/U
Santa Barbara	N	A/U	N	U	U	A/U	A	A/U	A	A/U	A	U	A	A/U
Ventura	N	N	N	U	A	A/U	A	A/U	A	A/U	A	A	A	A/U
Los Angeles	N	N	N	A/U	NP	NP	A	A/U	A	A/U	A	A/U	A	NP
Orange	N	N	N	A	N	N	A	A/U	A	A/U	A	A	A	A/U

[a] A = attainment; N = nonattainment; NP = nonattainment in part of the county; and U = unclassifiable. Nonattainment is highlighted in gray.

Sources: CARB (2017b); EPA (2017b).

4.3 Prevention of Significant Deterioration

The prevention of significant deterioration (PSD) regulations (*Prevention of significant deterioration of air quality*, 40 CFR § 52.21), which are designed to limit the growth of air pollution in attainment areas, apply to a major new source or modification of an existing major source within an attainment area or an unclassified area. While the NAAQS (and CAAQS) place upper limits on the levels of air pollution, PSD limits the total increase in ambient pollution levels above the established baseline levels for SO_2, NO_2, PM_{10}, and $PM_{2.5}$. The allowable increase is smallest in Class I areas, such as national parks (NPs) and wilderness areas (WAs). The rest of the country is subject to larger Class II increments. The maximum allowable PSD increments for Class I and Class II areas are given in Table 4-3.

Major (large) new and modified stationary sources must meet the requirements for the areas in which they are located and the areas they affect. For example, a source located in a Class II area in close proximity to a Class I area would need to meet the more stringent Class I increment in the Class I area and meet the Class II increment elsewhere, in addition to any other applicable requirements. Aside from capping increases in criteria pollutant concentrations below the levels set by the NAAQS, the PSD program mandates stringent control technology requirements for new and modified major sources. The CAA requires Federal land managers to evaluate whether the proposed project will have an adverse impact on air quality-related values in Class I areas, including visibility. There are several Federal Class I areas in California adjacent to the Southern California Planning Area, including the Pinnacles, Ventana, San Rafael, San Gabriel, and Cucamonga Wilderness Areas.

TABLE 4-3 Maximum Allowable PSD Increments for PSD Class I and Class II Areas

		Allowable Concentration Increment (g/m^3)		
PSD Class	Pollutant	Annual Arithmetic Mean	24-hour Maximum	3-hour Maximum
Class I	NO_2	2.5	a	-
	SO_2	2	5	25
	PM_{10}	4	8	-
	$PM_{2.5}$	1	2	-
	NO_2	25	-	-
Class II	SO_2	20	91	512
	PM_{10}	17	30	-
	$PM_{2.5}$	4	9	-

4.4 Air Emissions

The annual average emissions of criteria pollutants and reactive organic gases (ROG) from anthropogenic sources) projected by CARB for 2019 (using 2012 emissions data as a baseline) for each of the five counties along the Southern California Planning Area are presented in Table 4-4 (CARB 2019a). These include all sources both in the inland and OCS air basin, but not natural sources. Note that the CARB estimates only include emissions from O&G activities on platforms in Santa Barbara and Ventura counties, as their database does not include O&G emissions from the other counties (CARB 2019).

For year 2019, total emissions for Los Angeles County, the most populous county in California, is projected to account for about two-thirds of the total annual emissions of all criteria pollutants and ROG (which play a major role in the generation of photochemical oxidants in the atmosphere) for the five counties. Los Angeles County accounts for 50% of the NO_x and 60% of the SO_x projected annual average emissions from the five-counties (CARB 2019a). Orange County accounts for between 13–21% of the five-county total for six pollutants except for SO_x, for which the county accounts for about 6.7% of the five-county total. Santa Barbara and Ventura Counties are generally similar, accounting for between 5-16% for any one of the criteria pollutants and ROG. In the 2012 baseline year, Santa Barbara County accounted for about 33% of the five-county total of SO_X, due in large part to the large number of ocean-going vessels burning high sulfur content fuel oil visiting its ports. This amount has gone down, but this amount has gone down to about 12% in 2019, due in large part to the 2009 California ocean-going vessel fuel regulation (California Code of Regulations 2009). San Luis Obispo County is estimated to have the lowest emissions among five counties (4% for all pollutants). Compared to the 2012 baseline year, five-county total emissions are estimated to decrease in 2019 for all criteria pollutants and ROG, with decreases ranging from 6% for $PM_{2.5}$ to 46% for SO_x, except PM_{10}, which slightly increases at about 3% (Figure 4-1).

TABLE 4-4 2019 Projected Total Annual Average Emissions of Criteria Pollutants and Reactive Organic Gases, by County and by Source Category (tons per day)[a]

County or Source	ROG	CO	NO_x	SO_x	PM_{10}	$PM_{2.5}$
By county						
San Luis Obispo	17.4	51.8	27.7	1.1	11.5	3.6
Santa Barbara	27.9	75.4	69.7	2.3	14.3	3.9
Ventura	31.1	94.8	34.4	1.6	18.1	6.0
Los Angeles	231.3	890.6	231.2	13.2	102.6	42.1
Orange	76.1	302.9	55.5	1.3	24.2	10.4
Five-county total	389.82	1,415.5	418.5	19.5	170.7	66.0
By source category						
Fuel Combustion	11.3	55.6	46.6	7.28	6.8	5.9
Waste Disposal	9.7	1.4	2.4	0.6	0.4	0.3
Cleaning & Surface Coatings	48.6	0.1	<0.1	<0.0	1.7	1.6
Petroleum Production & Marketing	26.8	5.7	1.4	2.4	1.8	1.5
Industrial Processes	11.4	1.0	0.7	0.7	18.4	7.5
Solvent Evaporation	104.6	<0.0	<0.0	<0.0	<0.0	0.02
Miscellaneous Processes	16.5	78.4	15.0	0.6	112.1	32.7
On-road Motor Vehicles	75.4	585.4	140.5	1.6	21.5	9.5
Other Mobile Sources	79.4	687.9	211.8	6.8	8.0	6.9
Five-county total	389.82	1,415.5	418.5	19.5	170.7	66.0

[a] Includes emissions only from O&G activities on platforms in Santa Barbara and Ventura Counties.
Source: CARB (2019a).

The estimated five-county OCS total emissions for ROG, CO, PM_{10}, and $PM_{2.5}$ for 2019 are minor contributors (up to 2.6%) to five-county total emissions (Table 4-5) (CARB 2019a). However, NO_x and SO_x emissions are significant contributors, accounting for 27% and 15% of the five-county total emissions, respectively. In San Luis Obispo, Santa Barbara, and Ventura Counties, which have lower emissions levels compared to Los Angeles and Orange Counties, OCS emissions for NO_x and SO_x contribute a considerable portion of county total emissions, about 49-79% and 31-55%, respectively. Among source categories, ocean-going vessels and commercial harbor craft are primary and distant second contributors to five-county total OCS emissions for all criteria pollutants and ROG, accounting for about 50-88% and 10-39%, respectively. Oil and gas production and aircraft are minor contributors to total OCS emissions (CARB 2019a). Compared to the 2012 baseline year, five-county OCS total emissions in 2018 are projected to decrease by 84% for SO_x, 60% for PM_{10}, and 61% for $PM_{2.5}$ and to increase by 31% for ROG, 1% for CO, and 9% for NO_x (Figure 4-1).

TABLE 4-5 2019 Projected Offshore Continental Shelf Annual-Average Emissions of Criteria Pollutants and Reactive Organic Gases, by County and by Source Category (tons per day)[a]

County	ROG	CO	NO_x	SO_x	PM_{10}	$PM_{2.5}$
San Luis Obispo	1.03 (5.8%)[b]	1.38 (2.6%)	17.31 (62.2%)	0.35 (30.6%)	0.17 (1.5%)	0.16 (4.4%)
Santa Barbara	4.24 (15.1%)	4.64 (6.0%)	54.86 (79.1%)	1.27 (54.8%)	0.60 (4.2%)	0.55 (14.4%)
Ventura	1.32 (4.2%)	3.04 (3.1%)	17.06 (48.9%)	0.68 (44.3%)	0.30 (1.7%)	0.28 (4.7%)
Los Angeles	1.68 (0.7%)	5.37 (0.6%)	21.09 (8.7%)	0.50 (3.6%)	0.64 (0.6%)	0.60 (1.4%)
Orange	0.45 (0.6%)	1.04 (0.3%)	7.01 (12.0%)	0.28 (21.2%)	0.14 (0.6%)	0.12 (1.2%)
Five-county total	8.72 (2.2%)	15.48 (1.1%)	117.32 (27.1%)	3.07 (15.3%)	1.85 (1.1%)	1.72 (2.6%)

[a] Emissions from O&G activities on platforms in Santa Barbara and Ventura Counties only are included.
[b] A percentage of its respective county or five-county total emission for a pollutant of interest.
Source: CARB (2019a).

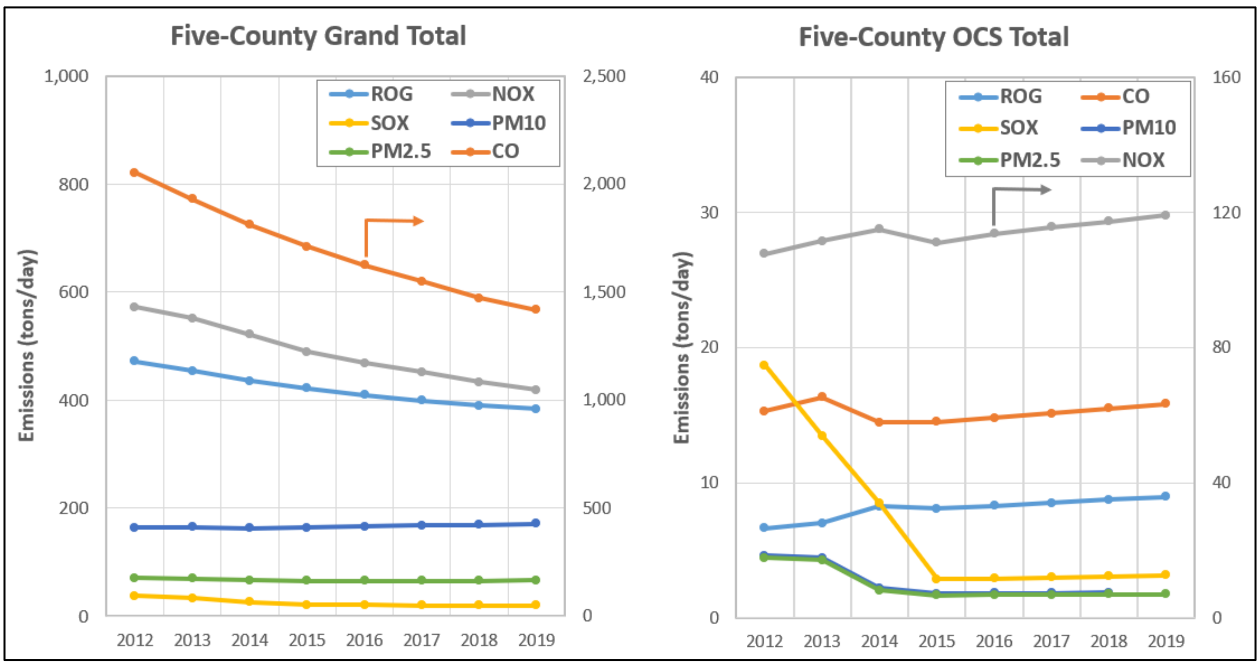

FIGURE 4-1 Trends of Five County Total (left panel) and OCS Total (right panel) Air Emissions, 2012-2019 (Source: CARB 2019a)

Emissions from other mobile sources (including off-road equipment and vehicles, aircraft, train, boats and vessels) and on-road motor vehicles are the largest and second-largest contributors, respectively, to five-county total emissions of CO and NO_X. Emissions from miscellaneous processes (including residential fuel combustion, cooking, construction and demolition, road and wind-blown dusts, etc.) and on-road motor vehicles are the largest and second-largest contributors, respectively, to both PM_{10} and $PM_{2.5}$. Fuel combustion account for about 36% of the SO_X emissions' total, followed by other mobile sources (about 33%). Solvent evaporation is the largest contributor to total ROG emissions and on-road motor vehicles and other mobile sources are equally second-largest contributors.

Diesel engines emit a complex mixture of pollutants, including very small carbon particles, or "soot" (also called black carbon [BC]) coated with numerous organic compounds, known as diesel particulate matter (DPM) (CARB 2019b). Diesel exhaust also contains more than 40 cancer-causing substances, most of which are readily adsorbed onto the soot particles. DPM cannot be measured directly and has to be estimated. In 1998, California identified DPM as a toxic air contaminant (TAC) based on its cancer potential. Most major sources of diesel emissions, such as ships, trains, and trucks operate in and around ports, rail yards, and heavily traveled roadways (CARB 2019b). These areas are often located near highly populated areas. Because of this, elevated DPM levels are mainly an urban problem, with large numbers of people exposed to higher DPM concentrations, resulting in greater health consequences compared to rural areas. In addition, DPM can affect the environment, such as visibility degradation and climate change (CARB 2019). Diesel black carbon, which is a major component of soot and the most solar energy-absorbing component of PM, is the second largest contributor to climate change after CO2.Statewide DPM ambient concentrations tend to decrease due to ARB's regulations of diesel engines and fuels (CARB 2019b). Since 1990, DPM levels have decreased by 68% and are anticipated to continue declining as additional controls are adopted and the number of new technology diesel vehicles increases.

Natural emission from all sources include biogenic emissions from plants and trees, geogenic emissions from marine seeps on the continental shelf, and wildfires. Except for Orange County, natural ROG and/or PM emissions are comparable to or up to 4 times higher than man-made emissions of ROG and/or PM (CARB 2019a). On the OCS, emissions of ROG from marine seeps can be a significant source of ROG, which is a precursor to smog-forming ozone (Hornafius et al. 1999). Geogenic emissions in this region are largely limited to Santa Barbara and Ventura Counties, where they are as much as 94% and 12%, respectively, of average annual man-made ROG emissions totals for these counties (CARB 2019a). Approximately 50 oil seeps occur off the shore of Southern California between Point Arguello and Huntington Beach, with at least 38 located in the Santa Barbara Channel. The Coal Oil Point seep field is an area of approximately 18-km^2 off the shore of Goleta, California, and has been estimated to emit 100–130 tons of natural gas per day (Hornafius et al. 1999).

In general, greenhouse gas (GHG) emissions data are not available at the county level. In California, the total Statewide gross[2] GHG emissions in 2017 (the most recent information

[2] Excluding GHG emissions removed due to forestry and other land uses.

available) were estimated to be about 424 million metric tons (MMT) carbon dioxide equivalent (CO_2e)[3] (CARB 2019a), which was about 6.6% of the total GHG emissions in 2017 for the United States (EPA 2019). About 83% of the California total GHG emissions are CO_2, followed by CH_4 (9%), high-global warming potential GHG[4] (5%), and N_2O (3%). By sector, transportation is the single largest source of GHG emissions (about 40%) in California, followed by industrial sources (21%) and electricity production (15%) (CARB 2019).

4.5 Regulatory Controls on OCS Activities Affecting Air Quality

The EPA has authority for Clean Air Act (CAA) compliance of air quality on the POCS as granted under Section 328 of the 1990 CAA Amendments (CAAA). On September 4, 1992, the EPA Administrator promulgated requirements (*Federal Register* 1992) to control air pollution from POCS sources to attain and maintain Federal and State air quality standards and to comply with CAAA provisions for the Prevention of Significant Deterioration.

EPA delegated control of offshore facilities to the local air districts under their individual regulatory programs as if the facility were located onshore. Within the Southern California Planning Area, oil and gas platforms were delegated to air districts of the corresponding onshore area (COA) (Table 4-6). Currently, the four southern counties all have POCS facilities, with no structures presently located offshore of San Luis Obispo County.

Table 4-6 POCS Platforms and Associated Air Pollution Control Districts

Air Pollution Control District	Assigned POCS Platforms[a]
Santa Barbara County Air Pollution Control District (SBCAPCD)	Irene, Hidalgo, Harvest, Hermosa, Heritage, Harmony, Hondo, A, B, C, Hillhouse, Henry, Habitat, Houchin, Hogan
Ventura County Air Pollution Control District (VCAPCD)	Grace, Gilda, Gail, Gina
South Coast Air Quality Management District (SCAQMD)	Edith, Ellen, Elly, Eureka

[a] See Figure 1-1 for platform locations.

Congress established a program under Title V of the 1990 CAAA to help find a solution to reduce air pollution. A Title V Operating Permit, which applies to stationary sources with air

3 A measure to compare the emissions from various GHGs on the basis of the global warming potential (GWP), defined as the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specific time period. For example, GWP is 25 for CH_4, 298 for N_2O, and 22,800 for SF_6. Accordingly, CO_2e emissions are estimated by multiplying the mass of a gas by the GWP.

4 Fluorinated GHGs, including sulfur hexafluoride (SF_6), nitrogen trifluoride (NF_3), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).

emissions over major source thresholds of air emissions (e.g., 100 tons per year), consolidates all applicable air quality regulatory requirements into a single, legally enforceable document. These permits are designed to improve compliance by clarifying what air quality regulations apply to a facility. Currently, 21 platforms[5] on Federal waters have Title V Operating Permits, and two platforms, Habitat off Santa Barbara County and Edith off Long Beach, have local (non-Title V) permits (SBCAPCD 2018; SCAQMD 2019; VCAPCD 2018).

Emission sources associated with O&G activities at offshore platforms include combustion units, marine traffic, and fugitive sources (SBCAPCD 2018; SCAQMD 2019; VCAPCD 2018). Emission sources vary from platform to platform, depending on whether the primary power on the platform is supplied by a subsea electric cable from shore. Three platforms under the Santa Barbara County Air Pollution Control District (SBCAPCD) (Harvest, Hermosa, and Hidalgo), two platforms under the Ventura County Air Pollution Control District (VCAPCD) (Grace and Gail), and four platforms (Edith, Ellen, Elly, and Eureka) under the South Coast Air Quality Management District (SCAQMD) generate the primary power using turbine generators burning either produced gas or diesel fuel. All other platforms are powered by the electric grid provided through a subsea cable from shore. In general, other combustion sources include gas turbine engines used to drive the sales gas compressors, diesel-fired pedestal cranes, production and drilling rig emergency generators, fire emergency water pumps, and/or high/low pressure flares. Marine traffic includes crew boats or helicopters for transportation of platform personnel, supply boats for transportation of equipment, fuel, and supplies to and from the platform, and emergency response boats. Solvent usage for cleaning/degreasing, fugitive components from the valves and associated connections in gas service, tanks/vessels/sumps/separators, and pigging equipment, belong to the category of fugitive sources.

In general, at non-grid-powered platforms, emissions from turbine generators are highest for criteria pollutants, followed by supply boats and combustion engines. Fugitive components are a primary source of ROG, followed by turbine generators. Other combustion sources such as engines, flares, turbine compressors are minor emission sources for criteria pollutants. At grid-powered platforms, supply boats and combustion engines are primary and secondary emission sources for criteria pollutants, respectively, while fugitive components dominate in total ROG emissions.

SBCAPCD, VCAPCD, and SCAQMD regulate emissions from offshore platforms, with Permits to Operate that define permitted emissions from specified equipment and service vessels. Diesel particulate matter (DPM) has been designated a carcinogen in the State of California. In Ventura County, all crude oil and produced water must be contained in closed-top tanks equipped with vapor recovery. Ultra-low-sulfur diesel (ULSD) with a sulfur content of 15 ppm or less was applied to both on-road and off-road engines in California from 2006 (CARB 2004).

[5] Three platforms (Ellen, Elly, and Eureka) are operated by Beta Offshore. Platform Ellen is a production platform connected by a walkway to Platform Elly, a processing platform for both Ellen and Eureka. These three platforms have one Title V permit.

Thus, diesel fuel used by all internal combustion engines, e.g., emergency diesel generators and supply boats, associated with O&G activities at platforms in federal waters should be ULSD as well.

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5 ACOUSTIC ENVIRONMENT

This chapter describes the acoustic environment of the Southern California Planning Area and its five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties).The following sections briefly discuss airborne and underwater sound, sound propagation, ambient noises, anthropogenic noises, climate effects on the underwater acoustic environment, and regulatory controls. Separate discussions cover the similarities and differences of underwater and airborne noise.

5.1 Sound Fundamentals

5.1.1 Underwater Sound

Light does not travel far in the ocean due to its absorption and scattering. Even in the clearest water, most light is absorbed within a few hundred meters, and visual communication among marine species is very limited in water, especially in deep or murky water, and/or at night. Accordingly, auditory capabilities have evolved to overcome this limitation of visual communication for many marine animals. Sound, which is mostly used by marine animals for such basic activities as finding food or a mate, navigating, and communicating, plays a crucial role in their survival in the marine environment. The same advantages of sound in water have led humans to deliberately introduce sound into the ocean for many valuable purposes, e.g., communication (e.g., submarine-to-submarine), feeding (e.g., fish-finding sonar), and navigation (e.g., depth finders and geological and geophysical surveys for minerals) (Hatch and Wright 2007). However, some sounds, such as the noise generated by ships and by offshore industrial activities, including oil and gas activities, are also introduced into the ocean as a byproduct.

Any pressure variation that the human ear can detect is considered sound, and noise is defined as unwanted sound. Sound is described in terms of amplitude (perceived as loudness) and frequency (perceived as pitch). The ear can detect pressure fluctuations changing over seven orders of magnitude. The ear has a protective mechanism in that it responds logarithmically, rather than lineally. To deal with these two realities (wide range of pressure fluctuations and the response of the ear), sound pressure levels[6] are typically expressed as a logarithmic ratio of the measured value to a reference pressure, called a decibel (dB). By convention, the reference pressures are 1 micropascal (µPa) for underwater sound and 20 µPa for airborne sound, which

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[6] There are two primary but different metrics for sound measurements: sound pressure level (SPL) and sound exposure level (SEL). SPL is the root mean square of the sound pressure over a given interval of time, given as dB re 1 µPa for underwater sound. In contrast, SEL is the total noise energy from a single event and is the integration of all the acoustic energy contained within the event. SEL takes into account both the intensity and the duration of a noise event, given as dB re 1 $\mu Pa^2 \bullet s$ for underwater sound. In consequence, SEL is similar to SPL in that total sound energy is integrated over the measurement period, but instead of averaged over the entire measurement period, a reference duration of 1 s is used.

corresponds to the average person's threshold of hearing at 1,000 Hertz (Hz)[7]. Accordingly, sound intensity in dB in water is not directly comparable to that in dB in air.[8]

There are primarily three ways to characterize the intensity of a sound signal (URI 2017). The "zero-to-peak pressure," or "peak pressure," denotes the range between zero and the greatest pressure of the signal, while "peak-to-peak pressure" denotes the range between negative and positive extremes of the signal. The "root-mean-square (rms) pressure" is the square root of the average of the square of the pressures of the sound signal over a given duration. Due to the sensitivity of marine animals to sound intensity, the rms pressure is most widely used to characterize underwater sound waves. Underwater dB is used to indicate decibels computed using root-mean-square pressure, unless otherwise indicated. However, for impulsive sounds, rms pressure is not appropriate to use because it can vary considerably depending on the duration over which the signal is averaged. In this case, peak pressure of impulsive sound, which could be associated with the risk of causing physical damage in auditory systems of marine animals, is more appropriately used (Coles et al. 1968). Unless otherwise noted, *source levels* of underwater sounds are typically expressed in the notation "dB re 1 µPa-m," which is defined as the pressure level that would be measured at a reference distance of 1 m from a source. In addition, zero-to-peak and peak-to-peak sound pressure levels are denoted as $dB_{0\text{-}p}$ and $dB_{p\text{-}p}$ re 1 µPa-m, respectively. In addition, the *received levels* (estimated at the receptor locations) are presented as "dB re 1 µPa" at a given location (e.g., 5 km [3 mi]).

Most animals, including humans, terrestrial and marine mammals, and fishes have varying sensitivity to sounds of different frequencies (URI 2017), i.e., not hear equally at all frequencies. Accordingly, species-specific frequency weighting that quantitatively account for these differing sensitivities can be applied, particularly when considering impacts on animal's hearing.

5.1.2 Airborne Sound

Sound pressure levels in air are also measured by using the logarithmic decibel (dB) scale. A-weighting (denoted by dBA) (Acoustical Society of America 1983, 1985) is widely used to account for human sensitivity to frequencies of sound (i.e., less sensitive to lower and higher frequencies and most sensitive to sounds between 1 and 5 kilohertz [kHz]), which correlates well with a human's subjective reaction to sound. Several sound descriptors have been developed to account for variations of sound with time. The equivalent continuous sound level (L_{eq}) is a sound level that, if it were continuous during a specific time period, would contain the same total energy as a time-varying sound. In addition, human responses to noise differ depending on the

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7 Hertz is the scientific unit of frequency, equal to one cycle per second. The general range of hearing in humans sound frequencies from approximately 20 Hz to 20,000 Hz.

8 Sound intensity in dB in water is not comparable to that in air due to the difference in reference standards as well as the differences in the sound speeds and the densities between the two. For the same pressure, higher density and higher sound speed both give a lower intensity. The difference in reference standards and the differences in sound speeds and densities cause about 26 dB and 35.5 dB, respectively. To compare noise levels in water to those in air, 61.5 dB should be subtracted from the noise levels in water to account for these two differences.

time of the day (e.g., higher sensitivity to noise during nighttime hours because of lower background noise levels). The day-night average sound level (L_{dn}, or DNL)[9] is a single dBA value calculated from hourly L_{eq} over a 24-hour period, with the addition of 10 dBA to sound levels from 10 p.m. to 7 a.m. to account for the greater sensitivity of most people to nighttime noise. Generally, a 3-dBA change over existing noise levels is considered a "just noticeable" difference; a 10-dBA increase is subjectively perceived as a doubling in loudness and almost always causes an adverse community response (NWCC 2002).

5.2 Sound Propagation

5.2.1 Underwater Sound Propagation

Understanding the impact of sound on a receptor requires a basic understanding of how sound propagates from its source. Underwater sound spreads out in space, is reflected, refracted, and absorbed. Sound propagates with different geometries under water, especially in relatively shallow nearshore environments. Vertical gradients of temperature, pressure, and salinity in the water as well as wave and current actions can also be expected to constrain or distort sound propagation geometries. Several important factors affecting sound propagation in water include spreading loss, absorption loss, scattering loss, and boundary effects of the ocean surface and the bottom (Malme 1995).

Among these, spreading loss, which does not depend on frequency, is the major contributor to sound attenuation. As propagation of sound continues, its energy is distributed over an ever-larger surface area. The surface of the water and the ocean floor are effective boundaries to sound propagation, acting either as sound reflective or absorptive surfaces. Spherical and cylindrical spreading are two simple approximations used to describe the sound levels associated with sound propagations away from a source. In spherical propagation, sound from a source at mid-depth in the ocean (i.e., far from the sea surface or sea bottom) propagates in all directions with a 6-dB drop per doubling of distance from the source. In cylindrical spreading, sound propagates uniformly over the surface of a cylinder, with sound radiating horizontally away from the source, and sound levels dropping 3 dB per doubling of distance. The surface of the water and the ocean floor are effective boundaries to sound propagation, acting either as sound reflective or absorptive surfaces. Consequently, some underwater sound originating as a point source will initially propagate spherically over some distance until the sound pressure wave reaches these boundary layers; thereafter, the sound will propagate cylindrically. Therefore, some sound levels tend to diminish rapidly near the source (spherical propagation) but slowly with increasing distances (cylindrical propagation).

Directionality refers to the direction in which the signal is projected. Many underwater noises are generally considered omnidirectional (e.g., construction, dredging, explosives). However, geophysical surveys, such as seismic airgun arrays, are focuses downward, while some

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[9] Only California requires the use of Community Noise Equivalent Level (CNEL), which is almost the same as DNL except the addition of 5 dB to noise levels in the evening between 7 p.m. to 10 p.m. There is usually little difference between CNEL and DNL, so they can be used interchangeably for most purposes.

geological surveys are fanned. Although airgun arrays are designed to direct a high proportion of the sound energy downward, some portion of the sound pulses can propagate horizontally in the water, depending on array geometry and aspect relative to the long axis of the array (Greene and Moore 1995). In any case, sound attenuation of directional sound with distance is lower than the spreading loss for omnidirectional sources discussed above.

As sound travels, some sound energy is absorbed by the medium such as air or water (absorption losses) which represents conversion of acoustic energy to heat energy. Absorption losses depend strongly on frequency, becoming greater with increasing frequencies, and vary linearly with increasing distance, and are given as dB/km. Sound scattering is affected by bubbles, suspended particles, organisms, or other floating materials. Like absorption losses, scattering losses vary linearly with distance, and are given as dB/km.

Whenever sound hits the ocean surface or seafloor, it is reflected, scattered, and absorbed and mostly loses a portion of its sound energy. Hard materials (like rocks) will reflect or scatter more sound energy, while soft materials (like mud) will absorb more sound energy. Accordingly, the seafloor plays a significant role in sound propagation, particularly in shallow waters.

Typically, a high-frequency sound cannot travel as far as a low-frequency sound in water because higher frequencies are absorbed more quickly. An exception is the rapid attenuation of low frequencies in shallow waters (Malme 1995). Shallow water acts as a waveguide bounded on the top by the air and on the bottom by the ocean bottom. The depth of the water represents the thickness of the waveguide. Sound at long wavelengths (low frequencies) does not fit in the waveguide and is attenuated rapidly by the effects of interference at the boundaries.

5.2.2 Airborne Sound Propagation

Airborne sound propagation is almost the same as underwater sound propagation. The only difference is that airborne sound encounters only one boundary, the earth'searth'searth's surface. Except with an elevated source, most noise sources are located on or near the surface, which leads to hemi-spherical spreading. As mentioned earlier, underwater sound propagates initially via spherical spreading followed by cylindrical spreading as the sound reaches the sea surface and the sea bottom. However, airborne sound propagation does not alter its spreading mode.

Among many attenuation factors, meteorological effects associated with vertical profiles of wind and temperature play the biggest role in sound propagation, especially over long distances. Because of surface friction, wind speed increases with height, which acts to bend the path of sound, "focusing" it on the downwind side and making a "shadow" on the upwind side of the source ("wind gradient effects"). On a clear night, temperature increases with height due to radiative cooling of surface air; this is called the "nocturnal temperature inversion." Another type of inversion occurs when cold air underlies warmer air during the passage of a cold front or invasions of a cooler onshore sea/lake breeze. Such temperature inversions may focus sound on the ground surface ("temperature gradient effects"), with effects exerted uniformly in all directions from the noise source. During clear nights, both wind and temperature gradient effects occur frequently, allowing noise to bend toward the ground and potentially affect the neighboring communities and/or habitat with relatively lower background levels.

5.3 Ambient Noise

Ambient noise is typical or persistent environmental background noise lacking a single source or point. In the ocean, there are numerous sources of ambient noise, both natural and anthropogenic, which are variable with respect to season, time of day, location, and noise characteristics (e.g., frequency). Natural sources include wind and waves, seismic noise from volcanic and tectonic activity, precipitation, marine biological activities, and sea ice (Greene 1995) while anthropogenic sources include transportation, dredging and construction, oil and gas drilling and production, geophysical surveys, sonar, explosions, and scientific studies (Greene and Moore 1995). Ambient noise can hamper basic activities of marine animals or specific human activities, depending on noise levels and frequency distributions. As the ambient noise level increases, sounds from a specific source disappear below the ambient level and become undetectable due to loss of prominence of the signal at shorter ranges. In particular, anthropogenic sound could have effects on marine life, including behavior changes, masking, hearing loss, and strandings. Due to its importance to the sensitivity of instrumentation for research and military applications, ambient noise has been of considerable interest to oceanographers and naval forces. Concerns over potential impacts of strong sources of sound from scientific and military activities have driven considerable public and political interest in the issue of noise in the marine environment (NRC 2003; Greene 1995).

For most of the world oceans, shipping and seismic exploration noise dominate the low-frequency portion of the spectrum (Hildebrand 2009). In particular, noise generated by shipping has increased as the number of ships on the high seas has increased. Along the west coast of North America, long-term monitoring data suggest an average increase of about 3 dB per decade in low-frequency ambient noise (Andrew et al. 2002; McDonald et al. 2006, 2008).

Various activities and processes, both natural and anthropogenic, combine to form the sound profile within the ocean. Except for sounds generated by some marine animals using active acoustics, most ambient noise is broadband (composed of a spectrum of numerous frequencies without a differentiating pitch). Virtually the entire frequency spectrum is represented by ambient noise sources.

In the frequency range of 20-500 Hz, distant shipping is the primary source of ambient noise (URI 2017). Spray and bubbles associated with breaking waves are the major contributions to ambient noise in the 500-100,000 Hz range. At frequencies greater than 100,000 Hz, “thermal noise” caused by the random motion of water molecules is the primary source. Ambient noise sources, especially noise from wave and tidal action, can cause coastal environments to have particularly high ambient noise levels.

Sources of ambient noise in the Southern California Planning Area include wind and wave activity, including surf noise along coastlines; precipitation noise from rain and hail; lightning; biological noise from marine mammals, fishes, and crustaceans; and shipping traffic (Greene 1995). Several of these sources may contribute significantly to the total ambient noise at any one place and time, although ambient noise levels above 500 Hz are usually dominated by wind and wave noise. Consequently, ambient noise levels at a given frequency and location may vary widely on a daily basis. A wider range of ambient noise levels occurs in water depths less than 200 m (shallow water) than in deeper water. Ambient noise levels in shallow waters are directly related to wind speed and indirectly to sea state[10] (Wille and Geyer 1984).

5.4 Anthropogenic Noise

Various types of man-made underwater and/or airborne noises occur in the ocean and coastal areas. Anthropogenic noise sources include transportation, dredging and construction, oil and gas drilling and production, geophysical surveys, sonar, explosions, and scientific studies. Noise levels from most human activities are greatest at relatively low frequencies (<500 Hz).

Transportation-related noise sources include aircraft (both helicopters and fixed-wing aircraft), small and large vessels (related to fishing, commercial traffic, recreation, and support and supply ships) and shipping traffic, including large commercial vessels and supertankers. In shallow water, shipping traffic located more than 10 km (6 mi) away from a receiver generally contributes only to background noise. However, in deep water, low-frequency components of traffic noise up to 4,000 km (2,485 mi) away may contribute to background noise levels (Greene1995).

Marine dredging and construction activities are common within the coastal waters of the OCS. Offshore drilling and production involve a variety of activities that produce underwater and/or airborne noises. Sounds from various onshore construction activities vary greatly in levels and characteristics. These sounds are most likely within shallow waters. Onshore construction activities may also propagate into coastal waters, depending upon the source and ground material (Greene and Moore 1995).

Pile driving during construction activities (such as pier or break wall construction and conductor installation) is of special concern because it generates signals with a very high source level and broad bandwidth. In general, the source level and frequency content of the sounds produced by pile driving depend on a variety of factors, including the type and size of the impact hammer and the pile, the properties of the seafloor, and the depth of the water. Thus, the actual sounds produced would vary from location to location.

Pile driving may generate sound levels in excess of 200 dB re 1 μPa at 100 m (330 ft) distance and have a relatively broad bandwidth from 20 Hz to the ultrasonic range above 20 kHz, with peak energy between 100 and 500 Hz (Madsen et al. 2006; Thomsen et al. 2006). Due to the impulsive nature of the sound, the radiation pattern is assumed rather omnidirectional (Madsen et al. 2006). Measurements from offshore wind farms in German Bight indicated that the broadband peak sound pressure level during pile driving were 189 $dB_{0\text{-}p}$ re 1 μPa (SEL = 166 dB re 1 $\mu Pa^2 \bullet s$) at 400 m (1,300 ft) distance, resulting in a peak broadband source level of 228 $dB_{0\text{-}p}$

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[10] Sea state is an index of wave action, related to wind speed. Sea states vary from “0,” which represents calm conditions, to “9,” which represents hurricane conditions.

re 1 μPa-m (SEL = 206 dB re 1 $\mu Pa^2 \bullet s$-m) (Thomsen et al. 2006). The 1/3 octave-band sound pressure level was highest at 315 Hz (peak = 218 $dB_{0\text{-}p}$ re 1 μPa-m) with considerable sound energy above 2 kHz. Pile driving noise can travel a long distance; even at 80 km (50 mi) distance, the sound pressure levels at frequencies below 4 kHz are well above background noise, by about 40–50 dB (Thomsen et al. 2006).

Offshore drilling and production involve a variety of activities that produce underwater noises. Irrespective of type of facilities, most noises associated with offshore oil drilling and gas production are generally below 1,000 Hz (Greene and Moore 1995).

Marine geophysical (seismic) surveys are commonly conducted to delineate oil and gas reservoirs below the surface of the land and seafloor. These operations direct high-intensity, low-frequency sound waves through layers of subsurface, which are reflected at boundaries between geological layers with different physical and chemical properties. The reflected sound waves are recorded and processed to provide information about the structure and composition of subsurface geological formations (McCauley 1994).

Active sonar systems are used for the detection of objects underwater. These range from depth-finding sonars (fathometers), found on most ships and boats, to powerful and sophisticated units used by the military. Sonars emit transient, and often intense, sounds that vary widely in intensity and frequency. Unlike most other man-made noises, sonar sounds are mainly at moderate to high frequencies, ranging from a few hundred hertz for long-range search sonar to several hundred kilohertz for side-scan sonars and military sonars, which attenuate much more rapidly than lower frequencies (Greene and Moore 1995). Acoustic pingers used for locating and positioning of oceanographic and geophysical equipment also generate noise at high frequencies.

Underwater explosions in open waters are the strongest point sources of anthropogenic sound in the sea. Sources of explosions include both military testing and non-military activities, such as offshore structure removals. Explosives produce rapid onset pulses (shock waves) followed by a succession of oscillating low-frequency bubble pulses, if the explosion occurs sufficiently deep from the surface (Staal 1985). Shock waves change to conventional acoustic pulses as they propagate.

5.5 Climate Change Effects on Noise

Potential impacts of climate change on the acoustic environment are relatively minor. Since the sound attenuation rate depends on seawater acidity, increasing ocean acidification resulting from rising anthropogenic CO_2 emissions could result in decreased sound absorption (Hester et al. 2008). Reported increases in ambient low-frequency noise are attributable largely to an overall increase in human activities, such as shipping that are unrelated to climate change (Andrew et al. 2002). Due to the combined effects of decreased absorption and anticipated increases in overall human activities, ambient noise levels will increase considerably within the auditory range of 10–10,000 Hz, which are critical for environmental, biota, military, and economic interests (Hester et al. 2008). There will also be changes in frequency spectrum distributions.

5.6 Noise Regulations

5.6.1 Underwater Sound

There are few standards that specifically address noise in underwater environments. Nevertheless, Federal and State agencies that oversee activities in offshore areas can establish effective noise controls as stipulations to leases or permits needed for such activities. For example, NMFS has finalized its *Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearin*g in July of 2016 and revised in April of 2018 (NOAA 2018). These in-water acoustic thresholds are intended to be protective of marine mammals (Table 5-1).

TABLE 5-1 National Marine Fisheries Service In-Water Acoustic Thresholds

Criterion	**Threshold Sound Levels for Onsert of a Permanent Threshold Shift (PTS)**	
Level A: Hearing Groups	**Impulsive [a]**	**Non-Impulsive**
Low-Frequency Cetaceans (LF)	Peak: 219 dB SEL_{cum}: 183 dB	SEL_{cum}: 199 dB
Mid-Frequency Cetaceans (MF)	Peak: 230 dB SEL_{cum}: 185 dB	SEL_{cum}: 198 dB
High-Frequency Cetaceans (HF)	Peak: 202 dB SEL_{cum}: 155 dB	SEL_{cum}: 173 dB
Phocid Pinnipeds (PW)	Peak: 218 dB SEL_{cum}: 185 dB	SEL_{cum}: 201 dB
Otariid Pinnipeds (OW)	Peak: 232 dB SEL_{cum}: 203 dB	SEL_{cum}: 219 dB
Criterion	**Criterion Definition**	**Thresholds**
Level B[b]	Behavioral disruption for <u>impulsive</u> noise (e.g., impact pile driving)	160 dB_{rms}
Level B[b]	Behavioral disruption for <u>continuous</u> noise (e.g., vibratory pile driving, drilling)	120 dB_{rms}[c]

[a] Dual metric thresholds for impulsive sounds: NMFS specieis using whichever results in the largest isopleth for calculating the onset of PTS. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration..

[b] All decibels referenced to 1 micro Pascal (re: 1 µPa). Note all thresholds are based off root-mean-square (rms) levels.

[c] The 120 dB threshold may be slightly adjusted if background noise levels are at or above this level.

Source: NOAA (2018).

5.6.2 Airborne Sound

Many local noise ordinances are qualitative, such as prohibiting excessive noise or noise that results in a public nuisance. Because of the subjective nature of such ordinances, they are often difficult to enforce. However, some states, counties, and cities have established quantitative noise-level regulations. For example, San Luis Obispo County specifies exterior noise level standards for noise-sensitive areas (e.g., residences or health care services), 50 dBA $L_{eq(1\text{-}hr)}$ and 70 dBA maximum level during the daytime hours (7 a.m. to 10 p.m.) and 45 dBA $L_{eq(1\text{-}hr)}$ and 65 dBA maximum level during the nighttime hours (10 p.m. to 7 a.m.) (San Luis Obispo County 2013). In addition, Santa Barbara County specifies environmental noise limits with a single value of 65 dBA CNEL (County of Santa Barbara 2008), while the City of Ventura bases noise limits on the land use of the property receiving the noise and by time of day (City of Ventura 2019).

The State of California requires each municipality and county to have a *Noise Element of the General Plan*, a substantial noise database and blueprint for making land use decisions in that jurisdiction (GOPR 2003). State land use compatibility criteria for the community noise environment in L_{dn} or CNEL identify noise levels compatible with various types of land uses. The *Noise Element of the General Plan* contains land use planning goals and policies for meeting these criteria for various land uses.

The EPA has a noise guideline that recommends an L_{dn} of 55 dBA, which is sufficient to protect the public from the effect of broadband environmental noise in typical outdoor and residential areas (EPA 1974). These levels are not regulatory goals but are “intentionally conservative to protect the most sensitive portion of the American population” with “an additional margin of safety.” For protection against hearing loss the general population from non-impulsive noise, the EPA guideline recommends an $L_{eq(24\text{-}hr)}$ of 70 dBA or less over a 40-year period.

The NOAA Fisheries *Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearin*g (NOAA 2018) identifies both in-air and in-water acoustic thresholds for the protection of marine mammal hearing (Table 5-2).

TABLE 5-2 National Marine Fisheries Service Current In-air Acoustic Thresholds

Criterion	Criterion Definition	Threshold
Level A	Permanent threshold shift (PTS) (injury) conservatively based on temporary threshold shift (TTS)	None established
Level B	Behavioral disruption for harbor seals	90 dB_{rms}
Level B	Behavioral disruption for non-harbor seal pinnipeds	100 dB_{rms}

Source: NOAA 2018

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6 OCEANOGRAPHY

This chapter describes the oceanography of the Southern California Planning Area adjacent to the five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). The following sections describe ocean circulation on the Southern California OCS, and the oceanography of the Santa Maria, Santa Barbara Channel, and San Pedro Basins.

6.1 Ocean Circulation in the Southern California OCS

The Eastern Boundary Current of the North Pacific Gyre system, namely the California Current (Figure 6-1), dominates the circulation of the Southern California Bight (SCB). Cold, low-salinity, highly oxygenated subarctic water of the California Current flows toward the equator with an average speed of approximately 0.25 m/s. In the SCB, it joins moderate, saline, central north Pacific water flowing into the bight from the west, and warm, highly saline, low-oxygen-content water entering the bight from the south via the California Counter-Current and the California Undercurrent. The top 200 m of these waters, with subarctic origins, is typically low in salinity and high in oxygen content, with temperatures between 9 and 18°C. Waters between 200 and 500 m in depth are high in salinity and low in dissolved oxygen, reflecting their equatorial Pacific origins; this water mass has temperatures between 5 and 9°C (MMS 2001).

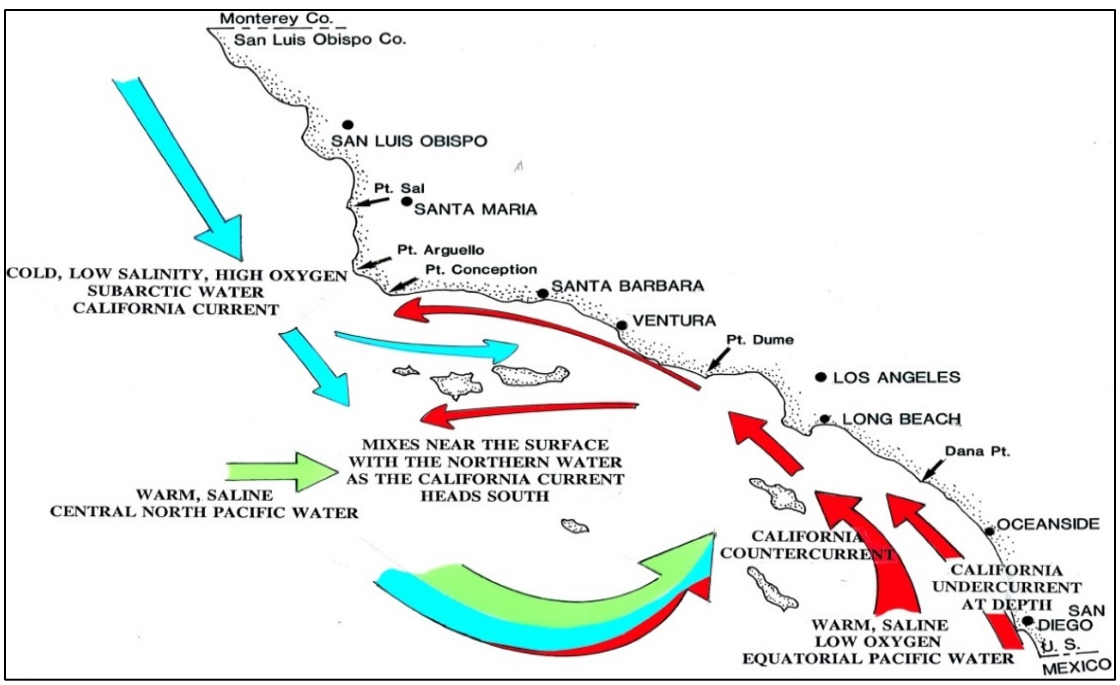

FIGURE 6-1 Characteristic Oceanic Circulation in the Southern California Bight (MMS 2001)

South of San Diego, part of the California Current turns eastward into the SCB and then poleward, forming the California Counter-Current, where it joins the deeper, inshore, California Undercurrent, generally confined to within 100 km of the coast. Below 200 m, the California Undercurrent brings warm, saline, low-dissolved-oxygen equatorial waters poleward into the SCB. Within the Santa Barbara Channel, the California Undercurrent shows considerable seasonal variability. At its weakest in winter and early spring, the California Undercurrent lies below 200 m depth; surface flow is typically equatorward. From late summer to early winter, poleward core flow increases and ascends to shallower depths, occasionally reaching the surface, where it joins from the inshore Countercurrent.

Winds blowing predominantly toward the southeast off the entire coast of California during the late spring to early fall move surface waters offshore. This gives rise to upwelling of cold, nutrient-rich, bottom water at the coast that, in turn, moves this water mass offshore in a continual cycle (MMS 2001). In the project area, surface currents can form clockwise or counterclockwise eddies driven by the atmospheric pressure gradients or by strong winds when they occur. Clockwise eddies tend to push water away from shore while counterclockwise eddies will tend to drive ocean water towards shore (BOEM 2011).

6.2 Santa Maria Basin Oceanography

Point Conception, where the coastline turns sharply eastward and topography begins to block the northwesterly winds, marks a transition between the large-scale upwelling region from Washington through central California, and the milder conditions of the Santa Barbara Channel and southward. The Santa Maria Basin lies in the larger upwelling zone north of Point Conception (Kaplan et al 2010). Consistent northwest winds off Points Sal, Arguello and Conception move surface waters offshore giving rise to upwelling of cold, nutrient rich, bottom water at the coast. These winds are most prominently in late spring and early fall.

Similarly, surface water temperatures in the region are lowest along the central coast near Point Arguello due to strong upwelling and highest inside the SCB, especially in summer. In winter, warmer waters from the SCB replace colder waters off Points Conceptions and Arguello (MMS 2005). Cooler water of the California Current enters the Santa Maria Basin from the north, while warmer equatorial water enters the SCB from the south. Across the region, seasonal water temperatures range from 12^{o}C to 19^{o}C at the surface, with a greater range at the surface (7^{o}C), and less variation at depth (about 4^{o}C at 50 m).Warmest temperatures are along the coast, with cooler temperatures offshore and deeper (Kaplan et al. 2010).

6.3 Santa Barbara Channel Oceanography

The break in the coastline and change in topography at Point Conception shield the Santa Barbara Channel from the persistent northwest winds that drive strong upwelling in the Santa Maria Basin. Three distinct circulation patterns occur within the Santa Barbara Channel: upwelling, surface convergent, and relaxation. Upwelling generally occurs during the early part of the warm season, after the spring transition. The surface convergent pattern is most prevalent in summer, while the relaxation pattern is typical of late fall and early winter. Local upwelling leads to cooler temperatures directly near the coast about 3-5 times per year (Kaplan et al. 2010).

In recent decades, upwelling favorable winds have increased. At the same time, surface temperatures have risen, leading to increased stratification, which inhibits upwelling. Observed reductions in nutrients and zooplankton concentration in the SCB might indicate less upwelling overall than in previous decades (Kaplan et al. 2010).

Wave energy is low in the Santa Barbara Channel due to the coastline break at Point Conception, while shallow bathymetry refracts incoming waves, creating complex wave patterns. Higher salinity water enters the SCB from the south, while lower salinity water enters from the north through the California Current. The salinity of the SCB reflects the balance of horizontal advection and wind-driven upwelling (Kaplan et al. 2010).

6.4 San Pedro Basin Oceanography

Periods of flushing, such as from 1982-1984, and periods of stagnation (1984-1987) indicate the importance of climate in controlling the renewal of bottom water in basins, such as the San Pedro Basin. When such 'renewal events' of bottom waters occurred in April and May of 1987 and in May 1988, bottom wwaters showed recovery to near-normal conditions in 1-2 years. Renewal events appear to relate to strong upwelling events in the Santa Barbara Channel. Further research would examine if these periods of renewal were related to the El Niño cycle. (Kaplan et al. 2010).

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7 WATER QUALITY

The Southern California OCS Planning Area encompasses, from north to south, portions of the Santa Maria Basin, north of Point Conception; the Santa Barbara Channel from Point Conception to Point Mugu; and San Pedro Bay off Los Angeles and Orange Counties (see Figure-1-1). The following sections describe water quality in Santa Maria, Santa Barbara Channel and San Pedro Bay Basins. Topics covered include point source and non-point-source pollution, nutrient pollution, storm water runoff, sediment quality, and hazardous algal blooms. Table 7-1 shows the values and characteristics of key water quality parameters in the region, which includes all three basins of interest.

Table 7-1 Key Water Quality Parameters (Source: BOEM 2011)

Parameter	Characteristics
Temperature	Temperature At surface ranges from 12-13°C in April to 15-19°C in July-October.
Salinity	33.2-34.3 parts per thousand.
Dissolved oxygen	Maximum about 5-6 ml/L at the surface, decreasing with depth to 2 ml/L at 200 m; below 350 m, as low as 1 ml/L; upwelling can bring this oxygen-poor water to the surface waters, especially from May to July.
pH	Range from about 7.8 to 8.1 at surface and with depth.
Nutrients	Important for primary production; include nitrogen, phosphorus, and silicon; other micronutrients include iron, manganese, zinc, copper, cobalt, molybdenum, vanadium, vitamin B12, thiamin, and biotin. Depleted near the surface but increasing with depth.
Suspended Sediment (turbidity)	Concentrations about 1 mg/L in the nearshore, surface waters with higher values in near-bottom waters (and after storms); lower levels (0.5 mg/L) in offshore regions. Highest turbidities correspond to periods of highest upwelling, primary production, and river runoff. Controls the depth of the euphotic zone, has applications for (absorbed) pollutant transport and is of aesthetic concern.
Metals	Include barium, chromium, cadmium, copper, zinc, mercury, lead, silver, and nickel all of which can serve as micronutrients in low levels (parts per trillion or parts per billion) and be potentially toxic at high levels (parts per million or higher).
Organics	May enter the marine environment from municipal and industrial wastewater discharges, runoff, natural oil seeps, and offshore oil and gas operations.

Since the introduction of the NPDES program, the SCB has seen great reductions in pollutants, including 50% for suspended solids, 90% of combined trace metals, and more than 99% for chlorinated hydrocarbons. Measurements of sediments, fish, and marine mammals all show decreasing contamination. This has occurred despite great increases in population and volumes of discharged wastewater (MMS 2001). Source control, pretreatment of industrial wastes, reclamation and treatment plant upgrades combined to accomplish this reduction (MMS 2001). Management efforts at publicly owned treatment works (POTWs) and other point sources has produced mass emissions to the SCB of major pollutants has decreased by more than 65% since the 1971 passage of the CWA (Lyon and Stein 2009).

7.1 Santa Maria Basin

The Santa Maria basin extends from the western end of the Santa Barbara Channel at Point Conception northward along Santa Barbara County and southern San Luis Obispo County to San Luis Obispo Bay. The Santa Maria basin has good water quality due to low population density and lack of major industrial pollutant inputs (MMS 2001, 2005).

Non-point-Source Pollution. Unregulated nonpoint sources contribute to water pollution. The Santa Maria basin area is sparsely inhabited with little industrial development but with more agriculture and ranching than urban centers to the south. Two major rivers, the Santa Maria River, which discharges on the border of San Luis Obispo and Santa Barbara Counties, and the Santa Ynez River, which discharges between Point Purisima and Point Arguello, represent the major sources of non-point pollution to the basin (MMS 2001). Major sources of pollutants in the Santa Maria basin are from agricultural runoff, which includes pesticides, pollutants related to animal wastes. Pollutant plumes are largest, but most dilute, during high runoff periods, usually in winter. Wind-driven plumes may reach southward beyond Point Conception, but are typically dilute from ocean mixing by the time they reach the outer continental shelf (MMS 2001, 2005). Most runoff is not treated. In 2003, San Luis Obispo County had by far the fewest number of beach advisory/closing days (64) of four counties in the project area. Los Angeles County had the largest number (1459), followed by Ventura County (720), and Santa Barbara County (360) (MMS 2005). The majority of these closings were due to high fecal coliform counts brought on by storm water runoff.

Point Source Pollution. Regulated point source pollution entering the Santa Maria basin include permitted outfalls from municipal and commercial sources. Among these, POTWs represent the largest point source contributors to the basin. Only two POTWs discharge directly, and only three, indirectly. All qualify as small, far less than EPA's 25 million gallons per day (mgd) criterion, and employ at least secondary treatment (MMS 2001, 2005). Offshore oil and gas operations, located in the southern portion of the Santa Maria basin, contribute relatively less pollution, but relatively higher amounts of hydrocarbon pollutants than do the other anthropogenic sources (Lyon and Stein 2010). The largest contributors of hydrocarbons to offshore waters, however, are the naturally occurring oil and gas seeps within the northwestern Santa Barbara basin near Point Conception. Southerly winds and currents can carry hydrocarbons from seeps northward into the Santa Maria basin (Lorenson et al. 2011). These seeps often produce localized, visible sheens on the water and lead to the production of tar balls commonly found on beaches after weathering and oxidation of oil (Hostettler et al. 2004; Farwell et al. 2009). For most of the central California coast, there are no oil and gas facilities. Platform Irene, located just northwest of Point Arguello is the northernmost oil and gas platform on the

POCS. There are no marine terminals or other major source of marine pollution in the Santa Maria Basin region, further accounting for the good water quality in this region (MMS 2005).

Nutrients. Nutrients are important to primary producers in the ocean, such as phytoplankton. An overabundance of nutrients, however can lead to algal blooms and low oxygen conditions produced by excess growth. Key nutrients to marine life are various forms of nitrogen - nitrate, nitrite and ammonia, phosphorus, iron, and silica (SiO_2). Nutrients occur naturally in the ocean, with anthropogenic sources also contributing. Most nitrogenous nutrients in Southern California waters come from ocean upwelling (Kaplan et al. 2010). North of Point Conception, in the Santa Maria Basin, stable equatorward winds generate coastal upwelling. Upwelling occurs suddenly during a spring transition in coastal winds and offshore currents, typically within a one-week period in March-April timeframe (Howard et al. 2012). Ocean upwelling brings nutrients at depth to the ocean surface, leading to cycles of phytoplankton growth and decline.

Point sources, mostly POTWs, contribute 92% of total anthropogenic nitrogen and 76% of total phosphorus loads to the SCB, with less than 1% of the loads in runoff from natural background sources. Discharges via direct ocean outfalls account for the majority of loads to the SCB, with about 10% of TN and 30% of TP via riverine discharges (Sengupta et al. 2013). Coastal runoff contributes relatively low nutrient loads to the Santa Maria basin compared to highly populated areas to the south. Agricultural sources, including fertilizers and animal wastes in runoff, dominate such inputs, with POTWs also contributing to overall nutrient loads. Most nutrient pollution inputs come in from the Santa Maria and Santa Ynez Rivers (MMS 2001). Storm water runoff occurs mainly in the winter rainy season, while POTWs discharge continuously year-round. Primary production in waters off Southern California appear to be iron limited, meaning that some quantities of other nutrients, such as nitrogen and silica go unused due to iron limitations (Kaplan et al. 2010).

Hazardous Algal Blooms. Certain dinoflagellates release biotoxins into the water, creating a potentially hazardous situation for warm-blooded birds and mammals, including humans. Releases of biotoxins from actively blooming phytoplankton are commonly known as Harmful Algal Blooms (HABs) (Kaplan et al. 2010). Although overall water quality has improved in recent decades as a benefit of the NPDES program, the frequency of algal blooms, particularly harmful algal blooms, has increased in the area.

Algal blooms result from natural nutrient upwelling in an annual cycle characterized by a transition from a diverse phytoplankton assemblage to a homogeneous assemblage dominated by diatoms, dinoflagellates, or a combination of nano- and pico- phytoplankton (Kaplan et al. 2010). However, nutrient pollution from agriculture and population growth may play a contributing role on the sub-regional scale from riverine sources and effluents (Howard et al. 2012). Blooms of *Pseudonitzschia*, several species of diatoms that produce the neurotoxin domoic acid, are becoming more common in the SCB and are associated with numerous strandings of marine mammals. HABs occur all along the U.S. west coast (NOAA 2017), including in the Santa Maria Basin.

The California Harmful Algal Bloom Monitoring and Alert Program maintains five monitoring stations along the Southern California OCS coast, including a monitoring station off Cal Ploy Pier in the Santa Maria Basin (California HABMAP 2019). In the Santa Maria Basin, algal blooms begin roughly in April, corresponding Spring upwelling, and last into November. Blooms tend to be large, extending more than 6 km offshore (Howard et al. 2012).

Ocean Acidification. Rising atmospheric carbon dioxide (CO_2) levels compared to the pre-industrial age has driven a reduction in ocean pH, referred to as ocean acidification, which, in turn, has caused a reduction in free carbonate ion (CO_3^{-2}) concentration in ocean waters around the world. An observed drop of 0.1 pH units and approximately 16% in carbonate concentration has implications for marine life that depends on carbonate for the formation of calcium carbonate mineral (calcareous) structures, including shell-forming bi-valves, such as oysters. Coral, pteropods and the larval stages of oysters and other bi-values appear to be particularly sensitive to reductions in carbonate ion, while adult bivalves showed net calcification in more acidified conditions in some studies (Barton et al, 2012). The effects of ocean acidification would contribute to cumulative stresses on these carbonate-dependent species and other species that depend on them on the POCS.

Sediment Quality. Ocean sediment quality is a reflection of long-term water quality, as contaminants in water, particularly persistent hydrophobic chemical contaminants, tend to migrate to sediments via sorption to suspended particulate matter, which slowly accumulates on the seafloor. In addition, contaminated sediments represent an ongoing source of contamination to overlying water and associated ecosystems.

The Southern California Bight Regional Monitoring Program administered by the SCCWRP has assessed the health of the SCB via surveys conducted at 5-yr intervals beginning in 1994. In the most recent 2013 survey, investigators evaluated sediment quality at 385 sites, including 170 embayment sites, across 1,539 sq. mi. of the SCB using a triad of chemical, toxicological and biological assessments of sediment samples (SCCWRP 2017). The study found that about 94% of the assessed seafloor area was un-impacted or likely un-impacted, 6% possibly impacted, and only 0.2% likely impacted. None of the sampling sites were highly impacted, the highest level of impact evaluated.

Embayments exhibited higher impacts than the broader continental shelf, with about 18% of sampling locations possibly or likely contaminated. Within embayments, marinas and estuaries exhibited the greatest impacts, with 48% of such areas possibly impacted and 35% likely impacted. The 2013 results represent improvement from results in 1998, when nearly 50% of embayment locations were similarly impacted, a two-thirds reduction, while the level impacts also dropped sharply over this period. Similar trends in sediment condition were observed in embayments based on levels of certain chemical contaminants (Dodder et al. 2016), which contributed to the overall assessment of sediment condition. The Santa Maria Basin was outside, but adjacent to the SCCWRP 2013 Survey study area, which extended from Point Conception to the U.S. – Mexico border. Based on trends observed within the study area, and the basin’s good water quality, sediments the Santa Maria Basin should be generally unimpacted, except possibly within embayments, marinas and estuaries.

7.2 Santa Barbara Channel

The Santa Barbara Channel region extends from Point Conception to Point Mugu. Water quality in the Santa Barbara Channel is generally good due to relatively low population and lack of major industrial pollutant inputs, but the pollution inputs are likely greater than north of Point Conception, with even lower population density (MMS 2005). The 1994 Southern California Bight Pilot Project, a comprehensive regional monitoring survey, found water quality to be good overall throughout the SCB (SCCWRP 1998). More than 99% of the SCB met California Ocean Plan waste quality objectives for dissolved oxygen and clarity. (MMS 2005).

Non-point-Source Pollution. Unregulated nonpoint sources contribute to water pollution. Major sources of pollutants in the Santa Barbara Channel Basin are agricultural runoff, which includes pesticides and fertilizer nutrients delivered to marine waters by local rivers and storm drains, urban runoff and atmospheric fallout from metropolitan areas (MMS 2001, 2005; Kaplan et al. 2010; Lyon and Stein 2010). The SCB collects drainage from about 5,600 sq. mi. of watersheds in coastal Southern California. Most runoff is not treated. The largest fresh water inputs to the basin are the Santa Clara and Ventura Rivers, both in Ventura County (MMS 2005). The rivers drain mostly agricultural land; however, storm drains from coastal cities and other non-point runoff contribute further pollution to the Channel, but only during the rainy season. Stormwater runoff plumes can reach across the Channel and reach the Northern Channel Islands National Marine Sanctuary (MMS 2005).

Point Source Pollution. Regulated point source pollution include numerous permitted outfalls from industrial and commercial sources. Among these, POTWs represent the largest point source contributors to the SCB in general and in the Santa Barbara Channel Basin. Other important regional inputs include chemicals from harbors, dumping activities, dredging, vessel traffic, military activities, and industrial activities including oil production (Kaplan et al. 2010). Six POTWs discharge into the Santa Barbara Channel. These all fall into the category of small dischargers, less than 25 mgd and perform at least secondary treatment (MMS 2005). Offshore oil and gas operations are relatively smaller contributors of pollution, but contribute relatively higher amounts of hydrocarbon pollutants than do the other anthropogenic sources (Lyon and Stein 2010). The largest contributors of hydrocarbons are the naturally occurring seeps within the Santa Barbara Channel. For example, the SBCAPCD has estimated that seeps off of Santa Barbara county are relasing as much as 26 tons of oil and gas per day. These seeps often produce localized, visible sheens on the water and lead to the production of tar balls commonly found on beaches after weathering and oxidation of oil (Hostettler et al. 2004; Farwell et al. 2009). The Santa Barbara Basin has the greatest inputs from hydrocarbon seeps of the regional basins (MMS 2001).

Nutrients. The coastal waters in the SCB are generally nitrogen limited, so any nitrogen inputs would likely have an impact on biological productivity, including algal blooms (Howard et al. 2012, 2014). Four main sources contribute nitrogen-containing nutrients to the SCB, ocean upwelling, wastewater treatment plant effluents, riverine discharges, and atmospheric deposition. These sources are compositionally different with respect to the form of nitrogen. Upwelling is dominated by nitrate (NO_3), while wastewater effluents are dominated by ammonium (NH_4).

Riverine inputs are roughly 60% organic nitrogen and 35% nitrate and atmospheric deposition is primarily nitrate.

On an SCB-wide basis, upwelling contributes the largest load of total nitrogen by an order of magnitude over effluents, with riverine inputs being the smallest of the three. In the Santa Barbara Channel Basin, however, Howard et al. (2014) reported that the Santa Barbara and Ventura sub-regions had net annual downwelling with respect to total nitrogen. Effluent and atmospheric deposition were the dominant nitrogen sources in the Santa Barbara region, while the Ventura subregion had roughly equivalent contributions of effluent, atmospheric and riverine inputs. Due to downwelling, however, the Santa Barbara Basin had negative estimated total nitrogen fluxes roughly equivalent in magnitude to the positive total fluxes in Santa Monica Bay and San Pedro Bay, which are dominated by upwelling. North of Point Conception, including the Santa Maria Basin, stable equatorward winds generate coastal upwelling (Howard et al. 2012). Sengupta et al. (2013) estimated fluxes range from to 44 kg total nitrogen (TN) km^{-2} and 19 kg total phosphorous (TP) km^{-2} in the lightly developed Santa Barbara Channel region compared to about 16,000 kg TN km^{-2} and 1,000 kg TP km^{-2} in the highly urbanized Santa Monica Bay. Point sources, mostly POTWs, contribute 92% of TN and 76% of TP loads to the SCB, with less than 1% of the loads from natural background sources. Discharges via direct ocean outfalls account for the majority of loads to the SCB, with about 10% of TN and 30% of TP via riverine discharges.

At a bight-wide scale, natural nutrient sources make a much larger contribution of nutrients than anthropogenic sources. However, at smaller spatial scales, anthropogenic and natural nitrogen sources may be comparable to natural sources. In the Santa Barbara Basin, anthropogenic sources somewhat offset net nutrient losses due to down-welling (Howard et al. 2014).

Hazardous Algal Blooms. Although overall water quality has improved in recent decades as a benefit of the NPDES program, the frequency of algal blooms, particularly harmful algal blooms, has increased in the Santa Barbara Channel. Algal blooms result from natural nutrient upwelling (Kaplan et al. 2010); however, nutrient pollution from agriculture and population growth may play a contributing role on the sub-regional scale from riverine sources and effluents (Howard et al. 2012). The Santa Barbara Channel is a well-known hotspot for domoic acid toxicity from HABs. A fall 2014 event resulted in a CDPH advisory against eating crabs, lobsters, and bi-valves harvested in the Santa Barbara Channel. The advisory remained well into February 2015, indicating the persistence of domoic acid (Anderson et al. 2016). A May 2003 outbreak of the diatom *Pseudo-nitzschia australis* in the Santa Barbara Channel linked to marine mammal mortality appears to have been limited by available silicon and may have been enhanced by a cyclonic eddy in the western end of the Channel (Anderson et al. 2006). Increased awareness of toxic HAB events was the primary motivation for establishing the Southern California Coastal Ocean Observing System (SCCOOS) and for implementing an ongoing HAB monitoring program in 2008 to collect weekly HAB species and toxin information from five pier locations in the SCB (data available online, http://www.sccoos.org/data/habs/index.php) (Howard et al. 2012).

Sediment Quality. The Southern California Bight Regional Monitoring Program 2013 survey of the SCB found that about 94% of the assessed seafloor area was un-impacted or likely un-impacted, 6% possibly impacted, and only 0.2% likely impacted (SCCWRP 2017). None of the sampling sites were highly impacted, the highest level of impact evaluated. Embayments exhibited higher impacts than the broader continental shelf, with 18% of the area of embayment sediments possibly or likely impacted, a two-thirds reduction from results in 1998, when nearly 50% of embayment locations were similarly impacted. Embayments incurred similar reductions of targeted chemical contaminants in sediments, mainly metals and organic contaminants (Dodder et al. 2016).Within embayments, the 2013 survey found 35% of estuary area and 48% of marina area sediments possibly or likely impacted (SCCWRP 2017).. Copper concentrations were highest in marinas throughout the SCB, from use in antifouling paints on ships and boats. Polynuclear aromatic hydrocarbons (PAH), products of fossil fuel combustion, were higher in embayments, likely due to runoff from lands loaded with atmospheric deposition. Pyrethroids, insecticides currently in use, were highest in estuaries and next highest in marinas, and elevated in ports and bays. Polybrominated diphenyl ether (PDBE), a flame retardant, was similarly low in embayments and offshore areas. In a 2008 survey, PDBE was about 10 times higher in embayments. Contaminant concentrations in the Santa Barbara Channel followed the same patterns of distribution, but levels were generally lower overall than off the metropolitan Los Angeles area and trended lower from east to west within the Channel (Dodder et al. 2016).

7.3 San Pedro Basin

The San Pedro basin embodies San Pedro Bay, which is located in the southern portion of the Los Angeles metropolitan area, on the border of Los Angeles and Orange Counties. Water quality in the San Pedro basin is generally good, but has much higher pollutant inputs from the adjacent metropolitan and industrial areas than theSanta Barbara Channel and Santa Maria basin.

Non-point-Source Pollution. Unregulated nonpoint sources contribute to water pollution. Major sources of pollutants in the San Pedro basin are urban, industrial and agricultural runoff delivered to marine waters by local rivers and storm drains, and atmospheric fallout from metropolitan areas (MMS 2001, 2005; Kaplan et al. 2010; Lyon and Stein 2010). Major rivers discharging into San Pedro are the San Gabriel River/Los Angeles River and the Santa Ana River. Four smaller rivers discharge into the San Pedro Basin down-coast of the Santa Ana River, Aliso Creek, Salt Creek, San Juan Creek, and San Mateo Creek. Due to improvements in treatment efficiency on the one hand, and the general increase in runoff due to hardening of surface areas due to construction of roads, buildings and other impervious surfaces, pollutant inputs from runoff now rival those from POTWs (Pondella et al. 2016).

Point Source Pollution. Regulated point source pollution include numerous permitted outfalls from industrial and commercial sources. Among these, POTWs represent the largest point source contributors to the SCB, contribute, and estimated three times as much nitrogen as rivers (Pondella et al. 2016). Two major POTWs discharge on either end of San Pedro Bay, the Los Angeles County Sanitation District Joint Water Pollution Control Plant (JWPCP) on the west end of the bay and the Orange County Sanitation District OCSD on the east end of the bay (Pondella et al. 2016). Discharging up to 200 mgd each, the JWPCP and OCSD plants are among the largest in the country. Advanced primary/secondary treatment has stabilized pollutant inputs, while discharge volumes have been trending downward due to an increase in water reclamation efforts (MMS 2005). Other important regional inputs include chemicals from harbors, dumping activities, dredging, vessel traffic, military activities, and industrial activities including oil production (Kaplan et al. 2010). Offshore oil and gas operations are relatively smaller contributors of pollution, but contribute relatively higher amounts of hydrocarbon pollutants than do the other anthropogenic sources (Lyon and Stein 2010).

Nutrients. The coastal waters in the SCB are generally nitrogen limited, so any nitrogen inputs would be likely have an impact on biological productivity, including algal blooms (Howard et al. 2012, 2014). Four main sources contribute nitrogen-containing nutrients to the SCB, ocean upwelling, wastewater treatment plant effluents, riverine discharges, and atmospheric deposition. These sources are compositionally different with respect to the form of nitrogen. Upwelling is dominated by nitrate (NO3), while wastewater effluents are dominated by ammonium (NH4). Riverine inputs are roughly 60% organic nitrogen and 35% nitrate and atmospheric deposition is primarily nitrate. On an SCB-wide basis, upwelling contributes the largest load of total nitrogen by an order of magnitude over effluents, with riverine inputs being the smallest of the three.

In San Pedro Bay, upwelling only moderately exceeds effluent inputs, both of which exceed riverine inputs and atmospheric deposition by over an order of magnitude (Howard et al. 2014). Wastewater treatment outfalls are located more than 8 km offshore to prevent recirculation of pollutants to nearshore areas. Plumes including nutrients move either up coast or down coast according to prevailing subsurface currents, but rarely approach within 2 km of shore. Due to rapid settling and mixing, freshwater riverine pollutant plumes, conversely, have highest concentrations within 2 km of shore (Pondella et al. 2016). The Los Angeles River discharges an estimated 220,000 kg/yr of dissolved inorganic nitrogen into the San Pedro Bay, the largest riverine nitrogen source to the SCB. However, estimates of nitrogen exposures in the Orange County offshore region were the lowest among four regions modeled; lower than Santa Monica Bay, Ventura County, and San Diego County, which had the highest estimated exposure level (Pondella et al. 2016).

Hazardous Algal Blooms. Howard et al. (2012) observed pronounced algal blooms in the SCB and in San Pedro Bay during 1997-2007, beginning in spring, corresponding to the Spring Transition when upwelling intensifies, and lasting 2-3 months. San Pedro Bay has incurred some particularly toxic algal blooms in recent decades, with among the highest domoic acid levels recorded on the west coast. Algal blooms in San Pedro Bay, as in other enclosed coastal areas or poorly flushed areas, may be affected by long water residence times, shallow waters, and with the presence of large riverine inputs or large POTW discharges. Upwelling, however, is the clear driver affecting overall temporal and spatial patterns of phytoplankton productivity in the SCB, at least as determined by remote sensing. Within San Pedro Bay, anthropogenic sources of nitrogen - effluents, runoff, and atmospheric deposition, rival inputs from upwelling, although not primarily as nitrate, the most biologically available form, and may affect the frequency, intensity or duration of algal blooms (Howard et al. 2012).

Sediment Quality. The most recent 2013 survey of the SCB conducted by the Southern California Bight Regional Monitoring Program found that about 94% of the assessed seafloor area was un-impacted or likely un-impacted, 6% possibly impacted, and only 0.2% likely impacted. None of the sampling sites were highly impacted, the highest level of impact evaluated. Embayments exhibited higher impacts than the broader continental shelf, with about 18% of sampling locations possibly or likely contaminated. Within embayments, marinas and estuaries exhibited the greatest impacts, with 48% of such areas possibly impacted and 35% likely impacted (SCCWRP 2017). The 2013 results represent improvement from results in 1998, when nearly 50% of embayment locations were similarly impacted, a two-thirds reduction, while the level impacts also dropped sharply over this period.

Similar trends in sediment condition were observed in embayments based on levels of certain chemical contaminants (Dodder et al. 2016), which contributed to the overall assessment of sediment condition. DDT was highest in sediments near Palos Verdes and Los Angeles Harbor due to historic discharges into those waters, and was also elevated in San Pedro Bay. Copper concentrations from antifouling paints were highest in marinas throughout the SCB and were elevated in San Pedro Bay. PAH were higher in embayments, likely due to runoff from lands loaded with atmospheric deposition. Pyrethroids were highest in estuaries and next highest in marinas, and elevated in ports and bays, including in San Pedro Bay. PDBE was also somewhat elevated in San Pedro Bay. Contaminant concentrations in the San Pedro Bay Basin were somewhat higher overall than in the Santa Barbara Basin and other areas of the SCB with more linear coastlines and smaller inputs from rivers and POTWs (Dodder et al. 2016).

7.4 Discharge Sources from Offshore Oil and Gas Activities

Offshore discharges from past and present oil and gas operations (in both State and Federal waters) include cooling water, produced water, sanitary waste, fire control system test water, well completion fluids, and miscellaneous other liquids. Of these, produced water represents by far the greatest discharge of petroleum-related chemical constituents. Well completion and treatment fluids represent the second largest (but relatively minor) source of chemical discharges to POCS waters.

Drilling Wastes. Steinberger et al. (2004) reviewed NPDES discharge monitoring reports for the platforms currently operating in POCS waters to quantify discharges to the SCB in 1996 and 2000. Lyon and Stein (2010) performed a similar review of platform discharges for 2005. Table 7-2 presents a comparison of major discharges by platform group for 1996, 2000, 2005 drawn from these two studies, the most recent available compilations of such data.

From drilling operations, POCS oil platforms discharged 12,127 metric tons (MT) in 1996, 2,956 MT in 2000, and 2,314 MT in 2005 of drill cuttings. Drilling mud discharge volumes followed a similar pattern (Table 7-2). Volumes of drill cuttings and muds reflect the level of well drilling in a given year and a declining trend overall. In 1996, platform operators drilled 31 new wells on the POCS, but only 13 new wells in 2000. Platforms discharging drilling fluids and cuttings dropped from six in 2000 to 4 in 2005 (Lyon and Stein 2010). As of August 2017, lessees have drilled a total of 351 exploration wells and 1231 development wells, or 1,582 wells in all, on the POCS (BSEE data). The data in Table 7-2 show that the vast majority of drilling waste discharges in the selected years occurred in the Santa Barbara Basin where the majority of platforms lie.

Produced Water. Produced water is formation water that accompanies oil and gas upon extraction. Generally, the amount of produced water is low when production begins, but increases over time near the end of the field life. Produced water is a mixture (an emulsion) of oil, natural gas, and formation water (water naturally occurring in a formation), as well as any specialty chemicals that may have been added to the well for process purposes (e.g., biocides and corrosion inhibitors). Produced water can exceed 10 times the volume of oil produced over the lifespan of a well, and may account for as much as 98% of extracted fluids during the later stages of production. In offshore operations, a tank on the oil platform separates dissolved natural gas from produced water emulsions; some platforms use the gas from their wells as a power source.

Table 7-2 presents produced water volumes by receiving basin for 1996, 2000 and 2005. In these years, the Santa Barbara Channel Basin received the greatest volume of produced water, with the Santa Maria Basin receiving about half as much and the San Pedro Basin only about 1% or less of the total.

Table 7-2 Comparison of Major Platform Discharges for Years 1996, 2000, and 2005, by Basin[a]

	Discharge Volume (L x 10^6)			
Discharge Type and Year	**Santa Maria Basin (4 Platforms)**	**Santa Barbara Channel Basin (15 Platforms)**	**San Pedro Bay Basin (4 Platforms)**	**Totals for all Basin (23 Platforms)**
Produced Water				
1996	1,689	3,638	47.0	5,374
2000	1,092	4,512	9.4	5,613
2005	4,264	5,153	30.7	9,448
Drilling Muds				
1996	2.10	45.10	6.9	54.1
2000	1.81	8.85	-	10.7
2005	2.43	4.59	-	7.0
Drill Cuttings (MT)				
1996	114	10,466	1,547	12,127
2000	250	2,706	-	2,956
2005	475	1,839	-	2,314
Cooling Water				
1996	399	39,560	6,092	46,051
2000	-	34,272	4,778	39,050
2005	21,442	37,697	367	59,506

[a] Data for 1996 and 2000 from Steinberger et al. 2004; data for 2005 from Lyon and Stein 2010.

Produced water total discharge from all POCS platforms rose from 5.6 billion L in 2000 to 9.4 billion L in 2005, a 68% increase overall, mainly due to increases of 400% each at two platforms, Harvest and Hermosa in the Santa Maria Basin (Lyon and Stein 2010). The annual average total produced water discharge for 2012 through 2014 was 5.2 billion L (Houseworth and Stringfellow 2015), a substantial reduction from 2005, but similar to levels in 1996 and 2000.

In 2016, POCS wells yielded 11.6 billion L of produced water and 0.98 billion L of oil, or 11.8 L of water per L of oil, reflecting depleting reservoirs. Operators reinjected offshore 9.8 billion L, or 84%, of produced water, and either discharged to the ocean or injected into onshore wells the remaining 1.6 billion L of produced water (BSEE data). These values compare to 10.43 billion L of produced water total discharge allowed under the NPDES permit. Constituent concentration for oil and grease, ammonia, copper, undissociated sulfides, and zinc were, with a few exceptions, well below permitted levels for 2012–2014 (Houseworth and Stringfellow 2015).

Producing platforms that do not discharge produced water transfer water either to other platforms or to an onshore facility for treatment. Offshore facilities may discharge treated water to the ocean or inject it into an offshore subsurface reservoir. Onshore treatment facilities may dispose of produced water through injection to a subsurface reservoir, or transfer water back to an offshore platform for disposal via injection or discharge to the ocean.

Platforms Irene, Ellen, Eureka, and Gail primarily reinject produced water into producing formations. Platform Elly, a processing-only platform, sends all produced water to platforms Ellen and Eureka. All remaining platforms discharge produced water into the ocean either directly or via another platform (Houseworth and Stringfellow 2015). All the POCS platforms (whether processing or producing) are addressed under the NPDES General Permit for ocean discharges (EPA 2013a).

Further treatments separate oil and other impurities from the produced water, either on the platform or onshore. Constituents in the remaining produced water may include trace metals and dissolved hydrocarbons, including benzene, toluene, ethylbenzene, and xylene (collectively termed BTEX). Dissolved metals may include arsenic, barium, chromium, cadmium, copper, zinc, mercury, lead, and nickel. Inorganic constituents may include cyanides and sulfides (Kaplan et al. 2010). Table 7-3 lists "end of the pipe" concentrations of chemical constituents measured in produced water samples from 15 platforms discharging to the POCS, representing several years of sampling as reported in Discharge Monitoring Reports (MRS 2005). Most produced water is brine, with total dissolved solids too high for human consumption or for agricultural use.

Operators treat produced water for discharge under the NPDES permit or for reinjection. Treatment methods include the use of heat, corrugated plate coalescers, electrostatic precipitation, bubbling, and chemical treatment. The NPDES General Permit defines a mixing zone of 100 m radius from the point of discharge. Calculated concentrations of the constituents at the edge of the mixing zone, after accounting for dilution, must meet the permit limits. All ocean discharges must meet the NPDES discharge limits, and are tracked through quarterly Discharge Monitoring Reports required by the NPDES permits (Kaplan et al. 2010).

TABLE 7-3 Concentrations (ug/L) of Chemical Constituents in Produced Water Samples from Platforms on the POCS

Class	Chemical	No. of Samples	No. of Detects (%)	Median Concentration[a]	95th Percentile Concentration[b]
Phenol	Phenol	405	269 (66%)	9.7	313
Phenol	2,4-Dimethylphenol	136	70 (51%)	25.1	2341
PAH	High-MW PAHs[c]	449	13 (3%)	0.10	3.2
PAH	Naphthalene	146	78 (53%)	10.5	97
Metal	Arsenic	425	28 (7%)	0.975	14.5
Metal	Cadmium	425	29 (7%)	0.091	1.13
Metal	Chromium	421	114 (27%)	0.68	13.6
Metal	Copper	429	106 (25%)	1.25	21.4
Metal	Lead	425	44 (10%)	0.463	7.6
Metal	Mercury	4210	24 (6%)	0.0058	0.0687
Metal	Nickel	419	72 (17%)	2.47	49.2
Metal	Selenium	180	6 (3%)	0.51	4.5
Metal	Silver	412	43 (10%)	0.25	6.7
Metal	Zinc	419	165 (39%)	5.9	168
BTEX	Benzene	233	193 (83%)	93.5	1,346
BTEX	Ethylbenzene	198	152 (77%)	23	271
BTEX	Toluene	199	150 (75%)	127	1,586
	Cyanide	388	27 (7%)	1.3	6.4
	Ammonia (w/o Harmony)	187	136 (73%)	9,405	85,486
	Ammonia (Harmony)	47	47 (100%)	85,831	335,277
	Undissociated Sulfide	99	82 (83%)	653	5,684

[a] The median concentration is that concentration that half of the samples exceed and the other half are below.

[b] The 95th percentile concentration is the concentration below which 95% of all the measured concentrations fall.

[c] PAHs with high molecular weights.

Source: MRS (2005).

A 2003 study used rhodamine dye to trace discharge plumes from Platforms Hogan, Harvest, Habitat, and Gina and measure the effects of platform discharges on water quality in the immediate vicinity of the platforms (Applied Ocean Science 2004). After mixing and diluting in seawater, there were no differences in salinity, temperature, or turbidity between background locations and locations within 25–50 m of the platforms. The study also reported no measurable impact on temperature, salinity, density, and turbidity of the receiving waters within the zone of initial dilution (i.e., within 100 m). Tracer dye was detectable out to distances of 0.4 to 1.5 km from the platforms.

While the effects of produced water have been shown to have some sublethal impacts on reproductive behavior and possibly on the overall health of some species, findings of robust fish populations around California offshore facilities indicate that the platforms provide improved environment for marine life around platforms relative to open seafloor (Houseworth and Stringfellow 2015). That is, any adverse impacts of intentional fluid discharge are less than the other advantages afforded by the platform environment, such as large surface areas and an isolated and access-restricted environment.

Other Production and Non-Production Effluents. Besides produced water, platform operations produce a variety of other liquid wastes. For example, in 1996 and 2000, the 23 platforms in Federal waters in the POCS discharged roughly 56 billion and 48 billion L of (non-drilling) liquid effluent, respectively (Steinberger et al. 2004). Almost 90% of this discharge in each year was seawater used for various purposes on the platforms (i.e., cooling water, fire control system water), which was then discharged back to the ocean in accordance with NPDES permit requirements; only 10–12% was produced water. In 2005, discharges from the 23 oil platforms in the POCS totaled 60 billion L, of which 16% was produced water (Lyon and Stein 2010). Operational discharges accounted for the remaining volume, 99% of which was cooling water.[11] (Table 7-2). Fire control system water, sanitary and domestic wastes, deck drainage, and minor discharges contributed the remaining 1% of this volume.

Discharges from platforms are relatively minor compared to effluents from large and small POTWs, with respect to both effluent volume and constituent mass. In addition, oil seeps may contribute almost 10 times more hydrocarbons to coastal waters than produced water discharges, while the transportation sector contributes about twice as much hydrocarbon pollution to the coastal ocean than does offshore oil and gas production (Steinberger et al. 2004). Hydrocarbon pollution from combustion sources, including the transportation sector, enters the ocean primarily in stormwater runoff during the rainy season after atmospheric deposition of particulate combustion products onto land surfaces. Stormwater discharges from rivers can sometimes create turbid plumes carrying chemical and bacterial contamination that can extend for several kilometers offshore (Kaplan et al. 2010).

Well Treatment, Workover, and Completion Fluids. Other platform discharges may include chemicals associated with well treatment, workover, and completion fluids (Kaplan et al. 2010). These chemicals fall into three categories:

- Production-treating chemicals: scale inhibitors, corrosion inhibitors, biocides, emulsion breakers, and water treating chemicals, including reverse emulsion breakers, coagulants, and flocculants;
- Gas-processing chemicals: hydrate inhibitors, dehydration chemicals, and occasionally H_2S removal chemicals; and
- Stimulation and workover chemicals: mineral acids, dense brines, and other additives.

EPA Region 9 evaluated the potential effects of all 22 NPDES permitted discharges from oil and gas operations on ESA listed species and critical habitat and concluded that the discharges would have no effect on threatened and endangered species (EPA 2013b).

[11] On-platform natural gas compressors requires cooling water to reject the heat of compression. Cooling water is typically treated with chlorine to prevent biofouling and is discharged to the ocean under the NPDES Permit.

Hydrogen Sulfide. Hydrogen sulfide (H_2S), a toxic gas, may accompany recovered oil and gas. EPA regulations prohibit H_2S discharge. Various waste separation systems (e.g., amine or Sulfurox) capture H_2S for onshore disposal. Regulations require strict monitoring of H_2S as a worker safety hazard and toxic air pollutant.

Shell Mounds. Upon their removal in 1996, Chevron found large mounds of mussel shells at the base of Platforms Heidi, Hilda, Hazel, and Hope in State waters near Summerland and Carpinteria in the Santa Barbara Channel Basin. The mounds, which are approximately 200 ft wide and 20 to 30 ft tall, had accumulated from periodic scrapings of the former platform legs (Kaplan et al. 2010). Cores taken from shell mound cores contained elevated concentrations of metals associated with drilling wastes (e.g., barium, chromium, lead, and zinc), and alkylated benzenes and PAH (Kaplan et al. 2010). A more recent study measured PAH in water near shell mounds associated with Platforms A and B on the POCS (Bemis et al. 2014) and detected very low levels of PAH in the parts per trillion range. Chemical characterization of the PAHs in the water samples indicated a predominance of unweathered crude, suggesting nearby petroleum seeps as the likely source of the PAH and a low likelihood of a significant contribution from shell mounds, which would appear as weathered crude because of how long the shell mounds had been on the sea floor. The study further found that PAH concentrations were more than an order of magnitude below California water quality objectives for the protection of marine biota and human health.

7.5 Other Discharge Sources

Publicly Owned Treatment Works (POTWs). Treated municipal wastes from POTWs, along with regulated industrial discharges, are large contributors to hydrocarbon and metal loads in the SCB (MMS 2005). Lyon and Stein (2010) compared 2005 discharges of produced water from POCS oil platforms to POTW effluents, and reported that produced water from oil platforms accounted for only 0.5% of the combined effluent volume from both sources. General constituent and metals loads from oil platforms, likewise, were insignificant compared to discharges from POTWs. However, discharges of petroleum hydrocarbons, including benzene, toluene, ethylbenzene, and PAHs, were greater from produced water than from POTWs.

Of the 23 POCS platforms, only the four San Pedro Bay Basin platforms are located in the southern SCB between Point Dume and the U.S.–Mexico border (Lyon and Stein 2010). In contrast, 17 of the 23 POTWs in the region are concentrated in the southern SCB, where they dominate discharges to the region. The four largest facilities each discharge over 100 million gallons per day (mgd), and account for 86% of the total POTW effluent volume (Lyon and Sutula 2011). Three of the large facilities are located in Los Angeles and Orange Counties near the San Pedro Bay Basin platforms. The fourth large POTW serves the city of San Diego. Constituent loads from platforms in the northern SCB, consequently, are a greater proportion of point source loads, ranging from 15% up to 100% of the combined platform and POTW loads of most metals, organics, oil/grease, and ammonia.

Lyon and Stein (2010) compared loads to the ocean of 15 chemical analytes from POCS oil and gas platforms and from POTWs within the same basin. They found that platform discharges in the San Pedro Basin were negligible compared to POTW loads, with the exception of PAH, for which platform loads were 6% of combined loads. In the Santa Barbara Basin, platform loads represented from 15% to 100% of combined loads. Platform loads were less than about 50% of combined loads for most metals, except for cadmium and silver, neither of which was detected in POTW effluents. Platforms discharged the majority of the combined loads phenol and PAH. In the Santa Maria Basin, no large POTWs were present for comparison.

Stormwater Runoff and Sediment Plumes. Untreated stormwater runoff from the SCB watershed represents a large non-point source of pollutant and nutrient loads to the SCB. Noble et al. (2003) found that 96% of the shoreline met water quality standards during dry weather, but 58% of the shoreline failed to water quality standards during wet weather, typically from late fall to early spring. Ackerman and Schiff (2003) compared stormwater runoff and POTW emissions to the SCB finding somewhat comparable contributions of heavy metals from the two sources, while nutrient contributions differed, with stormwater contributing about 1% of the ammonia of POTWs, but an order of magnitude more nitrate than POTWs. Lyon and Sutula (2011) found that regional stormwater runoff loads of suspended solids, nitrate-N, cadmium, chromium, copper, lead, mercury, zinc, and total DDT estimated earlier by Ackerman and Schiff exceeded the levels discharged by large POTWs in 2009. Stormwater is an episodic input to the SCB, producing visible plumes, while POTWs produce continuous inputs.

Bay et al. (2003) studied stormwater toxicity in the two largest discharges to Santa Monica Bay using a sea urchin fertilization toxicity test. These discharges lie between the eastern Santa Barbara Channel platforms and the San Pedro Bay platforms. They found that every sample tested from Ballona Creek, which drains a highly urbanized area, exhibited toxicity in this test, while Malibu Creek, which drains a mostly undeveloped watershed, exhibited a lower frequency and magnitude of toxicity. Toxicity extended as far as 4 km offshore; zinc was the primary toxicant in the Sea urchin test. Ahn et al. (2005) similarly found that stormwater runoff from the Santa Ana River, San Gabriel River, and Los Angeles River, which discharge near the San Pedro Bay platforms, contributes to poor surf zone water quality, causing fecal coliform to exceed ocean bathing water standards for up to 5 km from the river outlets in the SCB. Large stormwater plumes detected by satellite covered over 100 km^2.

Due the local lithology, topography, and meteorology along Southern California coast, watersheds in region deliver large sediment loads to the ocean, mainly as pulses carried by stormwater runoff occurring in winter months. These pulses generate the noted plumes with high turbidity from high levels of suspended solids in the coastal ocean. Sediment plumes as observed by satellite imagery originate from runoff from the Santa Ynez near the western Santa Barbara Channel Basin platforms and the Ventura and Santa Clara river watersheds near the eastern Santa Barbara Channel Basin platforms, and are typically the largest surface plume features in the winter coastal waters. Plumes as large as 10 km long and 25 m wide have occurring following periods of heavy rain (Mertes et al. 1998). Plume size as detected by satellite imagery correlates to the magnitude of rainstorms; lag times from rain event to maximum plume size range from 1-2 days (Nezlin et al. 2005, Nezlin and DiGiacomo 2005). Warrick et al. (2004) found that most of the sediment in stormwater discharges from the Santa Clara River near Santa Barbara settled out of the surface plume within 1 km of the mouth of the river.

Warrick et al. (2007), using a combination of satellite, radar, and shipboard water sampling observed that riverine stormwater plumes typically moved down-coast upon discharge into the SCB driven by local winds at rates of 20-40 km/day. Nezlin et al. (2008) developed correlations between plumes identified from satellite infrared imagery and measured fecal coliform levels. Reifel et al. (2009) developed correlations between TSS, salinity, and colored dissolved organic matter as plume indicators with coliform and nutrient levels for predicting the effects of plumes and concluded that could be effectively monitored using satellite measurements of TSS or CDOM. Warrick et al. (2007) likewise found CDOM fairly well correlated with salinity for potential freshwater plume monitoring with remote sensing. Alternatively, Rogowski et al. (2015) developed models of plume dispersal in coastal waters using radar measurements of surface currents. These authors noted that this method overcomes the short-term temporal limitations of satellite imagery.

Shipping. Other minor sources of chemical releases to coastal waters related to shipping include lubricating and hydraulic fluids from ocean vessel machinery. Soaps and solvents used on oceangoing vessels are typically biodegradable and pose little threat to the marine environment. Impacts on water quality from discharges of small volumes of petroleum-based solvents are small. Similarly, impacts of small releases of antifouling paint, interior paint, and exterior paint from vessels are negligible to small, based on volume. Discharges of kitchen and septic wastes potentially containing treatment chemicals, pathogens, and nutrients most likely represent negligible to minimal impacts on water quality of the POCS (Kaplan et al. 2010). Shipping is concentrated in the metropolitan Los Angeles area, which includes the San Pedro Bay Basin platforms.

Ocean Seeps. Natural oil seeps present in the immediate study area contribute to petroleum loads in the ocean. Approximately 50 oil seeps occur off the shore of Southern California between Point Arguello and Huntington Beach. At least 38 of these seeps are located in the Santa Barbara Channel; they release an estimated 40–670 bbl of crude per day to the channel, with the greatest releases near the Coal Oil Point Seep (MMS 2005). The Coal Oil Point seep field is an approximately 18-km^2 area off the shore of Goleta, California, and has been estimated to emit 50-170 bbl of oil and 100–130 tons of natural gas per day (Hornafius et al. 1999). Farwell et al. (2009) characterized the seeped oil as roughly 30% hydrocarbons and 70% resins plus asphaltenes, and described an associated 90-km^2 fallout plume on the near-west seafloor estimated to contain 3.1×10^{10} g (3.1×10^4 metric tons) of petroleum in the top 5 cm of sediments.

With respect to the Santa Maria Basin, no active seeps of oil, tar or natural gas were identified in a 2005 review of undeveloped oil and gas units and lease area offshore of Santa Barbara, Ventura, and San Luis Obispo Counties. The review notes, however, that geological conditions in the proposed areas are favorable for the formation of seeps and that MMS and USGS were pursuing a study of natural seeps in the Santa Maria Basin (MMS 2005). Lorenson et al. (2011) report abundant seafloor tar accumulations indicative of seeps off Point Conception and Point Arguello. Tar residues on beaches are common as far north as the Monterey Bay National Marine Sanctuary in the Santa Maria Basin, as well as on beaches of the Channel Islands and along the San Pedro Bay Basin, carried from source areas by prevailing currents (Hostettler et al. 2004).

Gale et al. (2013) compared exposures of Pacific sanddab (a flatfish) to petroleum hydrocarbons from seven platforms (one of which is in State waters) and from natural seeps offshore Goleta, California, in the SCB. Platform sites were no more polluted than the nearby natural areas, exhibiting only low concentrations of PAHs, polychlorinated biphenyls (PCBs), DDTs, and other contaminants.

Hostettler et al. (2004), in a study of tar balls commonly found along beaches of the SCB, concluded that tar balls are of natural and not anthropogenic origin, originating from source rock within the Monterey Formation via shallow offshore seeps. The authors found that the major occurrences were from offshore seepage near the west end of Santa Cruz Island.

Marine Debris. Marine debris and trash is an increasing problem in the SCB as determined in surveys of the coastal seafloor and river inputs (Moore et al. 2011, Moore et al. 2016). Plastic is the most prevalent object found across all habitats, with about one-third of the Bight seafloor sediments containing micro-plastic particles and one-third of seafloor sediments having macro-plastic surface debris. From 1994 to 2013, the extent of seafloor macro-debris nearly doubled and the extent of plastic increased threefold. The study concluded that that land-based trash is a major contributor to debris in the Bight and that marine habitats serve as a sink for plastic accumulation.

7.6 Regulatory Framework

The Federal Water Pollution Control Act of 1972, reauthorized as the Clean Water Act (CWA) in 1977, 1981, 1987, and 2000, protects water resources in the United States (MMS 2005). Section 402 of the CWA authorizes the U.S. Environmental Protection Agency (EPA) to issue National Pollutant Discharge Elimination System (NPDES) permits to regulate the discharges of pollutants to waters of the United States, the territorial sea, contiguous zone, and ocean. Implementation of the NPDES has resulted in greatly reduced pollution discharges into U.S. waters, including the study area. Discharges are regulated to maintain levels that will not cause exceedance of water quality criteria established under the CWA (EPA 1976) as updated in 2003 (*Federal Register* 2003), based on revised EPA guidance (EPA 2002).

NPDES General Permit No. CAG 280000 issued by EPA Region 9, effective on March 1, 2014, and expiring on February 28, 2019 regulates discharges from offshore oil and gas exploration, development, and production facilities in Federal waters off the Southern California coast (EPA 2013a). The EPA uses General Permits to streamline the permitting process for facilities anticipated to discharge within the limits of the permit and thereby would not significantly affect marine environments.

The General Permit issued by EPA regulates 22 identified discharges from oil and gas facilities, including drilling fluids and cuttings, produced water, well treatment, completion, and workover fluids, deck drainage, domestic and sanitary wastes and miscellaneous routine discharges. The General Permit sets forth effluent limitations and monitoring and reporting requirements, including pollutant monitoring and toxicity testing of effluents. The point of compliance for effluents is the edge of the mixing zone, which extends laterally 100 m in all directions from the discharge point and vertically from the ocean surface to the seabed. The permit covers all 23 platforms (22 production and one processing) on the POCS. The permit also covers exploration facilities discharging in the permit area. The General Permit does not apply to vessels supporting platform operations or pipeline maintenance or installation. The USCG regulates vessel discharges.

The State of California regulates ocean discharges into State waters, which extend to 3 nmi from the coast, via the California Ocean Plan, first issued in 1972 (California EPA 2012). This plan includes effluent limitations for 84 pollutants, which apply to any facility which discharges into State waters (Aspen Environmental Group 2005). Oil platforms in State waters do not discharge into the ocean.

BSEE oversees oil spill prevention and response planning, taking over this responsibility from EPA in 1991. Offshore operators are required to submit Oil Spill Response Plans to BSEE for review in accordance with 30 CFR 254 (EPA 2013b).

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8 LOWER TROPHIC RESOURCES AND HABITATS

This chapter describes the lower trophic resources (e.g., benthic invertebrates) and habitats (e.g., giant kelp beds) of the Santa Maria, Santa Barbara Channel, and San Pedro Basins of the Southern California Planning Area, and of the coasts of the five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). The following sections briefly discuss intertidal and subtidal habitats and their representative biota of each of the three basins. Threatened and endangered invertebrate species that occur or may occur in these habitats are also described.

Within the Southern California OCS Planning Area, there is a major biogeographic transition zone offshore of Point Conception, where the cold-temperate waters of the Oregonian Province located to the north meet with the warm-temperate waters of the San Diego Province (also referred to as the California Province) located to the south. Oil and gas platforms in the Santa Maria Basin are located within the Oregonian Province. The San Diego Province includes Southern California Bight (SCB), which extends from Point Conception to Punta Banda Mexico (Schiff et al. 2016). These Oregonian and San Diego Provinces and the transition zone between them, have resulted in the development of distinctive communities (Seapy and Littler 1978; Blanchette and Gaines 2007).

Within these regional biogeographic zones, the intertidal and subtidal zones show distinct differences in biological communities due to the physical conditions unique to each habitat type. The subtidal zone is the area below the low tide line while the intertidal zone is defined as the area between the high tide line and the low tide line. The geology, topography, and bathymetry of an area together with oceanographic and biological processes affect the composition and abundance of marine organisms associated with subtidal seafloor habitats. In addition to depth and wave energy across the tidal zones, benthic community composition is strongly determined by bottom type, which can be soft sediment (sand, mud, or a mixture) or hardbottom (e.g. rock, cobble, and boulder). Subtidal soft sediments, while less dynamic than the intertidal zone are subject to periodic disturbance from water movement at the seafloor, especially in shallow waters. Invertebrate community structure also changes across depth due to changes in temperature, dissolved oxygen and food availability from shallow inshore areas to the continental slope and abyssal plain.

8.1 Habitat Types

8.1.1 Intertidal Habitats

The two predominant intertidal habitats within the Southern California OCS Planning Area are sandy beaches and rocky shorelines. Rocky shore habitats are more common north of Point Conception and offshore along the Channel Islands, while sandy beaches predominate south of Point Conception. Intertidal sandy beach habitats are dynamic and subject to continual shifting of sand by wind, wave, and current actions. Unlike hardbottom, soft sediments support infaunal invertebrates that live within sediments feeding on diatoms, decaying organic matter, or other invertebrates (Dugan et al. 2000). Typical sandy intertidal invertebrates include sand crabs, polychaetes, molluscs and various insect species (Dugan et al 2000). Also found on sandy beaches, are beach wrack communities consisting of insect larvae, beetles, and crustaceans living in detached and decaying aggregations of giant kelp, surfgrass, and eelgrass (Dugan et al. 2000).

Rocky substrates provide stable attachment sites for sessile plants, algae, and invertebrate species that are unable to firmly attach to shifting sandy or to muddy sediments. Together with bare rock crevices, these sessile biological cover types create structurally complex habitat that provides food and shelter to a diverse community of mobile fish and invertebrates. Invertebrates found on intertidal rocky shorelines include grazers, filter feeders, and predators (Menge and Branch 2001; Witman and Dayton 2001). Rocky shoreline invertebrate communities exhibit distinct zonation and significant temporal and spatial variability due to a complex interaction of climatological, physical (wave energy attachment sites) and biological (competition and predation) factors (Menge and Branch 2001; Witman and Dayton 2001; Miner et al. 2015; Blanchette et al. 2015).

8.1.2 Subtidal Habitats

Subtidal soft sediments, while less dynamic than the intertidal zone are subject to periodic disturbance from water movement at the seafloor, especially in shallow waters. Subtidal hardbottom habitat in the Southern California OCS Planning Area ranges from the extensive offshore rocky reefs offshore of the mainland and the Channel Islands to isolated rock outcrops scattered throughout the continental shelf (Blake and Lissner, 1993; Pondella et al. 2015). Subtidal hardbottom topographic features in the study area are often classified as low (<1 m) or high (>1 m) relief based on how far they extend above the seafloor (MMS 2001). Biological communities on these two feature types can differ markedly because low-relief areas are subject to greater disturbance from river runoff and sediment resuspension, and consequently contain less-diverse, opportunistic, shorter-lived species tolerant of sedimentation (Blake and Lissner 1993; Aspen Environmental Group 2005). High-relief features are less subject to such disturbances, and are characterized by less-tolerant long-lived species of sponges, branching and cup corals, and feather stars. These sessile biological communities, in turn, support highly productive invertebrates and fish communities adapted to hardbottom habitat. The implementation of special fishery regulations or designation of such areas as habitats of particular concern is a reflection of the importance of these topographic subtidal habitats to fish and invertebrates.

One particularly valuable habitat associated with subtidal hardbottom are the giant kelp (*Macrocystis pyrifera*) beds which develop in wave sheltered hardbottom habitat throughout the study area at depths up to 100 feet with sufficient light penetration to support photosynthesis (ADL, 1984 cited in MMS 2001; Ponderella et al., 2015). Kelp beds are diverse, biologically productive habitats that support reef associated fish and invertebrates. In addition to physical factors like wave energy and water chemistry, kelp density and distribution are heavily influenced by herbivorous sea urchins (Ponderella et al. 2015).

In additional to the natural habitats present in the intertidal and subtidal zones, the POCS platforms present a novel artificial hardbottom habitat in contrast with the surrounding soft bottom habitats. The platform structure provides attachment sites for sessile invertebrates such as mussels, corals, bryozoans, and sponges, and attract a variety of mobile invertebrates and fish. Current details on the species and ecology on the Platforms will be presented in a dedicated volume Platform Science Synthesis in the Bulletin for Marine Science (http://bullmarsci.org/) in late 2019.

8.2 Santa Maria Basin

The Santa Maria Basin Area represents the transition between the Oregonian and Californian Provinces.

Intertidal Habitats. The shoreline habitat north of Point Conception has high wave energy and a mix of steep rocky shoreline interspersed with sand, boulder and cobble beaches. Each of these habitats support distinct benthic communities based on the physical conditions of the area such as substrate and wave energy (MMS 2001). Rocky shore habitats are more common north of Point Conception and offshore along the Channel Islands, while sandy beaches predominate south of Point Conception (MMS 2001). The invertebrates inhabiting soft bottom sandy intertidal habitats north of Point Conception are dominated by burrowing animal species, including crustaceans (isopods and amphipods), polychaete and nemertean worms, mollusks (snails and bivalves) and insects. The mole crab (*Emerita analoga*) is a particularly dominant species (MMS 2001). The location of these species within the intertidal will vary with intertidal depth zone, grain size, beach slope, and wave energy (Straughan 1982 cited in PXP 2012). Detailed descriptions of sandy beach ecology and associated biotic communities in the Point Arguello and the Santa Maria Basin Area may be found in MMS (2001) and PXP (2012).

Rocky intertidal sessile communities north of Point Conception consist of either attached invertebrates, algae, or sea grasses. Sessile invertebrates are primarily barnacles (*Chthamalus/Balanus*) and mussels (*Mytilus* spp.) while algal and plant species include primarily non-coralline crusting algae and rockweed (*Silvetia compressa*) as well as turfweed (*Endocladia muricata*), surfgrass (*Phyllospadix scouleri* and *P. torreyi*), kelp (*Egregia menziessi*) and iridescent weed (*Mazzaella flaccida*) (MMS 2001; Miner et al. 2015). Snails (*Littorina* spp., *Tegula funebrails*, *Lacuna* spp.), limpets (*Lottia* spp.), chitons (*Nuttallina* spp.), sea urchin (*Strongylocentrotus purpuratus)*, and various crab species are predominant epifaunal invertebrates. MMS (2001) and Miner et al. (2015) provide detailed descriptions of rocky benthic communities in central California.

Rocky intertidal species exhibit wide density fluctuations over time, related to El Niño and the regular occurrence of strong storms that dislodge sessile organisms (Miner et al. 2015). Although species have declined at individual sites, dominant species like *Mytilus* spp., barnacles, and several algal species did not show region-wide population trends over time. However, some species have persistently declined (Miner et al 2015). For example, the starfish, *Pisaster ochraceus*, has declined at multiple sites since 2014 presumably due to seastar wasting syndrome, which increases during periods of increasing water temperatures (Miner et al 2015; Blanchette et al. 2015). Similarly, black abalone have significantly declined since the 1990’s (MMS 2001; Miner et al. 2015).

Subtidal Habitats. Subtidal habitats in the Santa Maria Basin are primarily sandy sediments with more silty sediments in deeper waters. There have been multiple comprehensive surveys of soft sediments in the Santa Maria Basin and western Santa Barbara Channel (SAIC, 1986; Blake and Lissner 1993). Over 1,000 benthic species occur in the Santa Maria Basin. Amphipod crustaceans, polychaetes, echinoderms, and molluscs were dominant across most depth zones, but significant changes in the species composition of these genera occur based on depth, dissolved oxygen and grain size (Hyland et al. 1991). The dominant invertebrates were a mix of species found in the Oregonian Province and the California Provinces. Invertebrate density and species richness is highest in nearshore areas and declines with depth (Hyland et al. 1991; Blake and Lissner 1993).

Although uncommon compared to soft bottom habitats, biologically significant hard bottom habitats are also present in the form of rocky reefs and exposed rock and gravels scattered throughout the Santa Maria Basin (Blake and Lissner 1993; PXP 2012a). Higher relief sites are more common around the Channel Island Islands and lower relief reefs more common along the mainland (Pondella et al. 2015). Cnidarians (branching, cup, and encrusting corals and large anemones), Echinodermata (feather stars, brittle stars, basket stars, and sea urchins) and Porifera (vase, barrel, and shelf sponges) and crustaceans dominate the macrobenthic assemblage in low and high relief hardbottom habitat (Blake and Lissner, 1993; Diener and Lissner, 1995). However, species composition varies with depth and topographic relief with short-lived, opportunistic species better adapted to sedimentation stress being more common on low relief habitat (Blake and Lissner 1993; Harding et al. 1994).

Larger kelp beds of *Macrocystis pyrifera* and *Nereocystis leutkana* are associated with hard bottom habitats in greater densities north of Point Conception (ADL, 1984 cited in MMS 2001; Johnson et al. 2015; Johnson et al. 2017). Kelp beds in central California are species rich and highly productive habitats; regulated by a complex interaction of biological (e.g. sea urchin grazing and population connectivity) and physical (e.g. depth, complexity of the rocky reef, water temperature, and wave orbital velocities) factors (Young et al. 2016).

Surveys of Platforms Irene, Harvest, and Hidalgo located within the Santa Maria Basin indicated anemones (*Metridium spp. Anthopleura elegantissima*,) mussels (*M. californianus*), barnacles (*Tetraclita squamosa*, *Balanus* spp.), calcareous worm tubes, and encrusting sponges were dominant biological cover types (Continental Shelf Associates 2005). There were also species found on the platforms that were not found generally found in the eastern Santa Barbara Basin Platforms, such as the gooseneck barnacle (*Pollicipes polymerus*) and the ochre starfish (*P. ochraceus*) (Continental Shelf Associates 2005). See Blake and Lissner (1993), MMS (2001), and PXP (2012) for a comprehensive list of species found in the Santa Maria Basin and vicinity.

8.3 Santa Barbara Channel

The Santa Barbara Channel is influenced by the warmer waters of the northern counter current, and the beginning of the SCB, which extends down through San Diego County. One key offshore feature of this basin is that it is bounded offshore by the five biologically rich northern Channel Islands.

Intertidal Habitats. South of Point Conception, rocky shore habitat decreases and sandy beach begin to predominant the shoreline (Gaddam et al 2014). The shoreline of the SCB is primarily sandy beaches (Dugan et al. 2000). While less common on the Channel Islands, sandy beaches are still present especially on San Miguel and Santa Rosa Islands. Invertebrate species richness and density are high in both areas (Dugan et al., 2000). The most abundant and widespread species are the common sand crab (*Emerita analoga*), as well as insects, isopods, talitrid amphipods, polychaetes, and the Pismo clam (*Tivela stultorum*) (Dugan et al. 2000). One trend identified for intertidal beach communities is a decline in two isopod species (*Tylos punctatus and Alloniscus perconvexus*) that were once abundant in the central and Southern California beaches but which have disappeared or declined substantially in the last few decades. The decline may be attributable to beach development and structural modifications to prevent erosion and maintain recreational use (Hubbard et al. 2014).

Numerous investigations of rocky intertidal sites along the coast of the SCB indicated that similar species are found along the coast of the SCB, but depending on habitat conditions, different species dominant at different sites (Blanchette et al. 2015) and spatial and temporal trends in species composition are not always clear (Gaddam et al. 2014). Overall, foliose red algae and corallines were present at most sites. Other dominant cover types were rockweed (*Silvetia compressa*), surfgrass (*Phyllospadix* spp.), turfgrass (Blanchett et al., 2015). Common invertebrates include *Mytilus* spp. and barnacles (*Balanus* spp. and *Chthamalus* spp.) although these species are generally more dominant in the northern SCB (Gaddam et al. 2014; Miner et al. 2015). A diverse array of epifaunal invertebrates is associated with these habitats such as snails (*Tegula funebralis*, *Nucella* spp. and littorines), ochre stars, limpets (*Lottia* spp.), and shore crabs (*Pachygrapsus crassipes; Pagurus spp.* (Miner et al. 2015). As in the Santa Maria Basin, a significant decline in sea stars (*Pisaster* spp.) since 2014 has been well documented (Miner et al. 2015).

The Channel Islands are primarily rocky shoreline (Gaddam et al. 2014). Dominant intertidal biological cover types include red algae (*Chondracanthus* spp.), corallines, turfweed, polychaetes, *Mytilus* spp., and barnacles. Mobile epifauna are similar to the organism found on the rocky intertidal zone of the mainland, primarily, snails, chitons, limpets (Blanchette et al. 2015; Miner et al. 2015). There is also significant variation in species composition based on whether the shoreline is sheltered or wave exposed (need ref).

Subtidal Habitats. As elsewhere in the Southern California OCS Planning Area, both soft and hard bottom habitats may be found in subtidal areas of the basin. The soft bottom benthic communities have been assessed for 20 years from Point Conception to Sand Diego and found to be generally healthy, with less than 2% of the habitats studies classified as moderate to highly disturbed, and mostly in estuarine and marina locations (Schiff et al. 2016; Gillette et al. 2017). Overall, sediment quality has been improving over the last decade (Schiff et al. 2016; Gillette et al. 2017). In soft bottom zones, polychaete worms (spionids, capitelids, lumbrinerids and maldanids), amphipod crustaceans, bivalve molluscs, and echinoderms (brittle stars and sea cucumbers) dominate the benthic infauna (Allen et al. 2011; Ranasinghe et al. 2012; Gillette et al. 2017). However, there were species-specific differences that distinguished benthic communities into one of three community habitat groupings: embayment (estuaries, marina, port, and bays); off shore (inner shelf, mid shelf, outer shelf, Channel Islands, and MPAs); and deep water assemblages (Bergen et al. 2001; Gillette et al. 2017). Oil and gas platforms in the eastern Santa Barbara Channel and San Pedro Bay off Long Beach are primarily located in the inner shelf to mid shelf, where infaunal communities are dominated by the spionid, capitelid, and chaetopterid polychaetes, tellinid bivalves, ostracods, and ophiuroid echinoderms (Gillette et al. 2017). On the outer shelf and upper continental slope where platforms in the western Santa Barbara Channel are located, polychaetes and tellinid bivalves dominate along with amphipods (Gillette et al. 2017).

Epifaunal community structure also varies with habitat and depth. Species abundance was generally highest on the continental slope and the middle shelf near the Channel Island, and lowest abundance in the inner continental shelf (Allen et al. 2011). The most abundant epifauna were echinoderms, primarily sea stars, sea cucumbers, and sea urchins. A variety of crab species, including the commercially important rock crabs (*Cancer* spp.), also occur on sandy substrates (Carroll and Winn 1987).

There are at least 120 shallow (0-30m depth) subtidal rocky reefs/reef (approximately 49,055 hectares) along the coastline of the SCB, which is equivalent to 25% of the coastline (Pondella et al 2016). These rocky reefs support giant kelp in sheltered coves and bays. The Channel Islands, Palos Verdes and Point Loma are among the many sites with large kelp beds (Mearns et al. 1977; Pondella et al. 2015). The giant kelp beds of the Channel Islands, in particular, support dense and diverse communities of echinoderms, polychaetes, amphipods, decapods, and gastropods (Graham 2004). See Pondella et al. (2011 and 2016) for recent data on the location and physical and biological characteristic of nearshore subtidal rocky reefs in the Santa Barbara Channel and San Pedro Bay.

In addition, low and high relief rocky outcrops are scattered throughout the Santa Barbara Channel south to San Pedro Bay (Blake and Lissner 1993; MMS 2001), although high relief outcrops are relatively uncommon. Anemones, sea urchins, corals, hydroids, tubeworms, sponges and bryozoans, colonize both types of outcrops.

Diverse benthic communities also develop around production platforms and oil pipelines that run along the seafloor. In a study conducted in the Santa Barbara Channel, sea anemones, echinoderms (sea urchins and sea stars), and crustaceans (shrimp and crabs) were associated with the pipeline infrastructure (Love and York 2005). Cnidarians, mussels, barnacles, tube building worms, and ophiuroids were the most density dominant organisms on oil production platforms in the SCB, although there was significant variation among platforms at the species level (Continental Shelf Associates 2005). Many similar species are found on both natural rock outcrops and platforms, but diversity was higher at the natural rock outcroppings compared to the platforms (Continental Shelf Associates 2005).

8.4 Santa Monica Bay to Dana Point (San Pedro Basin)

Within Santa Monica Bay, a 600 km^2 embayment located offshore of Los Angeles, CA, the seafloor consists of unconsolidated sediment and areas of exposed bedrock, and supports a diverse invertebrate fauna (Edwards et al., 2003).

Intertidal Habitats. Intertidal habitats and their biota are similar to those present along the eastern portions of the Santa Barbara Channel (Section 8.2). However, due to the greater degree of human development and activity, such habitats in some areas (i.e., the Port of Long Beach) may be heavily modified, and less supportive of diverse communities. Rocky intertidal habitats are being heavily affected by human trampling and collecting, although habitats in the northern portion of the region are in better condition due to less human disturbance.

Subtidal Habitats. Muddy and sandy soft bottom habitats support invertebrate fauna that are dominated by echinoderms (sea urchins, sea cucumbers, brittle stars, and starfish) and polychaetes (e.g. unidentified worm tubes) (Edwards et al., 2003). Relatively smaller number of crabs, gastropods, octopods, cnidarians, and epifaunal shrimp also occur. Of the less abundant epifauna, various species of starfish, brittle stars, and sea cucumbers may be found throughout.

Soft sediments are a major reservoir of chemical contaminants in this area. Chemical contaminants have been introduced primarily through historical wastewater discharges. These sources include the Hyperion Treatment Plant (Hyperion) near Los Angeles International Airport; the Joint Water Pollution Control Plant near White Point on the Palos Verdes Peninsula; and a variety of industrial sources associated with the Los Angeles and Long Beach harbors (Reisch et al., 1980; Long Beach 2009; Bay et al., 2015). However, the quality of the soft-bottom habitats has been steadily improving, primarily due to improvements in water treatment methods, reductions in contaminant discharges, and the concomitant continuous decline of surface areas with high DDT, PCB, and mercury concentrations, even though they are still higher compared to the rest of the Southern California Bight (Bay et al., 2015). In addition, sedimentation and turbidity associated with storm water runoff and coastal landslides may greatly impact subtidal habitats and their biota (Pondella et al., 2010)

Santa Monica Bay includes a number of high quality reefs. For example, of 29 reefs spanning the entire Southern California Bight (from Pont Loma to Cojo) surveyed in 2007 and 2008, eight of the top 10 were in the Santa Monica Bay (Pondella, 2009). Ophiuroids (brittle stars) and attached gorgonians (sea fans) are characteristic epifauna of all shallow water (<100 m) hard bottom habitats throughout the Santa Monica Bay (Edwards et al., 2003).

Hard bottom habitat in San Pedro Bay is largely limited to linear features of the breakwater and riprap protecting the THUMS islands and facilities at the Ports of Long Beach and Los Angeles. Historically, rocky reef areas existed in San Pedro Bay prior to the development of the Los Angeles and Long Beach ports and harbors (Long Beach 2009). Similarly, kelp habitat within San Pedro Bay is also limited to linear features associated with the breakwater and other rock structures. Historically, there were extensive kelp beds in the San Pedro Bay area. For example, the Horseshoe Kelp Bed was reported to be two miles long and one-quarter to one-half mile wide (320 to 640 acres) and in water depths of 80 to 90 feet. This kelp bed completely disappeared in the 1920s to 1930s.

8.5 Threatened and Endangered Invertebrate Species

Of the coastal and marine invertebrates in central and Southern California, the Morro shoulderband snail (*Helminthoglypta walkeriana*), the black abalone (*Haliotis cracherodii*), and the white abalone (*Haliotis sorenseni*) have been listed as endangered under the Endangered Species Act of 1972 (ESA) (16 U.S.C. § 1531 et seq.).

Morro Shoulderband Snail. The Morro shoulderband snail is found only in coastal dune and scrub communities and maritime chaparral in western San Louis Obispo County. Its range includes the Morro Spit and areas south of Morro Bay, west of Los Osos Creek, and north of Hazard Canyon (USFWS 1998). The species was listed as endangered on December 15, 1994 (USFWS 1994), and critical habitat was listed on February 7, 2001 (USFWS 2001). There are 1,039 ha (2,566 ac) of critical habitat within San Luis Obispo County, designated across three Critical Habitat Units. These include Unit 1: Morro Spit and West Pecho (741 ha [1,830 acres]), Unit 2: South Los Osos (129 ha [320 ac]), and Unit 3: Northeast Los Osos (168 ha [416 ac]). Unit 1 borders about 10 km (6 mi) of the Pacific Ocean coast, while Unit 3 borders about 0.8 km (0.5 mi) of the eastern shoreline of Morro Bay. Unit 2 is an inland location south of Morro Bay and east of Unit 1.

The primary constituent elements for Morro shoulderband snail habitat are sand or sandy soils, slopes not greater than 10 percent, and the presence of (or capacity to develop) coastal dune scrub vegetation (USFWS 2001)). Threats to the species include habitat destruction and degradation from development, invasion by non-native plants, structural changes in vegetation due to plant senescence, and recreational use such as from off-highway vehicles. Other possible threats include competition with the brown garden snail (*Helix aspersa*), introduction of non-native predatory snails used to control the brown garden snail, molluscicides, and possible extirpation of small, isolated populations (USFWS 1998).

Black Abalone. The black abalone is a marine mollusk found in rocky intertidal and subtidal marine habitats. This species was listed as endangered on January 14, 2009 (NOAA 2009). In addition, most of the rocky subtidal and intertidal areas of the mainland California coastline south of Del Mar Landing Ecological Reserve to Government Point, the shoreline of the Channel Islands, and portions of the California coastline south of Point Conception have been listed as critical habitat for the black abalone (NOAA 2011). The black abalone population along the California coast south of Monterey County, California, has been estimated to have declined by as much as 95% (Neuman et al. 2010). Historical and/or ongoing threats include overfishing, habitat destruction, and more recently, the disease of withering syndrome. Black abalone abundance stabilized during 2011-2015 following the significant decline in abundance found between 1992 and 2005 (Miner et al. 2015). However, new abalone recruitment appears to be minimal in the region.

White Abalone. The white abalone, another marine mollusk, was listed as endangered throughout its range along the Pacific Coast (from Point Conception, California, United States, to Punta Abreojos, Baja California, Mexico) on June 2001 (NOAA 2001). No Critical Habitat designation has been made for this species. The initial decline in white abalone abundance has been attributed to commercial overharvesting. Regulatory measures taken by the State of California during the past 30 years, including the closure of the white abalone fishery in 1996 and the closure of all abalone fisheries in central and Southern California in 1997, have proven inadequate for recovery (NMFS 2008). Surveys conducted in Southern California indicate that there has been a 99% reduction in white abalone abundance since the 1970s (Smith et al. 2003).

Abalone are broadcast spawners whose successful reproduction requires a relatively high local density of adults during the winter to spring spawning period. After a brief planktonic stage, the larvae settle and remain relatively local. Adults are herbivorous, consuming diatoms, filamentous algae, and drifting *Laminaria* and *Macrocystis* detritus.

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9 MARINE AND COASTAL FISH AND ESSENTIAL FISH HABITAT

This chapter describes the marine and coastal fish of the Southern California Planning Area, including coasts of the five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). The following sections discuss the fish communities of each of the three basins, essential fish habitat and managed species, and the threatened and endangered fish species that occur or may occur in the Southern California Planning Area and adjacent waters.

9.1 Marine and Coastal Fishes

The POCS supports a diverse fish community, reflecting the diverse habitats (i.e., rocky reef, sand, and kelp) and the presence of cold and warm water masses divided by Point Conception (Dailey et al. 1993). Of the 554 species of California marine fishes, 481 species occur in the SCB (Horn, 1974 cited in MMS 2001). Broadly, fish species found in the POCS can be characterized as either diadromous, pelagic, soft bottom demersal, or reef associated based on their habitat associations and life history traits. Based on an analysis of fish-trawl data from off the coast of California at depths from 55 to 1,280 m, the overall composition of fish species in coastal waters of the SCB (waters of the Mexican border north to Point Conception and the South Central Coast region (Point Conception north to Lopez Point) were relatively similar (Stephens et al 2016). The life history can greatly differ between species in terms of seasonal movements, spawning location, season, and frequency, and depth and habitat distribution.

Diadromous Fish. Diadromous fish, such as salmon (*Oncorhynchus* spp.), are defined by their movement from oceanic feeding grounds to inland freshwater streams for spawning. Five species of salmon use nearshore and offshore waters, as well as spawning streams inshore of the Pacific region. The steelhead salmon (*Oncorhynchus mykiss*) is the predominant diadromous species found in Southern California waters. The distribution and life history information of steelhead are detailed in NMFS (2012).

Pelagic Fishes. Pelagic species are those that do not live in or on the seafloor, but rather swim through the water column. Pelagic fish may occupy specific depths within the water column from the near-surface epipelagic zone to the deeper mesopelagic and bathypelagic zones. As a group, pelagic fish occupy a number of trophic levels. Examples of common planktivorous pelagic species in central and Southern California include northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), Pacific herring (*Clupea pallasi*), and Pacific mackerel (*Scomber japonicus*). These species inhabit the photosynthetically productive euphotic zone of the water column; are fed upon by larger predatory fish like tuna (*Thunnus spp.*) swordfish (*Xiphias gladius*), and sharks. Fish assemblages in deeper waters of the mesopelagic and bathypelagic zones are dominated by bent-tooth bristlemouth (family Gonostomatidae) and lampfish (MMS 2001 citing DeWitt, 1972; Cailliet and Ebeling, 1990). Certain pelagic fish are known to make large migrations along the coast and between inshore and offshore areas. For example, certain species of tuna and shark may be present in waters of the planning area only in certain seasons. U.S. commercial and recreational fisheries harvest many of the pelagic fish species.

Soft Bottom Demersal Fishes. Soft bottom demersal fishes are associated with sand and mud bottom substrates. Soft bottom habitats are relatively featureless and have lower species diversity than the more structurally complex hard bottom habitats. Over 150 species of fish have been identified from trawl surveys in soft bottom habitat (Allen et al. 2011). Various species of soles and sanddab (*Citharichthys* spp.) are abundant and widely distributed demersal species across depth zones in the SCB (Allen et al. 2011; Miller and Schiff 2012). Queenfish, northern anchovy, surfperch (family Embiotocidae), white croaker (*Genyonemus lineatus*), and sole were common in surveys in nearshore beach habitat (Allen et al. 2004). In addition to white croaker and surfperch, lizardfish (*Synodus* spp.) and turbot were common inner shelf species. Rockfish (*Sebastes* spp.) and sculpins (*Icelinus* spp.) increase in abundance in the middle shelf, and combfish (*Zaniolepis* spp.), midshipmen (*Porichthys notatus*) and Pacific hake (*Merluccius productus*) are typical of outer shelf sites (Miller and Schiff 2012).

The middle and outer continental shelf generally have higher fish abundance than bays and harbors, the inner shelf, and the upper continental slope. The lowest density, biomass, diversity, and species richness was recorded in the inner shelf (Miller and Schiff 2012; Allen et al. 2011). Demersal fish community composition has historically varied with large-scale climatological change such as the warm water conditions created by the 1997-1998 El Niño and the resultant change in species ranges (Miller and Schiff, 2012). A description of demersal fish assemblages off Southern California is provided in Allen et al. (2004), Miller and Schiff (2012), MMS (2001), and Allen et al. (2011).

Reef Fish. Reef fish are structure oriented species inhabiting rocky seafloor and the associated sessile communities like mussel and kelp beds. Pondella et al, (2011) identified 78 fish taxa in reef surveys, while Claisse et al. (2014) observed 110 fish taxa. Kelp bass (*Paralabrax clathratus*), California sheepshead (*Semicossyphus pulcher*), garibaldi (*Hypsypops rubicundus*), and black perch (*Embiotica jacksoni*) were benthic species found at the greatest density (Pondella et al. 2011). Some species associated with reefs and kelp beds are found throughout the water column including blacksmith (*Chromis punctipinnis*), senorita (*Oxyjulis californica*), kelp perch (*Brachyistius frenatus*), tubesnouts (*Aulorhynchus flavidus*), opaleye (*Girella nigricans*), smelt (*Atherinops* spp.), and blue rockfish (*Sebastes mystinus*) (Pondella et al. 2011).

Structure-oriented species also congregate around offshore platforms and their associated pipelines. Some of the platforms in the Southern California OCS Planning Area have been reported to have the highest secondary fish production per unit area of seafloor of all marine habitat that has been studied globally (Claisse et al. 2014). Platforms are structurally similar to pinnacles that steeply rise from deep to shallow waters. Pinnacles, which harbor high densities of juvenile fishes, are uncommon along the California coast. Thus, the platforms provide this habitat function (Nishimoto and Love 2011). Martin and Lowe (2010) observed 28 fish taxa at inshore platforms and 39 taxa at offshore platforms. Nishimoto and Love (2011) observed over 18 species of rockfishes and over 22 species of non-rockfishes at 7 surveyed platforms. Claisse et al. (2014) observed 89 fish taxa at platforms; 75 taxa were observed at the platform base and 75 taxa at the platform midwater area.

Rockfish (*Sebastes* spp.) and lingcod (*Ophiodon elongatus*) are frequently observed species near platforms. In a survey of pipelines in the Santa Barbara Channel, fish densities along pipelines were six to seven times higher than the adjacent seafloor. Most species along the pipeline were rockfishes, sanddabs, and combfishes (Love and York 2005). Platforms tend to have higher abundances of large fishes, particularly economically important species such as cowcod, bocaccio, and lingcod compared to natural reefs; likely due to relatively low fishing effort around many platforms (Love and Schroeder 2006).

Platform location, local current patterns, and natural habitat distribution determine the balance between settlement of reef fish at a specific platform and settlement at natural reef habitats (Emery et al. 2006). Fish appear to use platforms in a manner similar to those occurring on natural reefs; with some species demonstrating higher site fidelity to platform habitat than to natural habitats (Lowe et al. 2009). The platforms in the Santa Barbara Channel function as important habitat for rockfishes; while the San Pedro Shelf platforms by Los Angeles and Orange Counties (particularly the shallower platforms) have species typical of offshore kelp bed habitats including sea basses (family Serranidae) and surfperches (family Embiotocidae) (Martin and Lowe 2010).

Extremely high numbers of young-of-the-year (YOY) rockfishes inhabit the midwater portions of oil platforms. Some rockfish species such as the bocaccio (*Sebates paucispinis*) recruit at much higher densities at some platforms than at natural reefs. The offshore location and vertical structure of the platforms serve as an important function for juvenile rockfish recruitment. The species and abundance of YOY rockfish vary spatially and temporally among platforms (Nishimoto and Love 2011). Nevertheless, if not for the platforms, many YOY rockfishes, not be transported by currents to natural reefs, would otherwise perish before finding settlement habitat (Emery et al. 2006). YOY rockfish are relatively rare at the shallowest levels of the platforms; the adults of some rockfish species inhabit the bottom under the platforms. Non-rockfish species are most abundant at shallower levels (Nishimoto and Love 2011). Survivorship of juvenile rockfish may be enhanced around the midwater structure of the platforms, as it provides habitat away from predators that utilize nearshore reefs (Love and Schroeder 2006). Love et al. (2007) determined that blue rockfish living around the platforms did as well as those living on natural reefs; which implies that some platforms may benefit regional fish populations. Lowe et al. (2009) noted that many reef-associated rockfishes shift to deeper water as they develop, thus shallower platforms export fishes faster than deeper platforms. Groundfish navigate between platforms and natural reef habitats, and platform habitat may be of higher quality to some individuals than natural reefs (Lowe et al. 2009).

9.2 Essential Fish Habitat and Managed Species

The Pacific Fishery Management Council (PFMC) was established by the Magnuson Fishery Conservation and Management Act of 1976 (FCMA) to manage fisheries resources in the Pacific exclusive economic zone (EEZ). The Act requires regional fishery management councils, with assistance from the NMFS, to delineate EFH in Fishery Management Plans (FMPs) or FMP amendments for all federally managed fisheries. An EFH is defined as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity (*Federal Register* 2002).

In addition to designating EFH, the NMFS requires fishery management councils to identify habitat areas of particular concern (HAPCs), which are discrete subsets of EFH. Councils may designate a HAPC based on (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; or (4) the rarity of the habitat type. Although a HAPC designation does not confer additional protection for or restrictions on an area, it can help prioritize conservation efforts.

The PFMC has designated EFH for four fishery management groups in the Pacific region: Pacific Coast groundfish, highly migratory species, coastal pelagic species, and Pacific coast salmon (Table 9-1). The Pacific Coast Groundfish Fishery Management Plan identifies EFH for flatfish, rockfish, roundfish, and sharks and rays (PFMC 2016a). A 2018 status report prepared by the NMFS (NMFS 2018a) reported that all the groundfish stocks within the California Current Ecosystem were above biomass limit reference values and that no groundfish species were presently considered overfished. At the time of the report, two groundfish species (yelloweye rockfish, and cowcod) were still rebuilding toward target biomass values while three previously overfished species (bocaccio, dark blotched rockfish, and Pacific Ocean perch) were declared rebuilt in 2017 (NMFS 2018a).

Habitat suitability models are used to identify EFH that would be suitable for as many managed groundfish species as possible based on their surveyed distribution. The EFH identified covers all of the waters within the vicinity of the POCS platforms (Figure 9-1) and includes all waters and substrate within depths less than or equal to 3,500 m, as well as the upriver extent of saltwater intrusion, and seamounts in depths greater than 3,500 m as mapped in the EFH assessment geographic information system (GIS).

The Pacific Coast Groundfish Management Plan also identified a variety of habitats as HAPCs for groundfish, including estuaries, canopy kelp, seagrass, rocky reefs and “areas of interest,” which in Southern California includes the San Juan Seamount, the Channel Islands National Marine Sanctuary, and the Cowcod Conservation Area (Table 9-2) (PFMC 2016a). The oil and gas platforms may serve important EFH functions that enhance the survivorship of juvenile rockfishes (Emery et al. 2006; Nishimoto and Love 2011).

The Coastal Pelagic Species Fishery Management Plan identified EFH for four finfish species (Pacific sardine, Pacific mackerel, northern anchovy, and jack mackerel), market squid, and all euphausiid (krill) species that occur in the West Coast EEZ that are key food sources for higher trophic levels (PFMC 2018a) (Table 9-1). The combined EFH for these species covers the “marine and estuarine waters from the shoreline along the coasts of California offshore to the limits of the California EEZ and above the thermocline where sea surface temperatures range between 10 C to 26 C.” (PFMC 2018a) (Figure 9-2). The EFH designation for all species of krill extends the length of the West Coast from the shoreline to the 1,000 m isobath and to a depth of 400 meters. No HAPC have been designated for coastal pelagics (PFMC 2018a; Table 9-2).

TABLE 9-1 Fishery Management Plans with Designated Essential Fish Habitat

Management Plan	Number of Species with EFH	Representative Species
Pacific Groundfish Fishery Management Plan	87	61 species of rockfish 12 species of flatfish 4 species of sharks and rays 6 species of roundfish
Coastal Pelagic Species Fishery Management Plan	8+	Pacific sardine Northern anchovy Jack mackerel Pacific mackerel Market squid species Several species of krill
Highly Migratory Species Fishery Management Plan	11	5 species of tuna 3 species of shark Striped marlin Swordfish Dorado
Pacific Coast Salmon Fishery Management Plan	3	3 species of salmon

Source: PFMC (2016a,b, c, and d)

Highly migratory species are defined by their pelagic habitat orientation and the large geographic extent of their migrations. The Highly Migratory Species Fishery Management Plan identified EFH for several species of tuna and oceanic sharks, as well as for Dorado (*Coryphaena hippurus*), swordfish (*Xiphias gladius*), and striped marlin (*Tetrapturus audax*) (PFMC 2018b). A 2016 stock assessment indicated that bigeye tuna and Pacific bluefin tuna are overfished (NOAA 2016b). EFH designation varies by species, but in total, it covers all offshore waters of Southern California (Figure 9-3). No HAPCs have been designated for highly migratory species (PFMC 2018a) (Table 9-2).

The Pacific Coast Salmon Fishery Management Plan designates EFH for three salmonid species (Table 9-1). The EFH includes estuarine and marine areas from the extreme high tide line in nearshore and tidal submerged environments within State territorial waters out to the full extent of the exclusive economic zone (200 nautical mi or 370 km) offshore of Washington, Oregon, and California north of Point Conception (PFMC 2016b). Although they have not been mapped, the PFMC also designated five HAPCs for the salmonids: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine submerged aquatic vegetation (PFMC 2016b) (Table 9-2). Estuaries and submerged aquatic vegetation are the primary HAPCs in the project area. The inland extent of the estuary HAPC is the high water tidal level along the shoreline or the upriver extent of saltwater intrusion (defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand (ppt) during the period of average annual low flow). The seaward extent is an imaginary line closing the mouth of a river, bay, or sound; and to the seaward limit of wetland emergents, shrubs, or trees occurring beyond the lines closing rivers, bays, or sounds.

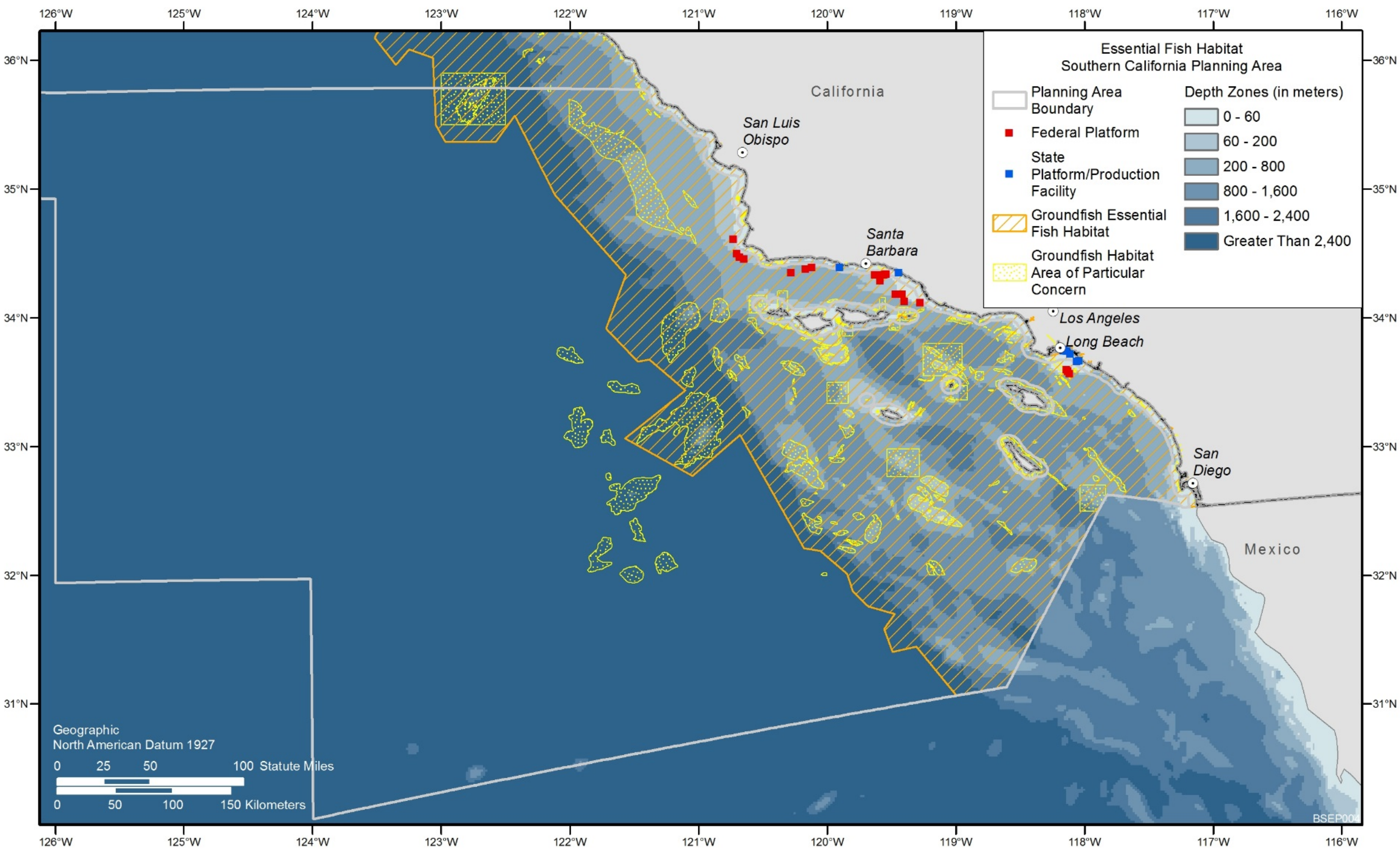

FIGURE 9-1 Groundfish EFH (including EFH-HAPC) Designated by the PFMC and NMFS (Source: NOAA 2018)

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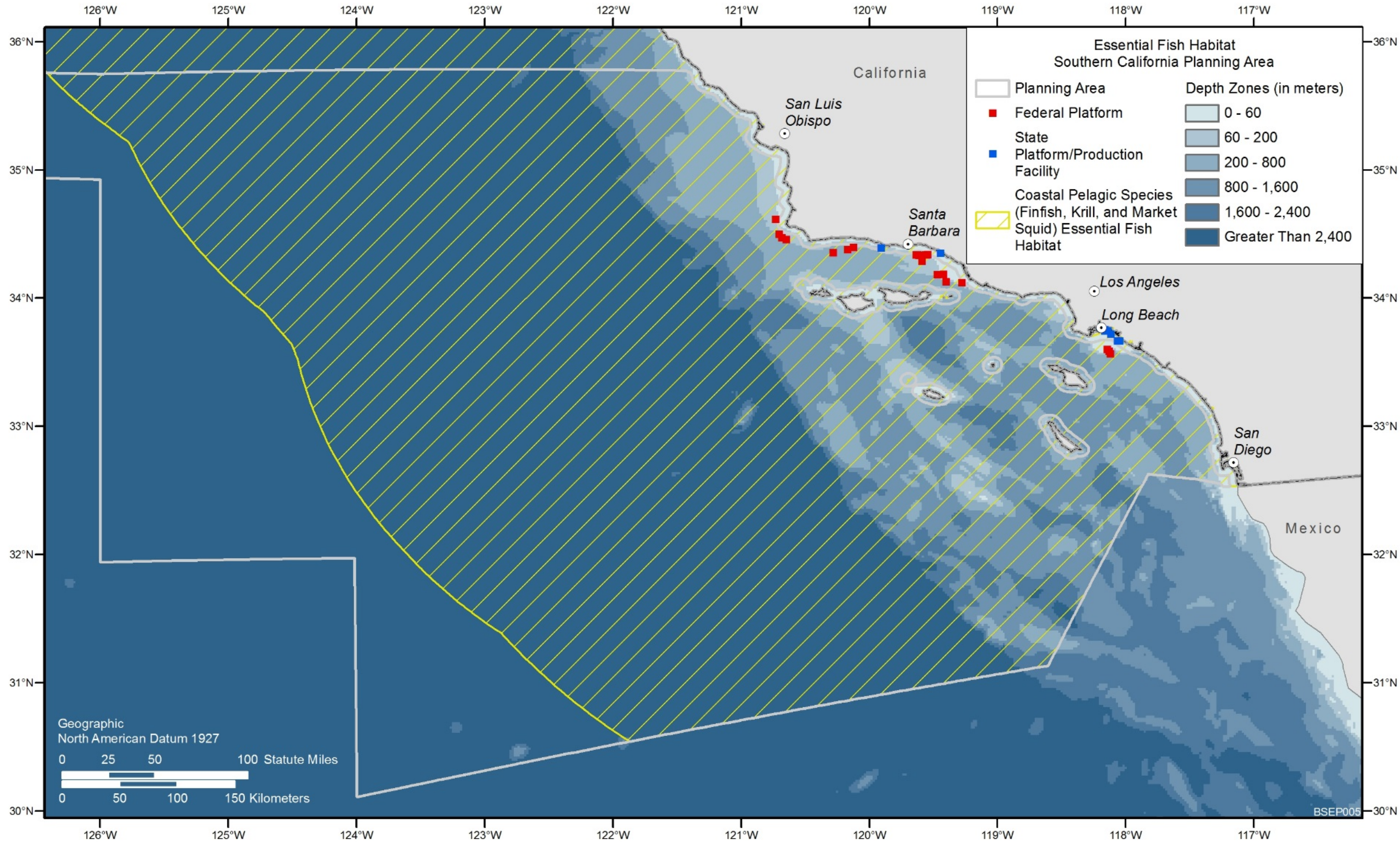

FIGURE 9-2 EFH for Coastal Pelagic Managed Species as Designated by the PFMC and NMFS (Source: NOAA 2018)

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Environmental Setting of the Southern California OCS Planning Area t
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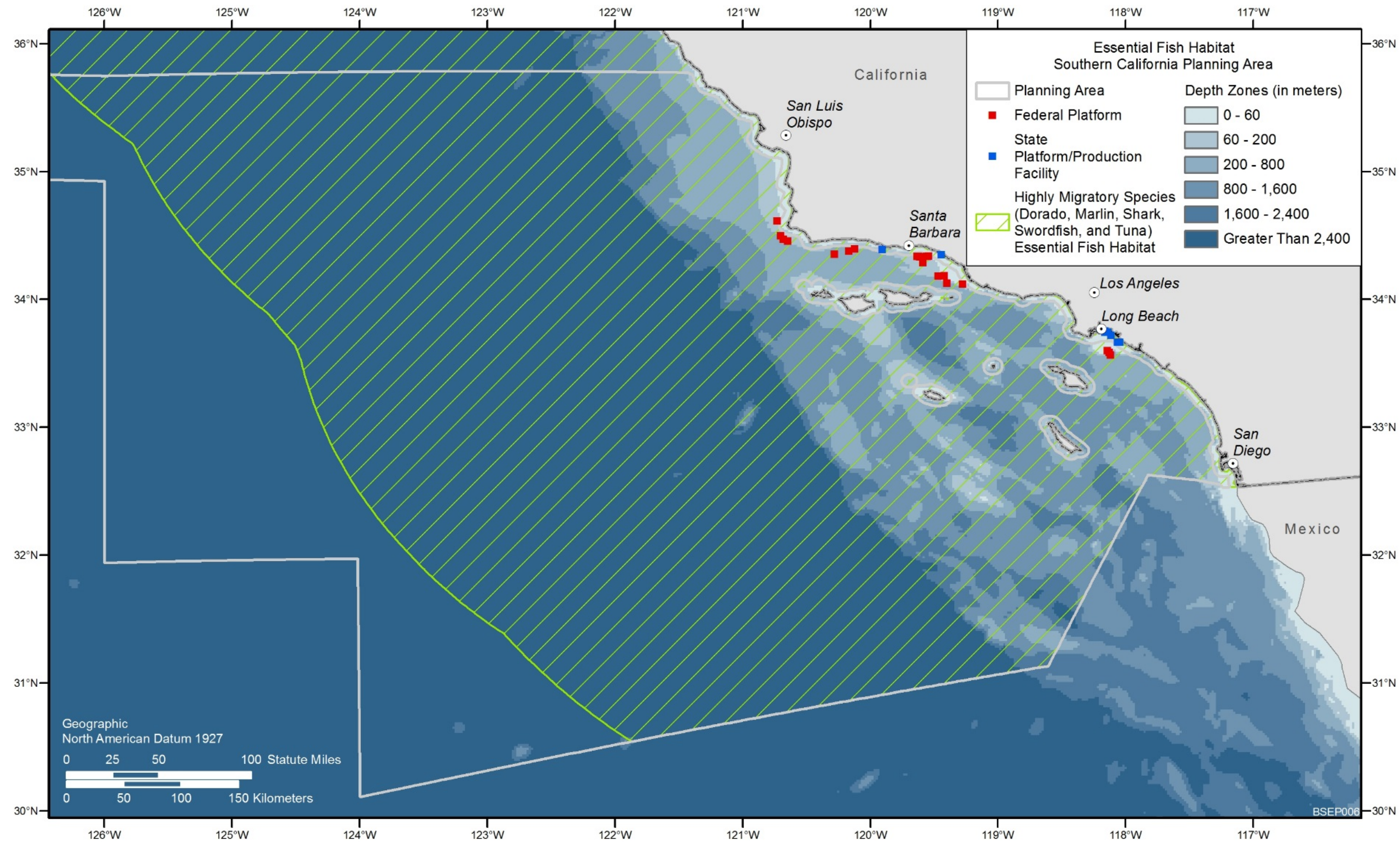

FIGURE 9-3 EFH for Highly Migratory Managed Species as Designated by the PFMC and NMFS (Source: NOAA 2018)

This HAPC also includes estuary-influenced offshore areas of continuously diluted seawater. The highly productive kelps and eelgrass that constitutes submerged aquatic vegetation provides habitat and food for managed salmon (PFMC 2016b).

TABLE 9-2 Species Management Groups and Habitat Areas of Particular Concern (HAPC) Designated by the Pacific Fisheries Management Council

Species Management Group	HAPC
Pacific Coast Groundfish	Estuaries, canopy kelp, seagrass, and rocky reef Areas of interest—San Juan Seamount; the Channel Islands National Marine Sanctuary; Cowcod Conservation Area
Pacific Coast Salmon	Complex channels and floodplain habitats Thermal refugia Spawning habitat Estuaries Marine and estuarine submerged aquatic vegetation.
Coastal Pelagic Species	There are no HAPCs designated at this time
Highly Migratory Species	There are no HAPCs designated at this time

Source: PFMC (2016a,b; 2018a,b)

9.3 Threatened and Endangered Fish Species

Several species of fish occurring in the coastal and marine habitats of Southern California are listed as threatened or endangered under the ESA. These species are the green sturgeon (*Acipenser medirostris*), the steelhead (*Oncorhynchus mykiss*), the scalloped hammerhead shark (*Sphyrna lewini*), and the tidewater goby (*Eucyclogobius newberryi*).

Green Sturgeon. The green sturgeon inhabits nearshore marine waters from Mexico to the Bering Sea and enters bays and estuaries along the west coast of North America (Moyle et al. 1995). The NMFS determined that the green sturgeon is composed of southern and northern populations, with the southern population spawning primarily in the Sacramento River Basin, and lited tThe southern population of green sturgeon as threatened in 2006 (NMFS 2006). Although the green sturgeon was historically found along the entire coast of California, studies suggest that the southern population of green sturgeon is primarily found to the north of the Sacramento River, and the NMFS has designated no critical habitat south of Monterey Bay (NMFS 2009, 2018b).

Steelhead. As diadromous fish, adult steelhead migrate to freshwater areas to spawn and the resulting young fish travel back downstream and eventually enter marine waters to mature.

NMFS has identified 10 distinct evolutionarily significant units (ESUs)[10] of steelhead, of which two are listed as endangered and eight are listed as threatened (NMFS 1999). Most of these populations are found north of Monterey Bay (Good et al. 2005) and only the Southern California Steelhead ESU (which is listed as endangered) is likely to occur in the vicinity of the OCS platforms. The geographic range of the Southern California steelhead ESU extends from the Santa Maria River basin to the U.S.–Mexico border. Major river systems with significant historical steelhead runs include the Santa Ynez, Ventura, Matilija Creek, and Santa Clara (Good et al. 2005).

The Southern California Steelhead (SCS) Recovery Planning Area includes seasonally accessible coastal watersheds and the upstream portions of watersheds that were historically used by steelhead, including in its north the Santa Maria, Santa Ynez, Ventura, and Santa Clara Rivers, and Malibu and Topanga Creeks. Major steelhead watersheds in the southern portion of the SCS Recovery Planning Area include the San Gabriel, Santa Margarita, San Luis Rey, San Dieguito, and Sweetwater Rivers, and San Juan and San Mateo Creeks (NMFS 2012). Critical habitat for the Southern California steelhead includes multiple rivers between the Santa Maria River and San Mateo Creek (NMFS 2005).

Scalloped Hammerhead Shark. The NMFS listed the Eastern Pacific Distinct Population Segment (DPS) of scalloped hammerhead sharks as an endangered species in 2014 (NMFS 1999). The scalloped hammerhead is found in coastal waters off the California coast, extending as far north as Point Conception (Baum et al. 2009). However, NMFS, found that there are no marine areas within the jurisdiction of the United States that meet the definition of critical habitat for the Eastern Pacific DPS (NMFS 2015).

Tidewater Goby. Although the tidewater goby historically occurred in at least 87 California coastal lagoons from San Diego County to Humboldt County, it has disappeared from most of these sites. The tidewater goby was listed as endangered in 1994 (USFWS 1994), but recently the U.S. Fish and Wildlife Service (USFWS) has proposed to reclassify this species as threatened (USFWS 2014).

The tidewater goby is found only in California, where it is restricted primarily to brackish waters of coastal wetlands, brackish shallow lagoons, and lower stream reaches larger than 2.5 ac where the water is fairly still but not stagnant (Lafferty et al. 1999). This goby is tolerant of a wide range of salinities and may be found in ocean water following flushing events that follow major rain events. As of February 6, 2013, a number of estuarine rivers and lagoons in San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties have been designated as Critical Habitat USFWS 2013).

[10] An evolutionary significant unit (ESU) is a population of organisms considered distinct for conservation purposes. To be considered an ESU, the population must be reproductively isolated from other populations of the same species, and must represent an important component of the evolutionary legacy of the species (NMFS 2002).

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10 SEA TURTLES

This chapter discusses the four sea turtle species that occur in the Southern California OCS Planning Area, all of which are listed under the ESA. Two species are federally endangered: leatherback sea turtle (*Dermochelys coriacea*) and loggerhead sea turtle (North Pacific Ocean Distinct Population Segment [DPS]) (*Caretta caretta*); and two species are federally threatened: the green sea turtle (*Chelonia mydas*) (East Pacific DPS) and olive ridley sea turtle (*Lepidochelys olivacea*). No known nesting habitat for any of these turtles occurs in the project area. Threats to sea turtles include incidental capture, entanglement, and injury/death from fishing gear; marine debris; environmental contamination; disease, loss, or degradation of nesting habitat; beach armoring; artificial lighting; non-native vegetation; and directed harvest (NMFS 2014a). Green and loggerhead sea turtles migrate to oceanic foraging grounds as hatchlings, and return to nearshore habitats as late-stage juveniles to finish their development. Olive ridley and leatherback sea turtles are thought to be oceanic developers (Kaplan et al. 2010). After a few years in the pelagic zone, small juveniles recruit to coastal foraging grounds. Adult sea turtles migrate between foraging grounds and nesting beaches (Kaplan et al. 2010).

10.1 Green Sea Turtle

The green sea turtle occurs worldwide in waters that remain above 20^{o} C during the coldest months. While the Southern California Bight is not within the breeding range of the green sea turtle, it is often seen there feeding during the summer months (Kaplan et al. 2010). It is uncommon along the California coast, but becomes more common south of San Diego (NMFS 2016a). Green sea turtles occur year-round off the Southern California coast with highest concentrations occurring duly July through September (BSEE 2011). The green sea turtle is usually seen in El Niño years when ocean temperatures are warmer than normal. It inhabits shallow waters of lagoons, bays, estuaries, mangroves, eelgrass, and seaweed beds; it prefers areas with abundant vegetation in shallow, protected water. Green sea turtles are herbivorous, feeding primarily on algae and seagrasses (NMFS 2016a).

The San Diego Bay was a foraging area for green sea turtles and a few green sea turtles are regularly seen in Orange County near the San Gabriel River. At least 100 green sea turtles resided in San Diego Bay, benefitting from warm water effluent associated with the South Bay Power Plant. This plant ceased operations on January 1, 2011 eliminating the warm water effluent altogether (Nafis 2018). Similarly, a Long Beach power plant warms the waters of the San Gabriel River (Sahagun 2008), and a small colony of green sea turtles now resides there (Nafis 2018). This colony is inshore from the San Pedro Bay Platforms.

10.2 Leatherback Sea Turtle

Leatherbacks may be the most common species of sea turtle in the Southern California OCS Planning Area but they continue to be rarely seen. About 150 to 170 leatherback sea turtles occur annually off the California coast between Point Conception and Point Arena during the summer and fall. They are typically observed in deeper waters over the continental slope (PXP 2012b). While mostly pelagic, the leatherback sea turtle occasionally enters shallower waters of bays and estuaries (NMFS 2016b). It is the most common sea turtle in U.S. waters north of Mexico. They tend to arrive in California waters in June and stay until mid-October when they move to waters off Hawaii. Diet is primarily jellyfish, but they also consume other invertebrates, small fish, and plant material (NMFS 2016a: Nafis 2018).

Designated critical habitat for leatherback sea turtles was revised to include the waters offshore Washington state and portions of the Oregon and California coast (NMFS 2012). These areas were recognized for their importance as leatherback foraging habitat. Occurrence of prey species, primarily jellyfish, is the only primary constituent element identified for leatherback critical habitat. In California, critical habitat extends from Point Arena to Point Arguello, inshore of the 3000-m depth contour. This area overlaps the northern edge of the Southern California Planning Area in the area of the Santa Maria Basin platforms. Locations where leatherback sea turtle have been observed in Southern California ranges from San Luis Obispo County south to San Diego County (Nafis 2018) which encompasses the region of the Santa Maria Basin, Santa Barbara Channel-West, and Santa Barbara Channel-East Platforms.

10.3 Loggerhead Sea Turtle

The loggerhead sea turtles is considered a rare visitor to Southern California waters. The species was originally listed as threatened in (NMFS and USFWS 1978). The listing designation for the loggerhead sea turtle has since been split into nine distinct population segments (NMFS and USFWS 2011). Loggerhead sea turtles that may be found in Southern California are presumed to be members of the North Pacific Ocean DPS, which is listed as endangered. The loggerhead sea turtle occurs worldwide in subtropical to temperate waters, generally in waters over the continental shelf. Within the North Pacific, loggerhead sea turtle nesting has only been documented in Japan with juveniles and adults traveling around the Pacific, north of the equator, to forage [(NMFS and USFWS 2011). Important foraging areas have been identified off the coast of Baja Sur, Mexico but none are apparent in Southern California although loggerheads may move up the Pacific coast during El Niño events following pelagic red crabs, a preferred prey species (NMFS and USFWS 2011).

In the eastern Pacific, loggerhead sea turtles are reported from Chile to Alaska. They are occasionally sited from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California. The most important development habitats for juveniles along the eastern Pacific are off the west coast of Mexico, including the Baja Peninsula. The only known nesting areas in the North Pacific are found in southern Japan (NMFS 2017). Sightings in California tend to occur from July to September but can occur over most of the year during El Niño years when ocean temperatures rise. The loggerhead sea turtle is primarily pelagic, but occasionally enters coastal bays, lagoons, salt marshes, estuaries, creeks, and mouths of large rivers (Nafis 2018). Loggerhead sea turtles consume whelks and conchs, but also sponges, crustaceans, jellyfish, worms, squid, barnacles, fish, and plants (NMFS 2017; Nafis 2018). Loggerhead sea turtles have been observed at scattered locations from Point Conception to the U.S./Mexico border (Nafis 2018). Therefore, the potential exists for individuals to be observed in the area of any of the OCS platforms.

10.4 Olive Ridley Sea Turtle

The olive ridley sea turtle occurs worldwide in tropical to warm temperate waters. In the Eastern Pacific, they normally range from Southern California to Chile but individuals have been documented as far north as Alaska. It is considered the most abundant sea turtle in the world, with an estimated 800,000 nesting females annually (NMFS 2014b). The olive ridley sea turtle rarely occurs along the California coast. Locations in the Southern California OCS Planning Area where it has been spotted include off Point Sal and Point Conception (CaliforniaHerps 2018). These observations are in the region of the Santa Maria Basin and Santa Barbara Channel-West Platforms. Olive ridley sea turtles are highly migratory and spend much of their non-breeding life cycle in the oceanic zone (NMFS and USFWS 2014), but are known to inhabit coastal areas (e.g., bays, estuaries) (NMFS 2014b. Olive ridley sea turtles are omnivorous and consume mollusks, crustaceans, jellyfish, sea urchins, fish, and occasional plant material (e.g., algae, seagrass) (NMFS 2014c; Nafis 2018). They dive to depths up to 500 ft (150 m) to forage on benthic invertebrates (NMFS 2014b).

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11 MARINE AND COASTAL BIRDS

This chapter describes the marine and coastal birds of the Southern California Planning Area and the five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). The following sections discuss the major categories of birds (e.g., seabirds, shorebirds) and their habitats, and the bird species of concern (e.g., California and ESA-listed species) that occur in the Southern California Planning Area and adjacent waters and coastal areas.

Southern California supports a diverse assemblage of birds. For example, 422 species are recorded from the Channel Islands (Collins and Jones, 2015). The Channel Islands provide essential nesting and feeding grounds for 99% of the breeding seabirds in Southern California and important wintering areas and stopover points for shorebirds (NPS 2017). Several of the species are listed as threatened or endangered under the ESA. The Bald Eagle (*Haliaeetus leucocephalus*) was delisted in 2007, but is afforded protection under the Bald and Golden Eagle Protection Act. Prior to delisting, Bald Eagles were successfully introduced into the project area. Nesting occurs on several of the Channel Islands (e.g., Santa Catalina, Santa Cruz, and Anacapa Islands) (Newsome et al., 2015).

A number of bird species breed along the Southern California coast, while others are non-breeding summer residents, winter residents, or migrants. Open waters of the planning are host a variety of seabirds and waterfowl, while shorebirds and wading birds occur in suitable coastal habitats (e.g., beaches). Waterfowl and wading birds may be found in coastal wetlands and estuaries. Even the developed harbor complexes contain a diverse avifauna. For example, over 500 bird species have been reported from Los Angeles County (eBird 2019a), including federally ESA-listed species such as California Least Tern (*Sternula antillarum browni*) and Western Snowy Plover (*Charadrius nivosus nivosus*) from the Los Angeles and Long Beach harbor complex (Aspen Environmental Group 2005). A listing of the coastal and marine bird species that occur along the Southern California coast and offshore areas are provided by NMSP (2008), Collins and Jones (2015), SAIC (2011b), and PXP (2012).

11.1 Seabirds

Mason et al. (2007) identified 54 seabird species during at-sea surveys between Cambria, California, and the Mexican border, which encompasses the area of the OCS platforms. Seabird densities averaged 33.7 birds/km^2 (range of 0.0 to 12,244 seabirds/km^2) throughout the surveyed area. Average densities were 11.3 seabirds/km^2 for at-sea transects and 70.9 seabirds/km^2 for coastal transects. Highest at-sea densities were near the Channel Islands in January and north of Point Conception in May, with lowest densities in the southwestern portion of the Southern California Bight in all survey months (Mason et al. 2007). Species from the area for which recent dramatic decreases have been reported include the Common Murre (*Uria aalge*), Sooty Shearwater (*Puffinus griseus*), and Bonaparte's Gull (*Larus philadelphia*) (Mason et al. 2007).

Some seabird species occupy relatively shallow waters close to shore. Common nearshore species include the Common (*Gavia immer*), Pacific (*G. pacifica*), and Red-throated (*G. stellata*) Loons; the Western Grebe (*Aechmophorus occidentalis*); and the Surf Scoter

(*Melanitta perspicillata*) (Mason et al. 2007). Nearshore species are most numerous in winter months, with relatively few remaining during the summer (MMS 2001).

Pelagic seabirds generally occur over deeper offshore waters compared with nearshore species. Common pelagic species off Southern California include the Northern Fulmar (*Fulmarus glacialis*), Sooty Shearwater, Black-vented Shearwater (*Puffinus opisthomelas*), Pink-footed Shearwater (*P. creatopus*), Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Brown Pelican (*Pelecanus occidentalis*), cormorants (*Phalacrocorax* spp.), Red Phalarope (*Phalaropus fulicaria*), Red-necked Phalarope (*P. lobatus*), and the Common Murre (Mason et al. 2007). Although pelagic species are generally present throughout the year, their abundance varies seasonally. For example, the Sooty Shearwater and Pink-footed Shearwater are most abundant during summer months (although they do not breed in Southern California) (Mason et al. 2007).

Common gulls and terns in the area include the California Gull (*Larus californicus*), Ring-billed Gull (*L. delawarensis*), Heermann's Gull (*L. heermanni*), Bonaparte's Gull, Western Gull (*L*. occidentalis), and Royal Tern (*Thalasseus maximus*). Densities of the gulls and terns tend to be highest along the mainland and Channel Island coasts and within the Santa Barbara Channel (Mason et al. 2007).

The migratory flyways for most seabirds are located farther offshore than the nearshore coastal region within which the OCS platforms are located. Spring coastal seabird migration typically begins in late February, with peak movement occurring between late March and early May. Fall movements of coastal seabirds generally occur between October and December (Johnson et al. 2011). Pelagic migratory species are most numerous from mid-April to early June and from mid-August to mid-October (Johnson et al. 2011). In the Southern California Bight, seabirds nest on cliffs and shores of the mainland coast and the Channel Islands, with the majority of them nesting on the Channel Islands (Kaplan et al. 2010).

Twenty seabird species breed in Southern California, almost entirely on the Channel Islands (Mason et al. 2007). The Channel Islands provide essential nesting and feeding grounds for many of the seabirds in Southern California. The islands support a number of breeding seabird species including Brown Pelicans, Scripps's Murrelets (*Synthliboramphus scrippsi*), Cassin's Auklets (*Ptychoramphus aleuticus*), Western Gulls, Ashy Storm-Petrels (*Oceanodroma homochroa*), Black Storm-Petrels (*O. melania*), Brandt's Cormorants (*Phalacrocorax penicillatus*), Double-crested Cormorants (*P. auritus*), Pelagic Cormorants (*P. pelagicus*), Pigeon Guillemots (*Cepphus columba*), and Common Murres (NPS 2017a).

Sydeman et al. (2012) identified "hotspots" of seabird abundance within the California Current Ecosystem along the west coast of North America, from Vancouver Island, British Columbia, Canada, south to Punta Eugenia, Baja California, Mexico. The hotspots are areas of consistently elevated abundance for one or more seabird species, and several hotspots have been identified in the Southern California OCS Planning Area and vicinity. These hotspots and their associated species include: Santa Cruz Island (Red-necked Phalarope and Scripps's and/or Guadalupe Murrelets [*Synthliboramphus scrippsi* and/or *S. hypoleucus*]), Santa Cruz Basin (Pink-footed Shearwater and Western Gull), San Miguel Island (Brandt's Cormorant, Pink-footed Shearwater, and Sooty Shearwater), Anacapa Island (Brown Pelican and Cassin's Auklet), Santa Barbara Island (Western Gull), Santa Barbara Basin (Brown Pelican and Western Gull), and Santa Rosa/Cortes Ridge (Sooty Shearwater). Other hotspots identified within the general area of the OCS platforms from San Luis Obispo County to Orange County include: Piedras Blancas (Sooty Shearwater), Point Sal (two locations) (Brant's Cormorant and Pink-footed Shearwater), Point Conception (Ashy Storm-Petrel and Pink-footed Shearwater), Santa Monica Basin (Brown Pelican), Santa Monica Basin (Black-vented Shearwater), Bolsa Bay (California Gull), and Palos Verdes/Bolsa Chica (Elegant Tern) (Sydeman et al. 2012). For many seabirds, the region off Point Conception is a particularly important foraging area due to sustained primary production resulting from seasonal upwelling (SAIC 2011).

Johnson et al. (2011) observed several seabird species (e.g., Brown Pelicans, Brandt's Cormorants, and Western Gulls) to habitually use the substructure of platforms for nighttime roosting. This association had more to do with the availability of appropriate structures to facilitate roosting rather than the lighting on the platforms (Johnson et al. 2011).

11.2 Shorebirds

While more than 40 shorebird species are recorded from central and Southern California, less than 25 species occur regularly in the planning area and vicinity. Few shorebirds breed in the area; most species migrate through the area in the fall with many overwintering. Wintering birds then leave in spring when other northbound migrants are moving through to return to their northern breeding grounds. Seasonal peaks in shorebird presence occurs in the fall (primary) and spring (secondary) (PXP 2012). Most shorebirds inhabit tidal wetlands, sandy beaches, and rocky shorelines (Hickey et al. 2003). The Channel Islands are important wintering areas and stopover points for shorebirds (NPS 2017a).

Shorebird species in the area include Black-bellied Plover (*Pluvialis squatarola*), Semipalmated Plover (*Charadrius semipalmatus*), Willet (*Tringa semipalmata*), Wandering Tattler (*T. incana*), Whimbrel (*Numenius phaeopus*), Marbled Godwit (*Limosa fedoa*), Black Turnstone (*Arenaria melanocephala*), Sanderling (*Calidris alba*), Western Sandpiper (*C. mauri*), Least Sandpiper (*C. minutilla*), Spotted Sandpiper (*Actitis macularius*), Dunlin (*C. alpina*), and Long-billed Curlew (*Numenius americanus*). Shorebirds that do breed in the area include the Black Oystercatcher (*Haematopus bachmani*), Black-necked Stilt (*Himantopus mexicanus*), American Avocet (*Recurvirostra americana*), Killdeer (*Charadrius melodus*), and the federally threatened Western Snowy Plover (Arata and Pitkin 2009; Rodriguez et al. 2011). Specific areas commonly used by shorebirds include Mugu Lagoon, Santa Clara River mouth, Carpinteria Marsh, Goleta Slough, Morro Bay, Santa Maria River mouth, the Santa Ynez River mouth, Malibu Lagoon, Ballona Wetlands, and the Orange County coastal wetlands (e.g., Seal Beach, Bolsa Chica, Huntington Beach Wetlands, Santa Ana River mouth, and Upper Newport Bay) (MMS 2001; Audubon California 2018; eBird 2017.

11.3 Waterfowl, Wading Birds, and Coastal Raptors

Waterfowl (e.g., geese and ducks) and wading birds (e.g., herons, egrets, and rails) inhabit coastal and interior wetlands. Along the planning area coastline, these birds inhabit saltwater marshes such as Carpinteria Marsh, Mugu Lagoon and Morro Bay, and various river and stream mouths. About 25 species of wading birds have been reported from the coastal regions of central and Southern California. Common species include Black-crowned Night Heron (*Nycticorax nycticorax*), Green Heron (*Butorides virescens*), Snowy Egret (*Egretta thula*), Great Egret (*Ardea alba*), Great Blue Heron (*A. herodias*), Virginia Rail (*Rallus limicola*), Sora (*Porzana carolina*), and American Coot (*Fulica americana*). Approximately 40 waterfowl species also occur in the coastal areas of central and Southern California. Common waterfowl include Canada Goose (*Branta canadensis*), Gadwall (*Mareca strepera*), Mallard (*Anas platyrhynchos*), Green-winged Teal (*A. crecca*), American Wigeon (*A. americana*), Northern Pintail (*A. acuta*), Northern Shoveler (*A. clypeata*), and Cinnamon Teal (*A. cyanoptera*) (MMS 2001).

Coastal raptors prey on fish, birds, and in some cases carrion (e.g., washed up carcasses of dead dolphins). Raptor species occurring along the coast include the Bald Eagle, Peregrine Falcon (*Falco peregrinus*), Osprey (*Pandion haliaetus*), Turkey Vulture (*Cathartes aura*), Northern Harrier (*Circus hudsonius*), and Red-tailed Hawk (*Buteo jamaicensis*).

11.4 Special Status Bird Species

A number of species that occur on the Southern California OCS Planning Area and adjacent coastal areas have special status under a number of federal and/or state regulations. Table 11-1 lists the special status marine and coastal bird species within or near the planning area.

TABLE 11-1 Special Status Marine and Coastal Birds within or near the Project Area

Common Name	Scientific Name	Federal Status[a]	State Status[a]
Brant	*Branta bernicla*	BMC*	SSC
Light-footed Ridgway’s Rail	*Rallus obsoletus levipes*	E, BMC	E, FP
American Oystercatcher	*Haematopus palliatus*	BCC, BMC*	
Black Oystercatcher	*Haematopus bachmani*	BCC, BMC*	
Western Snowy Plover	*Charadrius nivosus nivosus*	T, BCC, BMC*	SSC
Mountain Plover	*Charadrius montanus*	BCC, BMC*	SSC
Whimbrel	*Numenius phaeopus*	BCC, BMC	
Long-billed Curlew	*Numenius americanus*	BCC, BMC*	WL
Marbled Godwit	*Limosa fedoa*	BCC, BMC*	
Red Knot	*Calidris canutus*	BCC, BMC*	
Short-billed Dowitcher	*Limnodromus griseus*	BCC, BMC	
Marbled Murrelet	*Brachyramphus marmoratus*	T, , BMC	E
Scripps’s Murrelet	*Synthliboramphus scrippsi*	BCC, BMC	T
Guadalupe Murrelet	*Synthliboramphus hypoleucus*	BCC, BMC	T
Cassin’s Auklet	*Ptychoramphus aleuticus*	BCC, BMC	SSC

TABLE 11-1 Special Status Marine and Coastal Birds within or near the Project Area

Common Name	Scientific Name	Federal Status[a]	State Status[a]
Rhinoceros Auklet	*Cerorhinca monocerata*	–	WL
Tufted Puffin	*Fratercula cirrhata*	–	SSC
California Gull	*Larus californicus*	–	WL
California Least Tern	*Sternula antillarum browni*	E, BMC	E
Gull-billed Tern	*Gelochelidon nilotica*	BCC, BMC*	SSC
Elegant Tern	*Thalasseus elegans*	–	WL
Black Skimmer	*Rynchops niger*	BCC, BMC	SSC
Black-footed Albatross	*Phoebastria nigripes*	BCC, BMC*	–
Short-tailed Albatross	*Phoebastria albatrus*	E, BMC	SSC
Ashy Storm-Petrel	*Oceanodroma homochroa*	BCC, BMC	SSC
Black Storm-Petrel	*Oceanodroma melania*	–	SSC
Hawaiian Petrel	*Pterodroma sandwichensis*	E, BMC	–
Pink-footed Shearwater	*Ardenna creatopus*	BCC, BMC	–
Black-vented Shearwater	*Puffinus opisthomelas*	BCC, BMC	–
Double-crested Cormorant	*Phalacrocorax auritus*	BMC	WL
Brown Pelican	*Pelecanus occidentalis*	DE	DE, FP
Reddish Egret	*Egretta rufescens*	BMC*	–

[a] Status: C = candidate; BCC = bird of conservation concern; BMC = bird of management concern, DE = delisted (formerly endangered); E = endangered; FP = fully protected; SSC = species of special concern; T = threatened; WL = watch list; * = focal species under birds of management concern, – = not listed.

Source: CDFW (2018); USFWS (2018a,b,c).

ESA Listed Bird Species. The following provides brief descriptions of species protected under the ESA that may occur in the Southern California OCS Planning Area and adjacent coastal areas.

Short-tailed Albatross. The Short-tailed Albatross (*Phoebastria albatrus*) was federally listed as endangered on July 25, 2000 (USFWS 2000). It is also a USFWS Bird of Conservation Concern (USFWS 2018c) and a State of California Species of Special Concern (CDFW 2018). It is categorized as Vulnerable on the IUCN Red List of Threatened Species (IUCN 2019). This species is a large pelagic bird with long narrow wings adapted for soaring just above the water surface. Overharvesting and habitat loss were the primary reasons for its listing; habitat loss from volcanism and storms, competition with the Black-footed Albatross for nesting habitat, fishing, ingestion of plastic debris, oil contamination, and predation by introduced mammals are among the current threats (USFWS 2000). No critical habitat has been designated for the species.

In 2013, 78 percent of the known breeding population used a single colony, Tsubamezaki, on Torishima Island off Japan. The remaining population nests on other islands surrounding Japan, primarily the Senkaku Islands. During the non-breeding season, the Short-tailed Albatross regularly ranges along the Pacific Rim from southern Japan to the Gulf of Alaska, primarily along continental shelf margins. It is rare to casual but increasing offshore from British Columbia to Southern California (Howell 2012). All recent records along the west coast have been stage 1 immatures (Howell 2012), which travel more broadly throughout the north Pacific than adults (USFWS 2014). Most individuals found off California in recent years have been during the fall and early winter, with a few records in late winter and early spring (California Birds Record Committee 2007). The diet of this species is not well studied; however, research suggests at sea during the non-breeding season that squid, crustaceans, and fish are important prey (USFWS 2000).

The global population is currently estimated to be 4,354 birds (USFWS 2014). There have been 43 records of this species off California between 1977 and 2017. Thirteen of the records have occurred off the Southern California OCS Planning Area coast, including around and beyond the Channel Islands (California Birds Record Committee 2018).

Hawaiian Petrel. The Hawaiian Petrel (*Pterodroma sandwichensis*) was federally listed as endangered on March 11, 1967 (USFWS 2011a). It is a USFWS Bird of Management Concern (USFWS 2018b), and is categorized as Vulnerable on the IUCN Red List of Threatened Species (BirdLife International 2016b). The species breeds on larger islands in the Hawaiian chain where they nest in burrows on vegetated cliffs, volcanic slopes, and lava flows. The global population is comprised of approximately 19,000 individuals which includes an estimated 4,500-5,000 breeding pairs (USFWS 2011a; Lebbin et al 2010). The species is absent from Hawaiian waters from November-April when it disperses to the eastern tropical Pacific. Individuals have been recorded off Oregon and California from April-October (Onley and Scofield 2007) with the California records occurring from April to early September. The first of California’s 66 accepted records occurred in May 1992. There are 12 records near the Southern California OCS Planning Area; one was nearshore and the other 11 were from 24 to 100 miles offshore. Hawaiian Petrels with satellite transmitters have been tracked making regular foraging excursions to areas off northern California (where they are now seen regularly from boats and repositioning cruise ships off northern California in the summer).

Light-footed Ridgway’s Rail. The Light-footed Ridgway’s Rail (*Rallus obsoletus levipes*) (formerly Light-footed Clapper Rail [*Rallus longirostris levipes*]) was federally listed as endangered on October 13, 1970 (USFWS 1970). It is also a USFWS Bird of Management Concern (USFWS 2018b) and is a State of California endangered species that is fully protected (CDFW 2018). It is categorized as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2019). A recovery plan was approved in 1979 (USFWS 1979). Habitat loss was the primary reason for ESA listing (USFWS 1985). Critical habitat is not designated for this subspecies.

The Light-footed Ridgway’s Rail inhabits coastal salt marshes from the Carpinteria Marsh in Santa Barbara County, California, south to Bahia de San Quintin, Baja California, Mexico (Zembal et al. 1989, 1998). Dense growths of cordgrass (*Spartina foliosa*) and pickleweed (*Salicornia* sp.) are conspicuous components of rail habitat, and nests are located most frequently in cordgrass. Light-footed Ridgway’s Rails construct loose nests of plant stems, either directly on the ground when in pickleweed or somewhat elevated when in cordgrass (USFWS 1985). The nests are usually located in the higher portions of the marsh. Nests are buoyant and they will float up with the tide. The laying of eggs occurs from mid-March to the end of June, but mostly from early April to early May. The incubation period is about 23 days, and young can swim soon after hatching.

Historically, Light-footed Ridgway’s Rails probably occupied most of the salt marshes in the region, but no more than 24 marshes have been occupied since about 1980 (Zembal and Hoffman 1999). In 2016, 656 pairs from the California population of Light-footed Ridgway’s Rail exhibited breeding behavior in 18 marshes (Zembal et al. 2016). This is the largest statewide breeding population detected since the counts began in 1980. It also represents the fifth successive year of the California population exceeding 500 breeding pairs (Zembal et al. 2016). The Newport subpopulation comprised nearly 31% of the state population in 2016 (Zembal et al. 2016).

In the general area of the Southern California OCS Planning Area near the existing oil and gas platforms, only two marshes are, or have the potential to be, occupied by Light-footed Ridgway’s Rails. These are Carpinteria Marsh in Santa Barbara County and Mugu Lagoon in Ventura County. The next closest occupied locations are the Seal Beach NWR, Bolsa Chica, Huntington Beach Wetlands, and Upper Newport Bay in Orange County. Carpinteria Marsh and Mugu Lagoon represent the northern extent of the subspecies range along the California coast. The Light-footed Ridgway’s Rail subpopulation at Mugu Lagoon fluctuated between 3 and 7 pairs for nearly 20 years until recent augmentations with translocated birds from Newport Bay fostered its growth. Between 2010-2014, there was an average of 18 pairs and 5 unmated males in Mugu Lagoon on Naval Base Ventura County. The increased population at this location appears to have led to an expansion of habitat use within the lagoon. In Santa Barbara County, the taxon was formerly more widespread, but the loss of habitat and other factors restricted it to the Carpinteria Salt Marsh during the latter 1900s (Lehman 2014). Approximately 20 pairs were there in the early 1980s, dropping to just one individual by 2004. None were recorded after 2004 until a single individual was heard vocalizing there in 2011.

Western Snowy Plover. The Pacific Coast population of the Western Snowy Plover was federally listed as threatened on March 5, 1993 (USFWS 1993). It is also a USFWS Bird of Conservation Concern and Management Concern (including focal species) (USFWS 2018b,c); and is a State of California Species of Special Concern (CDFW 2018). It is categorized as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2019). The primary reasons for its federal listing are loss and degradation of habitat and human disturbance. A final recovery plan was signed August 13, 2007 (USFWS 2007). Critical habitat for the species was originally designated in 1999, revised in 2005, and revised again in 2012 (USFWS 2012). The revised critical habitat for the Western Snowy Plover includes 60 units totaling 24,527 acres (9,926 ha). Designated critical habitat includes coastal beach-dune ecosystem habitat along the Pacific Coast essential to the survival and recovery of the Western Snowy Plover. Thirty-five critical habitat units occur within Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties along the coast of the Southern California Planning Area. Three of the units (two for Mugu Lagoon and one for San Nicolas Island) are exempt as they are covered under an integrated resource management plan prepared by the Navy. The remaining 20 critical habitat units total 2637 acres (1067 ha), nearly 11% of the critical habitat for the species (USFWS 2012).

The Pacific Coast DPS of the Western Snowy Plover breeds on the Pacific Coast from southern Washington to southern Baja California, Mexico. It nests in depressions in the sand above the drift zone on coastal beaches, sand spits, dune-backed beaches, sparsely vegetated dunes, beaches at creeks and river mouths, and salt pans at lagoons and estuaries (USFWS 1999). In Southern California, nests usually occur <100 m from shore in areas where there is an unobstructed route to the water (Kaplan et al. 2010). The breeding season extends from early March to late September, with birds at more southerly locations beginning to nest earlier in the season than birds at more northerly locations (USFWS 1999). In most years, the earliest nests on the California coast generally occur during the first to third week of March. Peak nesting in California occurs from mid-April to mid-June, while hatching lasts from early April through mid-August.

Western Snowy Plover chicks leave the nest within hours after hatching to search for food. Adult plovers do not feed their chicks but lead them to suitable feeding areas. The chicks reach fledging age approximately 1 month after hatching; however, broods rarely remain in the nesting area throughout this time. Plover broods may travel along the beach as far as 4 mi (6.4 km) from their natal area.

Western Snowy Plovers are primarily visual foragers. They forage for invertebrates across sandy beaches from the swash zone to the macrophyte wrack line of the dry upper beach. They also forage in dry sandy areas above the high tide, on salt flats, and along the edges of salt marshes and salt ponds (USFWS 1993).

In winter, Western Snowy Plovers occur on many of the beaches used for nesting as well as on beaches where they do not nest, in man-made salt ponds, and on estuarine sand and mud flats. The winter range is somewhat broader and may extend to Central America (Page et al. 1995). During winter, the majority of the birds occur south of Bodega Bay, California (Page et al. 1986).

The Western Snowy Plover was formerly found on quiet beaches throughout California, but it has declined in abundance and is discontinuous in its distribution. Habitat degradation caused by human disturbance, urban development, introduced beachgrass (*Ammophila* spp.), and expanding predator populations have led to declines in nesting areas and the size of breeding and wintering populations (USFWS 2007).

In the Southern California OCS Planning Area, Western Snowy Plovers breed or winter along the coasts of San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties, from San Carpoforo Creek in northern San Luis Obispo County to Border Field State Park in San Diego County. They also occur on several of the Channel Islands, including San Miguel, Santa Rosa, Santa Cruz, San Nicolas, and San Clemente Islands. From 2010 through 2014, an average of 1,100 breeding adults occurred in this area, which is 58% of breeding adults in the range of the listed population. Significant breeding areas within this stretch of coast include the Morro Bay Sandspit, Oceano Dunes State Vehicular Recreation Area, the

Guadalupe Dunes, Vandenberg Air Force Base beaches, Coal Oil Point, Ventura Beaches (McGrath, Mandalay, and Hollywood), Ormond Beach, Naval Base Ventura County, San Nicolas Island, the Bolsa Chica Ecological Reserve, and Camp Pendleton. The average number of wintering Western Snowy Plovers in this area from 2008 through 2012 was 2,463, approximately 70% of the wintering population along the California coast.

Marbled Murrelet. The Marbled Murrelet (*Brachyramphus marmoratus marmoratus*) was federally listed in 1992 as threatened within the states of Washington, Oregon, and California (USFWS 1992). It is also a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c), and the State of California lists it as endangered (CDFW 2018). It is categorized as Endangered on the IUCN Red List of Threatened Species (IUCN 2019). The main reason for its listing was a dramatic population decline resulting from loss and degradation of old-growth forest habitats that it uses for nesting. The Marbled Murrelet spends most of its life in the nearshore marine environment, but nests and roosts inland in low-elevation old growth forests, or other forests with remnant large trees. Critical Habitat for the species was designated in 1996 and revised in 2011 (USFWS 2011). In 2016, a final determination was made that the critical habitat for the Marbled Murrelet, as designated in 1996 and revised in 2011, meets the statutory definition of critical habitat under the ESA (USFWS 2016). Areas of critical habitat include old-growth forests in the northern half of California (USFWS 2016). None of the terrestrial units are south of the Santa Cruz Mountains (the southern extent of known breeding along the Pacific Coast), which is approximately 100 mi (160 km) north of the Southern California OCS Planning Area. A decline of almost 30% of the Marbled Murrelet population occurred between 2000 and 2010, coinciding with reductions in the amount of nesting habitat (Miller et al. 2012).

While the Marbled Murrelet does not nest near the planning area, individuals from the population nesting in the Santa Cruz Mountains (and perhaps from more northerly populations) do disperse to the coast and offshore waters of San Luis Obispo and Santa Barbara Counties. Marantz (1986) characterized them as a rare transient and winter visitors offshore, but possibly regular in late summer in San Luis Obispo County. Lehman (2014) described the species as a very rare late summer, fall, and winter visitor along the Santa Barbara County coast, but somewhat regular in late summer in the Point Sal/north Vandenberg Air Force Base area. The San Luis Obispo coast extending south to Point Sal in Santa Barbara County is an important wintering area for the species (Peery et al. 2008). Marbled Murrelets occur less frequently south of Point Conception; however, they are observed occasionally off Ventura, along the Malibu coastline, and in Santa Monica Bay (eBird 2019).

Marbled Murrelets forage at sea by pursuit diving in relatively shallow waters, usually between 60 and 260 ft in depth, and 1,000 to 6,500 ft from shore (Strachan et al. 1995). After the breeding season, some birds disperse and are less concentrated in nearshore coastal waters. Ainley et al. (1995) conducted ship-based surveys off central California and detected most Marbled Murrelets within 4 mi (7 km) of shore, with the largest number occurring 2 to 3 mi (3 to 5 km) offshore. They observed one individual 15 mi (24 km) offshore near the edge of the continental shelf break.

California Least Tern. The California Least Tern (*Sterna antillarum browni*) was federally listed as endangered in 1970 (USFWS 1970). The recovery plan for the species was published in 1980 (USFWS 1980) and a revised recovery plan was later published in 1985 (USFWS 1985). The USFWS also considers it a Bird of Conservation Concern (USFWS 2018c), and the State of California lists it as endangered (CDFW 2018a). This subspecies of Least Tern has not yet been categorized on the IUCN Red List of Threatened Species (IUCN 2019). The main reasons for its federal listing were loss of habitat, human disturbance, and predation. Critical habitat has not been designated. In the 5-year review of the California Least Tern, it was recommended to downlist the species to threatened (USFWS 2006). However, a proposed rule to downlist the species has not been published to date so the status of the taxa remains endangered throughout its range.

The California Least Tern is a summer visitor to California. It breeds on sandy beaches close to estuaries and embayments discontinuously along the California coast from San Francisco Bay south into Baja California. The earliest spring migrants arrive in the San Diego area after the first week in April and reach the greater San Francisco Bay area by late April (Small 1994). Nesting colonies are usually located on open expanses of sand, dirt, or dried mud, typically in areas with sparse or no vegetation. Colonies are also usually located in close proximity to a lagoon or estuary where they obtain most of the small fish the birds consume, although they may also forage up to 2 to 3 mi (3 to 5 km) offshore. Nests consist of a shallow scrape in the sand, sometimes surrounded by shell fragments. Eggs (usually two per clutch) are laid from mid-May to early August. Incubation takes 20 to 28 days, and young fledge in about 20 days (USFWS 1980). California Least Terns are fairly faithful to breeding sites and return year after year regardless of past nesting success. In the Southern California OCS Planning Area, California Least Terns breed along the coasts of San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties from Oceano Dunes in San Luis Obispo County to the Tijuana River Estuary in San Diego County. Fall migration begins the last week of July and first week of August (USFWS 2006) when it departs for its wintering grounds in Central and South America. Most individuals are gone from Southern California by mid-September.

In 1970, the California Least Tern population in California was estimated at 600 breeding pairs. Population growth rates have increased, especially since the mid-1980s, when active management was initiated at breeding colonies. Although the increase in the breeding population has not been consistent from year to year, the long-term trends have shown steady population growth. Fluctuations in the California Least Tern population are thought to be attributable to a combination of high levels of predation and low prey availability.

In the general area of the Southern California OCS Planning Area, upwards of 30 sites have been reported as used for nesting by the California Least Tern. Range-wide survey results from 2015 reported a minimum of 3,737 breeding pairs, a maximum of 4,800 breeding pairs, and 4,982 nests in this region, which was approximately 91% of the nesting population and effort that year in California. Significant breeding areas within this stretch of coastline include Oceano Dunes, Vandenberg Air Force Base, McGrath State Beach, Hollywood Beach, Ormond Beach, Point Mugu, Venice Beach, Los Angeles Harbor, Seal Beach NWR, Bolsa Chica Ecological Reserve, Huntington State Beach, Burris Basin, Upper Newport Bay, Camp Pendleton, Batiquitos Lagoon, Mission Bay, Naval Base Coronado, Sweetwater Marsh NWR, and Tijuana River Estuary.

Studies conducted at some of the larger colonies in Southern California show that at least 75% of all California Least Tern foraging activity during the breeding season occurs in the ocean (Atwood and Minsky 1983). Approximately 90 to 95% of ocean feeding occurred within 1 mi of shore in water depths of 60 ft or less. California Least Terns were rarely seen foraging at distances between 1 and 2 mi from shore and were never encountered farther than 2 mi offshore (Atwood and Minsky 1983). However, there is evidence of some migration off California that occurs as far as 20 mi (offshore or more based on observations off Southern California (Pereksta 2015). Similar observations have been reported from offshore Mexico (Howell and Engel 1993; Ryan and Kluza 1999).

Other Special Status Bird Species. In addition to the federal listed species, other special status species (e.g., USFWS Birds of Conservation Concern or Birds of Management Concern and/or State listed) may occur in the Southern California Planning Area. Birds of Conservation Concern include migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent highest conservation priorities. Birds of Conservation Concern include nongame birds, gamebirds without hunting seasons, subsistence-hunted nongame birds in Alaska; and Endangered Species Act candidate, proposed endangered or threatened, and recently delisted species (USFWS 2018c). Birds of Management Concern are species which pose special management challenges because of several factors (e.g., too few, too many, conflicts with human interests, or societal demands). Focal Species are a subset of the Birds of Management Concern that have high conservation need, are representative of a broader group of species sharing the same or similar conservation needs, act as potential unifiers for partnership, and/or have a high likelihood that factors affecting their status can be addressed (USFWS 2018b). Brief descriptions of these species follow.

Brant. The Brant is a USFWS Bird of Management Concern (including focal species) (USFWS 2018b) and a State of California Species of Special Concern (CDFW 2018a). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). In its winter range, farmers may disturb the Brant, while predation on nesting grounds and avian influenza may also threaten the species (BirdLife International 2019). Other threats include activities that perturb eelgrass, disturbance from boats and aircraft, commercial shellfish harvests, development, and dogs (Davis and Deuel 2008). The worldwide population of this small sea goose is estimated at upwards of 650,000 birds (BirdLife International 2019). During the non-breeding season, the Brant gathers in groups of a few individuals to several thousand individuals, inhabiting mostly coastal areas such as estuaries, tidal mudflats, sandy shores, coastal saltmarshes, and shallow muddy bays. It grazes on coastal cultivated grasslands and winter cereal fields. Outside the breeding season, the Brant feeds on marine algae and other aquatic plants (IUCN 2019). The Brant occurs throughout coastal Southern California (eBird 2019). The Brant occurs in California mainly from late October to late May. Small numbers remain through the summer. The entire California coastline is within the winter and migrant staging range for the Brant. It is very numerous in coastal bays during spring migration, but most are well offshore during fall migration (Davis and Deuel 2008).

American Oystercatcher. The American Oystercatcher is a USFWS Bird of Conservation Concern and Management Concern (including focal species) (USFWS 2018b,c). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). Along the Pacific coast, its primary range is from northwestern Baja California south to Panama. The American Oystercatcher is a very rare and irregular resident and visitor to California. It occurs on the Channel Islands, coastal promontories from San Luis Obispo to San Diego Counties, and the Salton Sea (CDFW 2018). Most observations in Southern California are from Point Conception south. Observations north of Point Conception are in the San Francisco area (eBird 2019). Preferred nesting locations are rocky or shell areas above the high ride. It feeds on molluscs and worms in coastal sand or shell beaches, salt marshes, and rocky islands (CDFW 2018).

Black Oystercatcher. The Black Oystercatcher is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c). It is not included on the IUCN Red List of Threatened Species (IUCN 2019). The species is highly susceptible to human disturbance. Gulls prey on eggs and chicks. Storm waves may destroy some nests. Oil spills can affect food supplies. The Black Oystercatcher has been observed throughout coastal Southern California, including the Channel Islands (eBird 2019). It is a permanent resident on rocky shores of marine habitats along most of the California coast and adjacent islands. The Black Oystercatcher is uncommon to fairly common locally on the Channel Islands and central and northern California. It is rare on the mainland coast south of Pt. Conception. It mainly consumes invertebrates of rocky intertidal areas, especially mussels and limpets. During high tide, it roosts on cliffs, rock outcrops, offshore rocky islets, and jetties. Breeding occurs on undisturbed rocky, open ocean shore. Nests are slight depressions on a rock ledge just above the high tide or splash zone (CDFW 2018).

Mountain Plover. The Mountain Plover is a USFWS Bird of Conservation Concern and Management Concern (including focal species) (USFWS 2018b,c), and a State of California Species of Special Concern (CDFW 2018). It is categorized as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2019). The Mountain Plover continues to decline in numbers due to habitat loss and degradation from cultivation, urbanization, over-grazing, and changes in native herbivore populations. Other threats include hunting and mining. It breeds in parts of Canada and the central United States as far south as New Mexico and Oklahoma. It winters from Sacramento south to Baja California, Mexico, and irregularly in south Arizona and south Texas. The overall population is estimated at upwards of 20,000 birds. It flocks in winter and during migration. In winter, the Mountain Plover inhabits semi-desert land and dry, bare agricultural land (IUCN 2019). The Mountain Plover is strongly associated with short-grass prairie habitats or equivalent. It is primarily insectivorous (Hunting and Edson 2008). The Mountain Plover has been observed at scattered inland and coastal locations throughout Southern California (eBird 2019). Hunting and Edson (2008) stated that the Mountain Plover was extirpated from the Channel Islands. Along the Southern California coast, there are a few recent winter sitings (e.g., at Vandenberg Air Force Base and the Isla Vista area in Santa Barbara County and at Seal Beach National Wildlife Refuge in Orange County (eBird 2019).

Whimbrel. The Whimbrel is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). The global population is estimated at upwards of 2.3 million individuals. The Whimbrel is migratory and does not breed in California. Fall migration starts in July with spring migration mainly occurring between March and May. During migration, the Whimbrel frequents wetlands, tidal flats, wet and dry grasslands, and heathland. It generally inhabits coastal habitats in winter, including muddy, rocky, or sandy beaches; coral shores; exposed reefs; tidal mudflats; sand flats; and lagoons. While on the coast, it preys on crustaceans, molluscs, and polychaete worms. It will also eat fish, reptiles, and young birds. The Whimbrel is susceptible to avian influenza (IUCN 2019).The Whimbrel has been observed throughout Southern California with highest concentrations along the coast (eBird 2019).

Long-billed Curlew. The Long-billed Curlew is a USFWS Bird of Conservation Concern and Management Concern (including focal species) (USFWS 2018b,c) and is on the State of California Watch List (CDFW 2018). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). Major threats include sea-level rise that may reduce intertidal wintering habitat and, more importantly, loss and conversion of short grass prairie breeding habitat to agricultural lands. It was once an abundant breeder in the prairie regions of the United States, but populations have declined from over-hunting and habitat loss. It no longer breeds in a number of Midwestern states, Manitoba, and southeastern Saskatchewan. It winters in the southern United States, Mexico, and Central America. Breeding habitat is short-grass or mixed-grass native prairies, varying from moist meadows to arid grasslands. Winter habitat includes intertidal habitats and dry grasslands, and it will feed in adjacent pastures during this time (IUCN 2019). The Long-billed Curlew has been observed throughout Southern California (eBird 2019).

Marbled Godwit. The Marbled Godwit is a USFWS Bird of Conservation Concern and Management Concern (including focal species) (USFWS 2018b,c). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). The major threat to the species is conversion of breeding habitat to agricultural lands. The Marbled Godwit is a common to abundant migrant and winter visitor to estuarine habitats throughout California (mid-August to early May). It is most common on mudflats, but also sandy beaches, open shores, saline emergent wetlands, and adjacent wet upland fields. Some non-breeders remain along the coast throughout the summer. It forages on wet mud or sand for invertebrate such as snails, clams, crabs, amphipods, and worms (CDFW 2018). The Marbled Godwit has been observed throughout Southern California with highest concentrations along the coast (eBird 2019).

Red Knot. The subspecies of Red Knot that occurs in the western U.S. is *Calidris canutus roselaari*. It is a USFWS Bird of Conservation Concern and Management Concern (including a focal species) (USFWS 2018b,c). It is categorized as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2019). Major threats to the species include habitat loss, over exploitation of shellfish, damming, dredging, pollution, aquaculture, oil exploration, renewable energy development, invasion of mudflats by Spartina, recreational activities, aircraft, illegal hunting, fish traps, avian influenza, and climate change. The Red Knot breeds from Alaska, across the Arctic to Greenland, and northern Russia; while it winters on the Atlantic and Pacific coasts of North and South America, northwestern Europe, west coast of Africa, across southern Asia, and around Australia. The global population is just shy of one million birds. Outside of the breeding season, the Red Knot is strictly coastal. It frequents tidal mudflats or sandflats, sandy beaches of sheltered coasts, rocky shelves, bays, lagoons and harbors, and, occasionally oceanic beaches and salt marshes. During this period, it consumes intertidal invertebrates (IUCN 2019). The Red Knot has been observed at coastal areas throughout Southern California (eBird 2019).

Short-billed Dowitcher. The Short-billed Dowitcher is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). The Short-billed Dowitcher is common to abundant during migration along the entire California coast (late March to mid-May and mid-July to October), but is a rare migrant on the Channel Islands. It typically inhabits intertidal mudflats. It is rare to uncommon along the southern coast in winter. Some individuals remain in California during the summer. It breeds in the subarctic regions of southern Alaska and central Canada. The Short-billed Dowitcher forages on soft mud substrates mostly for small molluscs, crustaceans, marine worms, and some vegetative material. It requires undisturbed areas above the high tide for roosting (CDFW 2018). The Short-billed Dowitcher has been observed throughout Southern California (eBird 2019).

Scripps's and Guadalupe Murrelets. The Scripps's Murrelet and Guadalupe Murrelet are listed as threatened species by the State of California (CDFW 2018) and as USFWS Birds of Conservation Concern and Management Concern (USFWS 2018b,c). The Scripps's Murrelet is categorized as Vulnerable while the Guadalupe Murrelet is categorized as Endangered on the IUCN Red List of Threatened Species (IUCN 2019). These species were formerly considered one species, the Xantus's Murrelet (*Synthliboramphus hypoleucus*), until the taxonomic revision by the American Ornithologists' Union (2012). Past and ongoing threats to the species include invasive mammalian predators, nest-site disturbance, fishing nets, bright lights used by the squid fishery, and organochlorine pollution (IUCN 2019). The breeding range of these species is restricted to 12 nesting islands or groups of islands over a distance of 500 mi (800 km) in Southern California and Baja, Mexico (Pacific Seabird Group 2002). The estimated global population of Scripps's Murrelet is 15,000 to 30,000 birds and for the Guadalupe Murrelet is 7,500 birds. During the breeding season, they concentrate in or near the breeding colonies on the Channel Islands and off the coast of northern Baja California. The two species typically nest in crevices, caves, under large rocks, on steep cliffs and canyons of offshore islands. The nesting period extends from February through July but may vary depending on food supplies (IUCN 2019).

These murrelet species occur off Southern California at different times of the year. The northern breeding Scripps's Murrelet occurs primarily from January to September, with a peak of abundance between late February and July. Within the United States, this species breeds on San Miguel, Santa Cruz, Anacapa, Santa Barbara, and San Clemente Islands (IUCN 2019). The Guadalupe Murrelet is known to breed on Guadalupe and San Benito Islands off the Pacific coast of Baja California (Schulenberg 2018). Within the United States, breeding is unconfirmed on San Clemente and Santa Barbara Islands (IUCN 2019). It occurs off Southern California from July to December.

During the breeding season, Scripps's Murrelets are generally concentrated in the Southern California Bight. Their distribution at sea during this time varies based on conditions in the marine environment. Whitworth et al. (2000) tracked Scripps's Murrelets nesting on Santa Barbara Island and found that they were dispersing to forage in cool upwelling areas averaging 39 mi (62 km) from the island in 1996 and 69 mi (111 km) in 1997. Briggs et al. (1987) observed bird concentrations around Santa Barbara Island and off San Diego in the breeding months (March to May), with birds off San Diego presumably from the nearby Coronado Islands. The greatest densities were near Santa Barbara and Anacapa Islands and north of Point Conception along the coast. The Channel Islands provide nesting habitat for 34 percent of the world's Scripps's Murrelets (Hamer et al. 2014).

The pelagic distributions of both species overlap during the post-breeding dispersal in late summer and autumn, when both move primarily northward (Whitworth et al. 2000). At this time of year, they occur from southern Baja California to Vancouver Island, British Columbia, with the bulk between central Oregon and central Baja California, Mexico. Karnovsky et al. 2005) found the murrelets (reported as Xantus's Murrelets) on open waters with depths ranging from 85 to 15,000 ft. The highest densities occurred over the upper continental slope over water depths ranging from 650 to 3,280 ft. Densities were moderately high on the outer slope at depths ranging from 3,280 to 9,840 ft, but were low over pelagic waters with depths greater than 9,800 ft (depths > 9,840 ft or 3,000 m), as well as over the continental shelf with depths of 650 ft. The distance from the mainland ranged from just over 1 mi to 156 mi, with highest densities occurring at distances of 16 to 93 mi from shore. In central California waters, the murrelets were associated with high sea surface temperature, low salinity, and a shallow but highly stratified thermocline.

Cassin's Auklet. Cassin's Auklet is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c) and a State of California Species of Special Concern (CDFW 2018). It is categorized as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2019). Major threats are introduced predators and grazing animals such as goats. Oil pollution is also a serious threat, as are lights from oil and gas extraction operations and vessels. Other threats include bycatch in fishing nets, loss of habitat and disturbance from tourism development, and climate change. It ranges from Baja California, Mexico up the Pacific coast to the Aleutian Islands. Over 130,000 birds occur in California, with a total species population estimate of 5.4 million individuals (IUCN 2019). It occurs offshore and along seacoasts, mostly over the continental shelf to the edge, but also beyond into the deep ocean. Its major prey is crustaceans supplemented by other invertebrates and larval fish (IUCN 2019). The Cassin's Auklet nests locally on islands along the entire length of California, including the smaller islands associated with the Channel Islands (Adams 2008). It winters mainly offshore within the breeding range (IUCN 2019). Cassin's Auklet has been observed at sea throughout Southern California (eBird 2019).

Rhinoceros Auklet. The Rhinoceros Auklet is on the State of California Watch List (CDFW 2018). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). Occurring in the North Pacific, the Rhinoceros Auklet breeds from California, off the coasts of Canada and Alaska to the Aleutian Islands, on Japan and North Korea, and on the far eastern Siberian coast. Threats include predation by invasive species. It occurs both offshore and along seacoasts and islands. Breeding occurs on maritime and inland grassy slopes and rarely on steep island or mainland cliffs. In winter, it occurs in offshore pelagic waters and sometimes in nearshore coastal waters. It feeds mostly on fish, supplemented by invertebrates such as squid and krill in winter. It is colonial during nesting; colonies may number over 100,000 individuals (IUCN 2019). The Rhinoceros Auklet has been observed at sea throughout Southern California (eBird 2019).

Tufted Puffin. The Tufted Puffin is a State of California Species of Special Concern (CDFW 2018). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). The global breeding population is estimated at over 3.5 million birds (IUCN 2019). Predation by invasive species is considered a threat to the Tufted Puffin (BirdLife International 2019). Other threats include reductions in prey availability, competition with commercial fisheries, oil spills, and climate change. Western Gulls may prey on chicks and kleptoparasitize adults. Its only recent known breeding location in Southern California (1989-1991) was on Prince Island in Santa Barbara County. At sea during the breeding season, it occurs mainly in waters of the outer continental shelf and continental slope within 65 km of colonies. In the nonbreeding season, Tufted Puffins are more numerous in California, ranging widely over pelagic waters along the entire length of California. In Southern California, it is most numerous in midwinter and spring. Young feed mostly on fish while adults also prey on squid and small crustaceans (McChesney and Carter 2008). There are sporadic observations of the Tufted Puffin between Los Angeles and San Luis Obispo Counties (eBird 2019).

California Gull. The California Gull is on the State of California Watch List (CDFW 2018). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). Its breeding range is western North America from Canada south to eastern California and Colorado. The California Gull winters in coastal regions from southwest Canada to southwest Mexico. Habitat includes open ocean, coasts, estuaries, bays, mudflats, and fields. Breeding occurs in open habitats usually on low rocky islands in freshwater and hypersaline lakes. San Fransisco has one of the largest breeding populations in the world (Ackerman et al., 2018). It feeds on insect, eggs and young of birds, rodents, rubbish, grains, and berries (IUCN 2019). The California Gull has been observed throughout Southern California (eBird 2019).

Gull-billed Tern. The Gull-billed Tern is a USFWS Bird of Conservation Concern and Management Concern (including focal species) (USFWS 2018b,c) and a State of California Species of Special Concern (CDFW 2018). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). Its population is suspected to be in decline due to habitat loss and degradation and human disturbance at breeding colonies (IUCN 2019). Other threats include chemical use, oil spills, urban and industrial waste, increased salinity of the Salton Sea, and predation by feral and domestic pets. In California, the Gull-billed Tern is primarily a summer resident (mid-March to mid-September), but is also a very rare winter visitor (Molina 2008a). It breeds in a variety of locations such as bare or sparsely vegetated islands, banks, flats, or spits of dry mud and sand including barrier beaches, dunes, saltmarshes, saltpans, freshwater lagoons, estuaries, deltas, inland lakes, rivers, marshes, and swamps. Migratory and wintering habitats are somewhat similar. The Gull-billed Tern is mostly insectivorous (IUCN 2019). The Gull-billed Tern has been observed along the coast from Los Angeles, Ventura, Santa Barbara, and San Luis Obispo Counties (Molina et al. 2010; eBird 2019). The only recent breeding noted in Southern California occurred at the Salton Sea and San Diego Bay (Molina 2008a).

Elegant Tern. The Elegant Tern is on the State of California Watch List (CDFW 2018). It is categorized as Near Threatened on the IUCN Red List of Threatened Species due to its restricted breeding range (90 percent of the breeding population on a single island) and potential negative effects of climate change, human intrusions, and overfishing (IUCN 2019). Its population also undergoes large fluctuations in response to El Niño Southern Oscillation events and subsequent fluctuations in fish populations (Bird Life International 2019). It breeds along the Pacific coast from Southern California (e.g., Los Angeles Harbor, Bolsa Chica, San Diego Bay) to Baja California and the Gulf of California, Mexico, with most breeding on Isla Rasa in the Gulf of California. Non-breeding birds summer from California to Costa Rica (IUCN 2019), and is observed along all of coastal Southern California (eBird 2018). The Elegant Tern forages in inshore waters, estuarine habitats, salt ponds, and lagoons. Some individuals occur further offshore during the non-breeding season (IUCN 2019).

Black Skimmer. The Black Skimmer is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c) and a State of California Species of Special Concern (CDFW 2018). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). The major threat to the species is the lack of suitable open nesting habitat and its continued loss. Urban development and associated increase in disturbance by humans, feral animals, and pets can disrupt nesting of an entire colony. The Black Skimmer is a ground nesting colonial waterbird that requires large areas of bare earth free from predators and other disturbances. During winter, flocks commonly roost on urban beaches above the tide line or on mud flats in estuaries. In Southern California, it nests along the coast and the Salton Sea (Collins and Garrett 1996; Molina 2008b). On the Pacific coast, it winters from Southern California to as far south as El Salvador and Nicaragua (Molina 2008b). The Black Skimmer is observed from coastal areas throughout Southern California (eBird 2019). It is present year-round in coastal Santa Barbara, Ventura, Los Angeles, Orange, and San Diego Counties. It winters locally in substantial numbers on the Southern California coast from Santa Barbara to San Diego Counties. Small numbers observed at Morro Bay in San Luis Obispo County are mainly spring and fall migrants (Molina 2008b). It feeds on small fish and possibly crustaceans (Molina 2008b).

Black-footed Albatross. The Black-footed Albatross is a USFWS Bird of Conservation Concern and Bird of Management Concern (USFWS 2018b,c). It is categorized as Near Threatened on the IUCN Red List of Threatened Species based on modeling of likely mortality from longline fishing combined with potential losses to breeding colonies from sea-level rise and storm surges (IUCN 2019). Other threats include oil spills, organochlorines, heavy metals, introduced predators, plastic ingestion, volcanic eruption, and climate change. The Black-footed Albatross is observed throughout Southern California, mostly far offshore (eBird 2019). Mason et al (2007) found on average that Black-footed Albatrosses occurred greater than 45 km from shore over deeper waters (1,260 m). Breeding only occurs on the Northwestern Hawaiian Islands, U.S. minor outlying islands, and four outlying islands of Japan. It feeds on fish, squid, crustaceans, fish offal, and human refuse (IUCN 2019).

Ashy Storm-Petrel. The Ashy Storm-Petrel is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c), and a State of California Species of Special Concern (CDFW 2018). It is categorized as Endangered on the IUCN Red List of Threatened Species (IUCN 2019). It is one of the rarest storm-petrels in the world, with an estimated global population of about 10,000 individuals (NPS 2016). The Ashy Storm-Petrel breeds on offshore islands from central Mendocino County to the southern Channel Islands and the Todos Santos Islands off northwestern Baja California, Mexico (Carter et al. 2008). Half of the world's population of Ashy Storm-Petrels breed on San Miguel, Santa Barbara, Santa Cruz, and Anacapa Islands (NPS 2016). It moves to and from colonies at night. Its breeding season is spread throughout most of the year (Carter et al. 2008), although off Southern California breeding typically occurs from March to October. Breeding colonies occur on offshore islands in the area, including the Southeast Farallon islands, San Miguel, Santa Barbara, Santa Cruz, Anacapa, San Clemente and Mexico's Coronados Islands (NPS 2016). It is not known to breed on Santa Rosa and San Nicolas Islands.

The Ashy Storm-Petrel forages widely in waters seaward of the continental shelf, near islands, and near the coast within the Southern California Current ecosystem (Ainley et al. 1974; Briggs et al. 1987; Mason et al. 2007; Spear and Ainley 2007). The species does not travel significantly far from its colonies after breeding, and many birds remain offshore from their breeding grounds. However, some individuals can make short seasonal migrations. In fall, large numbers congregate in Monterey Bay and on the Cordell Bank. Fall concentrations in Monterey Bay probably include Farallon Islands' breeders, non-breeders, and fledglings along with individuals from southern populations (Ainley 1976).

Mason et al. (2007) observed Ashy Storm-Petrels throughout their study area in the Southern California Bight and the waters north of Point Conception. Three specific areas where they found aggregations of Ashy Storm-Petrels included the waters between Santa Cruz and San Nicolas Islands, the western Santa Barbara Channel, and 6 to 43 mi (10 to 70 km) offshore from San Miguel Island to Point Buchon. Briggs et al. (1987) observed Ashy Storm-Petrels in greatest abundance near San Miguel Island from April to June. After October, birds occurred near San Clemente and Santa Catalina Islands, over the Santa Rosa-Cortes Ridge, and in the western Santa Barbara Channel to Point Buchon (Briggs et al. 1987). Based on the normal distribution and abundance, this species could occur within the Southern California OCS Planning Area year-round, but has the highest potential of occurrence during the spring, summer, and fall months.

Black Storm-Petrel. The Black Storm-Petrel is a State of California Species of Special Concern (CDFW 2018). It is categorized as Least Concern on the IUCN Red List of Threatened Species IUCN 2019). The population is suspected of being in decline due to predation by invasive species. It is also vulnerable to pollution, pesticides, and human disturbance on breeding islands. The Black Storm-Petrel occurs year-round in waters off Southern California. It frequents waters of the continental shelf, shelf break, and continental slope (100- to 3,000-m deep). It breeds on the Channel Islands, the Baja Peninsula, and the Gulf of California, and winters off the coasts of Colombia and Ecuador. Southern California is at the northern periphery of its range. Nesting occurs on rocky talus or cliff crevices, breeding in small numbers (e.g., 50 to 100) on a few of the Channel Islands. The Black Storm-Petrel forages both inshore and offshore on planktonic crustaceans, small fish, and offal. Breeding occurs on islands adjacent to the coast and occasionally in rocky areas. Breeding colonies start to form in May (Ainley 2008; BirdLife International 2019). The Black Storm-Petrel has been observed at sea throughout Southern California (eBird 2019).

Pink-footed Shearwater. The Pink-footed Shearwater is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c). It is categorized as Vulnerable on the IUCN Red List of Threatened Species (IUCN 2019). It has only three known breeding locations off the coast of Chile, which make it susceptible to adverse natural events and human impacts. Predation by dogs and cats may be the most serious threat to the species. Other threats include harvesting of chicks or eggs, competition for burrows by rabbits, soil erosion by goats and cattle, vegetation loss (which leads to erosion), fishing gear entanglement, chemical contaminants, plastic debris, oil pollution, and climate change. Following breeding (late April to late May), it disperses along the continental shelf as far north as the northern Gulf of Alaska. It feeds mainly over the continental shelf but also in pelagic waters on sardines, anchovies, squid, and some crustaceans. The Pink-footed Shearwater may number upwards of 150,000 individuals (IUCN 2019). The Pink-footed Shearwater has been observed at sea throughout Southern California (eBird 2019). Its numbers off Southern California increase from March to May and then decrease from September to November. The Pink-footed Shearwater is usually uncommon within 5 mi of shore (Unitt 2004).

Black-vented Shearwater. The Black-vented Shearwater is a USFWS Bird of Conservation Concern and Management Concern (USFWS 2018b,c). It is categorized as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2019). Past declines to the species were due to road building and predation by introduced cats and rodents. They are also preyed on by natural predators such as Western Gulls, Common Ravens, and white-tail antelope squirrels. Introduced large herbivores (e.g., donkeys, goats, and sheep) also affect habitat, while rabbits may displace birds from their burrows. Disturbance by humans also occurs. Some mortality may also occur from gill netting. The Black-vented Shearwater breeds on six islands or small islets off the west coast of Mexico. The population was estimated at 160,000 mature individuals in 1998-1999, but the methods used may have overestimated the population size. The mature individuals in 2016 was estimated at 75,600; but the population trend was considered uncertain (BirdLife International 2019). The birds attend colonies for at least 10 months. Birds then disperse to the north reaching central California, and rarely as far north as British Columbia (IUCN 2019). The Black-vented Shearwater has been observed at sea throughout Southern California (eBird 2019) where they are generally found with 25 km of shore.

Double-crested Cormorant. The Double-crested Cormorant is a USFWS Bird of Management Concern (USFWS 2018c). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). It is widely distributed across North America from Alaska to northwest Mexico on the Pacific coast and North Carolina to Cuba on the Atlantic coast. Summer breeding occurs over much of the United States and southern-central and eastern Canada. Its habitat includes estuaries, bays, mangrove swamps, rocky coasts and coastal islands, inland lakes, rivers, swamps, reservoirs, and ponds. The Double-crested Cormorant feeds primarily on fish and crustaceans. Individuals may fish cooperatively with as many as several thousand birds at one time. It is a colonial nester on a wide variety of substrates. Nesting colonies may be upwards of several thousand pairs (IUCN 2019). The Double-crested Cormorant occurs throughout Southern California (eBird 2019).

Brown Pelican. The Brown Pelican was removed from the federal list of endangered and threatened wildlife due to recovery on November 17, 2009 (USFWS 2009). The Brown Pelican was similarly relisted as recovered by the State of California June 3, 2009 (CNDDB 2019). It is categorized as Least Concern on the IUCN Red List of Threatened Species (IUCN 2019). Along the Pacific coast, it breeds from Southern California to Chile; during the non-breeding season, it can range into Canada (BirdLife International 2016t). The only breeding colonies in the western U.S. are on West Anacapa and Santa Barbara Islands (NPS 2018). It inhabits shallow inshore waters, estuaries, and bays. The Brown Pelican preys mostly on fish such as sardines and anchovies. It is a colonial nester. Nests are usually on the ground, but sometimes on cliffs and less often trees or bushes (IUCN 2019). The Brown Pelican occurs throughout coastal Southern California (eBird 2019). Non-breeding pelicans, including juveniles and non-breeding adults, disperse during the late spring, summer and early fall months from breeding colonies along the Gulf of California and in southern California as far north as southern British Columbia, Canada, and south into southern Mexico and Central America (USFWS 2011c).

Reddish Egret. The Reddish Egret is a USFWS Bird of Conservation Concern and Management Concern (including focal species) (USFWS 2018b,c). It is categorized as Near Threatened on the IUCN Red List of Threatened Species (IUCN 2019). It mainly occurs in Baja California and south along the Pacific coast of Mexico, the Gulf coast of the United States, through the Caribbean islands, and down the Central American coast to northern Colombia and Venezuela. There are up to 1,260 breeding pairs along the Pacific coast (BirdLife International 2019). Reddish Egrets from the west coast of Mexico wander north into California. Breeding is not reported to occur in California (IUCN 2019; National Audubon Society 2018); it has been observed in low numbers in coastal areas throughout Southern California (as far north as Monterey County) (eBird 2019). It is seldom observed away from coastal areas. Current threats are not well known, but commercial development of the coastline is a likely contributor (IUCN 2019).

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12 MARINE MAMMALS

This chapter describes the marine mammals that occur in the Southern California Planning Area and along the five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). The following sections discuss the occurrence, abundance, and distribution of these species, and provides brief descriptions of each species. The waters offshore of Southern California support a diverse marine mammal community, with their abundance varying yearly based on changing oceanographic conditions such as El Niño and prey availability and distribution (Henderson et al. 2014; Jefferson et al. 2013). Species in the orders Cetacea and Carnivora occur, at least seasonally, in waters of Southern California (Carretta et al. 2017, 2018; Muto et al. 2018). The Cetacea include baleen whales (Suborder Mysticeti, commonly referred to as mysticetes) and toothed whales (Suborder Odontoceti, commonly referred to as odontocetes). The seven species of Carnivora in the area include true seals, eared seals, and the southern sea otter.[12, 13]

All marine mammals that occur in the project area are protected under the Marine Mammal Protection Act (MMPA). In addition, eight of the species are listed under the ESA. The blue whale, fin whale, humpback whale, North Pacific right whale, sei whale, and sperm whale are endangered; while the Guadalupe fur seal and the southern sea otter are threatened. All of the federal listed species are under the jurisdiction of NMFS, except the southern sea otter, which is under the jurisdiction of the USFWS.

12.1 Whales, Dolphins, and Porpoises

At least 8 species of baleen whales and 23 species of toothed whales (including dolphins and porpoises) have been reported from the Southern California OCS Planning Area (Table 12-1).[14] Based on aerial surveys, the 16 most commonly observed species in the Southern California Bight, in descending order of frequency, are:

- Long-beaked common and short-beaked common dolphins – listed together as they are often difficult to differentiate at sea;
- Risso’s dolphin;
- Fin whale;
- Common bottlenose dolphin;
- Gray whale;
- Blue whale;
- Pacific white-sided dolphin;
- Humpback whale;

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12 Scientific names of the marine mammals provided in Table 12-1.

13 Seals (family Phocidae) and fur seals sea lions (family Otariidae) were formerly included in the suborder Pinnipedia, but Pinnipedia is now considered a clade within the suborder Caniformia.

14 The rough-toothed dolphin (*Steno bredanensis*) and false killer whale (*Pseudorca crassidens*) are not addressed in this document as their occurrence in the area likely represents extralimital occurrences (Douglas et al. 2014). However, more than 50 false killer whales were observed in 2014 (Kim 2014) and about 30 in 2016 (Ritchie 2016).

- Northern right whale dolphin;
- Minke whale;
- Dall's porpoise;
- Killer whale, Bryde's whale, and Cuvier's beaked whale – these three species observed with equal frequency; and
- Sperm whale (Smultea and Jefferson (2014).

Whale Alert – West Coast (2018) provides observational data of cetaceans in the Channel Islands region. The information from these observations includes the number of individuals observed on a monthly and yearly basis, as well as a mapped location of the observations. Most observations are focused between the mainland of Santa Barbara and Ventura Counties and the northern Santa Barbara Channel Islands, but do include observations made throughout Southern California. Table 12-2 presents monthly observations of select cetacean species for January 2014 through August 2018.

California Cooperative Fisheries Investigation (CalCOFI) cruises are conducted in Southern California to provide an assessment of cetacean abundance, density, distribution, and habitat use patterns (Hildebrand 2018). The surveys made from July 2004-August 2017 include visual monitoring incorporating standard line-transect survey protocols. Acoustic detection methods using towed hydrophone arrays and sonobuoys deployed at oceanographic sampling stations are also used. The area surveyed extends from San Diego County to San Francisco County, but most surveys only extend northward to the middle of San Luis Obispo County. Eighteen cetacean species have been observed during the surveys. The baleen whales observed include the blue, fin, gray, humpback, and minke whales. Odontocete sightings include the Baird's and Cuvier's beaked whales, bottlenose dolphin, Dall's porpoise, killer whale, long-beaked common dolphin, northern right whale dolphin, Pacific white-sided dolphin, Risso's dolphin, short-beaked common dolphin, short-finned pilot whale, sperm whale, and striped dolphin (Campbell et al. 2011, 2012, 2014, 2015; Debich et al. 2017; Douglas et al. 2014; Hildebrand et al. 2018).

The following are among the general observations noted from the CalCOFI surveys for 2012 through 2017 (Campbell et al., 2014; Debich et al., 2017; Hildebrand et al. 2018):

- During winter and spring, most baleen whale sightings occur in waters of the continental shelf;
- During summer, there are more baleen sightings along the continental slope and offshore waters;
- During fall, baleen whale sightings are concentrated in the Channel Islands region; Short-beaked common dolphin sightings are detected more frequently offshore than inshore; and
- Winter cruises had the highest species diversity for mysticetes and odontocetes.

TABLE 12-1 Marine Mammals of Southern California[a]

Species[a]	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Order Cetacea: Suborder Mysticeti (baleen whales):			
Blue whale: Eastern North Pacific Stock (*Balaenoptera musculus musculus*)	E/D	1,647 (1,551)	Occurs in the continental shelf, continental slope, and offshore waters. First observed around the Channel Islands in May/June and are present on the continental shelf in the area from August to November. Tend to aggregate in the Santa Barbara Channel along the shelf break (seaward of 200-m line). Considered common in Southern California.
Bryde's whale: Eastern Tropical Pacific Stock (*Balaenoptera edeni*)	--	Unknown	Occurs in the continental shelf waters. Little known about its occurrence in the Southern California Bight. Typically not considered part of the Southern California cetacean fauna. Infrequent summer occurrence, considered accidental in Southern California.
Fin whale: California/Oregon/Washington Stock (*Balaenoptera physalus physalus*)	E/D	9,029 (8,127)	Occurs in the continental shelf, continental slope, and offshore waters. Occurs year-round off central and Southern California, peaking in summer and fall. In Southern California Bight, summer distribution is generally offshore and south of the northern Channel Island chain. Usually in pelagic but sometimes nearshore waters. Considered common in Southern California.
Gray whale: Eastern North Pacific Stock (ENPC) and Pacific Coast Feeding Group (PCFG) (*Eschrichtius robustus*)	DL	ENPC 20,990 (20,125) PCFG 209 (197)	Transient during seasonal migrations. Generally migrates through the area in coastal and Channel Islands waters between December and April. Considered common in Southern California.
Humpback whale: California/Oregon/Washington Stock (*Megaptera novaeangliae*)	E/D[c]	1,918 (1,876)	Occurs in the continental shelf, continental slope, and offshore waters. Migrates through the area in spring and fall. Occurs throughout the western two-thirds of the Santa Barbara Channel. Tends to concentrate along the shelf break north of the Channel Islands. Considered common in Southern California.

TABLE 12-1 Marine Mammals of Southern California[a]

Species[a]	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Minke whale: California/Oregon/Washington Stock (*Balaenoptera acutorostrata*)	--	636 (369)	Occurs in the continental shelf, continental slope, and offshore waters. Occur year-round off California. Winter range includes Southern California Bight with a small portion residing there throughout the summer, especially around the northern Channel Islands. Considered common in Southern California.
Order Cetacea: Suborder Odontoceti (toothed whales, dolphins, and porpoises):			
Baird's beaked whale: California/Oregon/Washington Stock (*Berardius bairdii*)	--	2,697 (1,633)	Prefers cold deep oceanic waters 3300-ft or greater, but may occur occasionally near shore along narrow continental shelves. Often associated with submarine canyons, seamounts, and continental slopes. Considered uncommon in Southern California. Primarily along continental slope from late spring to early fall.
Common bottlenose dolphin: California Coastal Stock (CCS) and California/Oregon/Washington Offshore Stock (COWOS) (*Tursiops truncatus truncatus*)	--	CCS 453 (346) COWOS 1,924 (1,255)	The California Coastal Stock occurs primarily from Point Conception south within 1 km of shore. The California/Oregon/Washington Offshore Stock has a more-or-less continuous distribution off California. There are coastal populations that migrate into bays, estuaries, and river mouths as well as offshore populations that inhabit waters along the continental shelf. Considered common in Southern California.
Cuvier's beaked whale: California/Oregon/Washington Stock (*Ziphius cavirostris*)	--	3,274 (2,059)	Prefer pelagic waters usually greater than 3,300 ft of the continental slope and edge, as well as around steep underwater geologic features like banks, seamounts, and submarine canyons. Occurs year-round in the deep waters of the Southern California Bight. Considered uncommon in Southern California.
Dall's porpoise: California/Oregon/Washington Stock (*Phocoenoides dalli dalli*)	--	25,750 (17,954)	Occurs in the continental shelf, continental slope, and offshore waters. Common in winter. Western Santa Barbara Channel is an area of higher densities. Considered common in Southern California.
Dwarf sperm whale: California/Oregon/Washington Stock (*Kogia sima*)	--	Unknown	Most common along the continental shelf edge and slope. Considered rare in Southern California.

TABLE 12-1 Marine Mammals of Southern California[a]

Species[a]	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Killer whale: Eastern North Pacific Offshore Stock (*Orcinus orca*)	--	240 (162)	Occurs in the continental shelf, continental slope, and offshore waters. May occur in the Southern California Bight year-round. Observed west of San Miguel Island and over the shelf north of Point Conception. Considered common in Southern California.
Long-beaked common dolphin: California Stock (*Delphinus capensis capensis*)	--	101,305 (68,432)	Prefer shallow waters closer to the coast (e.g., 50-100 nautical miles) and on the continental shelf. Commonly found from Baja California northward to central California. Considered common in Southern California. Year-round presence.
Mesoplodont beaked whales: California/Oregon/Washington Stock (*Mesoplodon* spp.)	--	3,044 (1,967)	Generally found along the continental slope and offshore waters (seaward of 500 to 1000-m depth) from late spring to early fall with fewer individuals observed during winter and early spring.
Northern right whale dolphin: California/Oregon/Washington Stock (*Lissodelphis borealis*)	--	26,556 (18,608)	Occurs in the continental shelf, continental slope, and offshore waters. Considered common in Southern California, but is rare south of Point Conception in summer. Mostly observed around the western side of the Northern Channel Islands. Mostly occurs during winter and spring.
Pacific white-sided dolphin: California/Oregon/Washington Stock (*Lagenorhynchus obliquidens*)	--	26,814 (21,195)	Occurs in the continental shelf, continental slope, and offshore waters. Considered common in Southern California. Mostly observed around the western side of the Northern Channel Islands. Year-round but more abundant November-April.
Pygmy sperm whale: California/Oregon/Washington Stock (*Kogia breviceps*)	--	4,111 (1,924)	Most common in waters seaward of the continental shelf edge and the slope. Considered rare in Southern California.
Risso's dolphin: California/Oregon/Washington Stock (*Grampus griseus*)	--	6,336 (4,817)	Occurs from nearshore to oceanic waters, but prefers the continental shelf and continental slope waters over nearshore and oceanic waters. Present off Southern California year-round (higher densities November-April) where it is considered as common. Mostly observed around the western side of the Northern Channel Islands.

TABLE 12-1 Marine Mammals of Southern California[a]

Species[a]	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Short-beaked common dolphin: California/Oregon/Washington Stock (*Delphinus delphis delphis*)	--	969,861 (839,325)	Primarily oceanic and offshore, but also occurs along the continental slope in waters 650 to 6500-ft deep. Prefers waters altered by underground geologic features where upwelling occurs. Found off California coast especially during warmer months. Considered common in Southern California.
Short-finned pilot whale: California/Oregon/Washington Stock (*Globicephala macrorhynchus*)	--	836 (466)	Associated with continental slope waters and pelagic and island waters characterized by steep bathymetry. Observed south of Point Conception. Considered uncommon in Southern California.
Sperm whale: California/Oregon/Washington Stock (*Physeter macrocephalus*)	E/D	1,997 (1,270)	Often associated with deep-water areas well offshore of the coast and are rarely observed in the vicinity of existing oil and gas facilities. Present in offshore waters year-round with peak abundance during migrations from April to mid-June and from late August through November. Generally found in waters with depths >600 m. Uncommon at depths <300 m. Uncommon in the Southern California Bight.
Striped dolphin: California/Oregon/Washington Stock (*Stenella coeruleoalba*)	--	29,211 (24,782)	Prefers oceanic and deep waters. Often linked to upwelling areas and convergence zones. Infrequently observed in project area. Considered common in Southern California.
Order Carnivora: Suborder Caniformia (includes seals, sea lions, and sea otters):			
California sea lion: U.S. Stock (*Zalophus californianus californianus*)	--	296,750 (153,337)	Reside in shallow coastal and estuarine waters. Sandy beaches are preferred haul out sites. They will also haul out on marina docks, jetties, and buoys. Breed in Southern California and are present year-round. Breed on San Miguel, San Nicolas, Santa Barbara, and San Clemente Islands. Highest densities in Santa Barbara Channel in nearshore waters, with moderate densities in nearshore waters north of Point Conception. Considered common in Southern California.

TABLE 12-1 Marine Mammals of Southern California[a]

Species[a]	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Guadalupe fur seal: Mexico to California Stock (*Arctocephalus townsendi*)	T/D	20,000 (15,830)	Occurs in offshore waters. Occur in coastal rocky habitats and caves during the breeding season; little known about their whereabouts during non-breeding season. Regularly occurs in the Channel Islands. Breeding occurs off the coast of Baja California, Mexico. A birth was reported on San Miguel Island. Considered uncommon in Southern California.
Harbor seal: California Stock (*Phoca vitulina richardii*)	--	30,968 (27,348)	Occurs in continental shelf waters. Breed in Southern California and are present year-round. Spend most of their time throughout fall and winter at sea. Haul out on all Channel Islands and on beaches along the mainland, particularly from Ventura County northward. Considered common in Southern California. Bulk of stock north of Point Conception.
Northern elephant seal: California Breeding Stock (*Mirounga angustirostris*)	--	179,000 (81,368)	Occurs in continental shelf, continental slope, and offshore waters. Breeds in Southern California and are present year-round. San Miguel and San Nicolas are the major rookery islands. Some also born on Santa Rosa, Santa Barbara, and San Clemente Islands. When on land, they occur on sandy beaches. Considered uncommon in Southern California. Feeding occurs in deep waters seaward of the continental slope.
Northern fur seal: California Stock (*Callorhinus ursinus*)	--	14,050 (7,524)	Most fall and winter sightings are in offshore waters west of San Miguel Island. Breeds in Southern California and is present year-round. Breeds on San Miguel Island. Considered uncommon in Southern California. In winter and spring, large numbers feed along the California coast beyond the edge of the continental shelf.
Southern sea otter (*Enhydra lutris nereis*)	T/D	2,826 (2,723)	Occurs along mainland coast from San Mateo County south to Santa Barbara County with a small colony also on San Nicolas Island. Typically inhabit waters <18-m deep and rarely move more than 2 km offshore. Considered uncommon in Southern California.

TABLE 12-1 Marine Mammals of Southern California[a]

Species[a]	Status[b]	Population Estimate (Minimum Estimate)	Occurrence/Distribution in Southern California
Steller sea lion: Western U.S. Stock (*Eumetopias jubatus*)	DL	53,303 (53,303)	Forages near shore and in pelagic waters. Rookery sites do not occur in Southern California.

[a] The rough-toothed dolphin (*Steno bredanensis*) and false killer whale (*Pseudorca crassidens*) are also not included as their occurrence in the area likely represents extralimital occurrences (Douglas et al. 2014).

[b] Status: D = depleted under the Marine Mammal Protection Act (MMPA); DL = delisted under the ESA; E = endangered under the Endangered Species Act (ESA); T = threatened under the ESA; – = not listed. All species are protected under the MMPA.

[c] Individuals from the endangered Central America Distinct Population Segment (DPS) and threatened Mexico DPS make use of the waters off California as feeding areas, as do a small number of whales from the non-listed Hawaii DPS. Until stock delineation under the MMPA is completed, the California/Oregon/Washington stock will continue to be considered E/D for MMPA management purposes.

Sources: Carretta et al. (2017, 2018); Jefferson et al. (2014b); Kaplan et al. (2010); Maxon Consulting (2014); Muto et al. (2018); NMFS (2019a, b, c); Smultea and Jefferson (2014).

Table 12-2 Average Monthly Number of Whale, Dolphin and Porpoise Observed in the Santa Barbara Channel Area, January 2014-August 2018

Species[a]	Monthly Average Observations[b]											
	J	F	M	A	M	J	J	A	S	O	N	D
Blue Whale	0.2	0.7	0.7	1.6	9.2	234.4	19.6	221.5	14.0	12.0	5.8	8.8
Fin Whale	5.8	3.6	2.8.0	5.4	1.6	8.6	3.8	2.2	2.8	0.2	2.8	4.2
Gray Whale	100	95	187	86	49	6	0.0	0.2	0.0	0.0	1	46
Humpback Whale	12	41	54	67	76	197	134	142	136	69	68	32
Killer Whale	6.2	12.5	1.8	0.0	1.2	0.0	0.0	0.0	6.2	0.0	3.0	3.0
Minke Whale	0.6	0.4	1.8	4.4	2.2	4.2	10.4	30.4	10.2	10.0	4.0	0.2
Bottlenose Dolphin	77	110	5,646	211	82	387	311	575	172.0	117.0	13.3	35.7
Long-Beaked Common Dolphin	3,605	7,039	13,474	9,417	11,318	19,382	12,297	21,780	13,870	7,598	3074	6362
Short-Beaked Common Dolphin	1,026	161	1,408	651	591	2,146	4,204	1,249	2,878	3,157	1264	571
Common Dolphin	1,222	774	3,902	5,785	2,118	4,663	6,505	4,606	2106	2235	323	1723
Dall's Porpoise	0.8	0.0	2.8	0.0	1.5	9.0	0.0	0.0	2.0	3.2	3.0	17.2
Pacific White-Sided Dolphin	0	37	201	133	0.0	2	0.0	11	0.0	30	24	4
Risso's Dolphin	10	0.0	9	0.0	2	13	73	66	40	22	9	29

[a] One sperm whale was observed in October 2016 and one in August 2018. Scientific names are provided in Table 12-1.

[b] The observation numbers do not equate to actual numbers of individuals. Thus, the observation numbers only provide an indication of which months a species is present and its relative prevalence.

Source: Whale Alert - West Coast (2018).

Douglas et al. (2014) determined abundance estimates by seasonal period (summer-fall and winter-spring) and depth (shallow: <6,400 ft and deep: ≥6,400 ft) for the 11 most commonly encountered cetaceans off Southern California based on CalCOFI cruise data from 2004 to 2008. (The shallow waters all start west of the Channel Islands – so all OCS platforms are within the shallow area.) Results are summarized in Table 12-3. Campbell et al. (2014, 2015) also reported on the spatial distribution patterns for several cetacean species off Southern California. The humpback whale, gray whale, bottlenose dolphin, Risso's dolphin, and long-beaked common dolphin concentrate in coastal and shelf waters; whereas, the sperm whale was detected exclusively in pelagic waters. Blue whales, fin whales, short-beaked common dolphins, Pacific white-sided dolphins, and Dall's porpoise had broad distributions occurring in coastal, shelf, and pelagic waters.

TABLE 12-3 Density and Abundance of Most Frequently Observed Cetacean Species off Southern California in Shallow Water Depths (<2,000 m)

Species/Season	Density (No./1,000 km^2)	Uncorrected Abundance (No./71,407 km^2)
Blue whale (*Balaenoptera musculus musculus*)		
Winter-spring	0.0	0.0
Summer-fall	3.2	228
Fin whale (*Balaenoptera physalus physalus*)		
Winter-spring	2.33	166
Summer-fall	3.67	262
Humpback whale (*Megaptera novaeangliae*)		
Winter-spring	2.66	190
Summer-fall	3.08	220
Common bottlenose dolphin (*Tursiops truncatus truncatus*)		
Winter-spring	22.12	1580
Summer-fall	40.32	2879
Dall's porpoise (*Phocoenoides dalli*)		
Winter–spring	45.5	3,249
Summer–fall	2.11	151
Long-beaked common dolphin (*Delphinus capensis*)		
Winter–spring	30.90	2,207
Summer–fall	687.87	49,118
Northern right whale dolphin (*Lissodelphis borealis*)		
Winter–spring	107.31	7,662
Summer–fall	6.72	480
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)		
Winter–spring	110.57	7,896
Summer–fall	29.24	2,088
Risso's dolphin (*Grampus griseus*)		
Winter–spring	35.65	2,546
Summer–fall	3.90	279

TABLE 12-3 Density and Abundance of Most Frequently Observed Cetacean Species off Southern California in Shallow Water Depths (<2,000 m)

Species/Season	Density (No./1,000 km^2)	Uncorrected Abundance (No./71,407 km^2)
Short-beaked common dolphin (*Delphinus delphis*)		
Winter–spring	307.83	21,981
Summer–fall	1,319.69	94,235
Sperm whale (*Physeter macrocephalus*)		
Winter-spring	0.83	59
Summer-fall	0.94	67

Source: Douglas et al. (2014).

12.1.1 Cetacea Species Accounts – Non-ESA Listed Species

Bryde's Whale. The Bryde's whale is usually observed individually or in pairs. It preys on copepods, krill, crustaceans, and small schooling fish (NMFS 2019a). The Bryde's whale is extremely rare in the Southern California Bight. None have been observed during the CalCOFI surveys. Smultea et al. (2012) photo-documented five separate sightings of single Bryde's whales in the Southern California Bight waters between August 2006 and September 2010. The sightings occurred over bottom depths ranging up to 3 mi and approximately 45 to 72 mi from the mainland of Southern California. Four individuals were sighted off California from May to July 2014 (Kim 2015).

Using pooled data from 1991 to 2005, the abundance of Bryde's whales in Southern California was estimated at 0.0 animals, and at 7 for Central California (Barlow and Forney 2006). Throughout the entire study area (California, Oregon, and Washington), Bryde's whale density was estimated at 0.01 whales/1000 km^2. As Bryde's and sei whales are difficult to distinguish at sea, Barlow and Forney (2006) gave an estimate of 7 Bryde's/sei whales in Southern California and 18 individuals for the entire study range with an estimated density of 0.02 whales/1000 km^2.

Gray Whale. The Western North Pacific stock of gray whales is endangered, but the Eastern North Pacific stock is de-listed (USFWS and NMFS 1994). The primary reason for its initial listing was a severe worldwide population decline due to intensive commercial whaling. The Western North Pacific stock occurs along the coasts of Russia and China but recent photo identification and satellite telemetry work has confirmed that a few animals photographed/tagged in western North Pacific joined members of the Eastern North Pacific stock on their migration to breeding lagoons in Mexico. NMFS maintains that the Western North Pacific stock is genetically distinct and has begun to include the Western North Pacific stock in consultations for the Pacific coast of the United States (NMFS 2019a). Visually, it is impossible to differentiate between whales from the two stocks but gray whales from the Western North Pacific Gray whales are rare visitors to the Southern California Planning Area.

The gray whale travels alone or in a small, unstable group, but large aggregations may occur on feeding and breeding grounds. They prey on benthic amphipods (NMFS 2019a). Within the Santa Monica Bay area (located between the Santa Barbara Channel-East Platforms and the San Pedro Bay Platforms), gray whale group sizes averaged 1.70 individuals (range of 1 to 3) (Bearzi and Saylan 2011). The Eastern North Pacific stock has a narrow migration route that is quite close to shore (e.g., generally within 3 km) (BSEE 2011). Nearly the entire population migrates along the coastal waters of the West Coast during its winter southbound migration, and again northward in the spring. In Southern California, the peak of the southbound migration is in January and during the northbound migration is in March. The northward and southward migrations of gray whales overlap in Southern California, with individuals observed moving in both directions during January and February (CMLPAI 2009). Highest numbers of gray whales observations reported by Whale Alert - West Coast (2018, Table 12) occurred in January through April.

While gray whales migrate along the coast, most travel outside the Channel Islands (Kaplan et al. 2010). Biologically important areas for gray whales are based on their migratory corridor as they transit between primary feeding areas in the northern latitudes and breeding areas off Mexico, and as the primary feeding areas for a smaller population of resident gray whales. The six gray whale feeding biologically important areas occur from northern California into Washington. The biologically important areas for the three migratory phases of the gray whales are within 10 km of the U.S. West Coast (Calambokidis et al. 2015).

Minke Whale. Minke whales are usually observed individually or in small groups of two or three animals, but loose aggregations of up to 400 individuals have been reported at feeding areas in higher latitudes (NMFS 2019a). Within the Santa Monica Bay area (located between the Santa Barbara Channel-East Platforms and the San Pedro Bay Platforms), minke whale group size has been reported to average 1.33 individuals (range of 1 to 2) (Bearzi and Saylan 2011). The minke whale prey items include krill, copepods, and small schooling fish (NMFS 2019a).

In Southern California, they are observed in spring through fall with highest numbers in spring (Kaplan et al. 2010; Douglas et al. 2014). Highest numbers of minke whale observations reported by Whale Alert - West Coast (2018) (Table 12-2) occurred in July through October, although individuals are observed year-round. Based on pooled data from 1991 to 2005, the abundance of minke whales in Southern California was estimated at 226 animals, with 823 minke whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, minke whale density was estimated at 0.72 whales/1000 km^2 (Barlow and Forney 2007).

Baird’s Beaked Whale. Baird’s beaked whale primarily occurs over or near the continental slope and oceanic seamounts with water depths ranging from 0.6 to 1.8 mi, but may also occur close to shore where deep water approaches the coast (Culik 2010). Along the California coast, they apparently spend the winter and spring months well offshore, moving in June onto the continental slope off central and northern California (Culik 2010). Baird’s beaked whales are usually found in small groups of 2 to 20 individuals, but occasionally occur in groups of up to 50 animals. They feed on pelagic fishes, crustaceans, sea cucumbers, and cephalopods (NMFS 2019a). Based on pooled data from 1991 to 2005, the abundance of Baird’s beaked whales in Southern California was estimated at 127 animals, with 1005 Baird's beaked whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, Baird's beaked whale density was estimated at 0.88 whales/1000 km^2 (Barlow and Forney 2007).

Bottlenose Dolphin. In many regions, including California, the bottlenose dolphin occurs as a separate coastal and offshore population. Coastal bottlenose dolphins feed on benthic invertebrates and fish while offshore animals prey on squid and fish (NMFS 2019b). The California coastal bottlenose dolphins are found within about 1 km of shore, occurring within 500 m of shore 99% of the time and within 250 m 90% of the time. There is little site fidelity among the coastal bottlenose dolphins. The offshore stock occurs at distances greater than a few kms from the mainland and throughout the Southern California Bight (Carretta et al., 2017). The bottlenose dolphin commonly occurs in groups of 2 to 15 individuals, but offshore stock can contain herds of several hundred individuals (NMFS 2019b). Within the Santa Monica Bay area, inshore group size has been estimated to average about 8 individuals (range of 1 to 35) and offshore group size to average about 16 individuals (range 1 to 57) (Bearzi and Saylan 2011).

Highest numbers of bottlenose dolphin observations reported by Whale Alert - West Coast (2018, Table 12) occurred in March (average of 5,646 observations for 2014 through 2018), but an average of more than 80 observations are reported for all months except for November through January. Based on pooled data from 1991 to 2005, the abundance of offshore bottlenose dolphins in Southern California was estimated at 1831 animals, with 2026 individuals estimated for Southern California through Oregon/Washington. Throughout the entire study area, offshore bottlenose dolphin density was estimated at 1.78 dolphins/1000 km^2 (Barlow and Forney 2007).

Cuvier's Beaked Whale. Cuvier's beaked whale is widely distributed in offshore waters of all oceans, preferring areas near the continental slope. They are generally observed in waters with a bottom depth >500 ft and frequently recorded in waters with bottom depths >0.6 mi (Maxon Consulting 2014). It is rarely observed close to mainland shores (Taylor et al. 2008). Cuvier's beaked whale occurs individually or in small groups of 2 to 12 animals. They feed on cephalopods and sometimes fish and crustaceans (NMFS 2019a). Based on pooled data from 1991 to 2005, the abundance of Cuvier's beaked whales in Southern California was estimated at 911 animals, with 4342 Cuvier's beaked whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, Cuvier's beaked whale density was estimated at 3.82 whales/1000 km^2 (Barlow and Forney 2007).

Dall's Porpoise. Dall's porpoise is usually observed in groups numbering 2 to 20 individuals, but are occasionally observed in loosely associated groups of hundreds to thousands of animals. Dall's porpoise feeds on small fish and cephalopods, and occasionally crabs and shrimp (NMFS 2019b). Dall's porpoise primarily occurs in Southern California in winter and spring, with few sightings made in summer and fall (Kaplan et al. 2010). Highest numbers of Dall's porpoise observations reported by Whale Alert - West Coast (2018) (Table 12-2) occurred in June (9) and December (173) based on an average for 2014 through 2018, with no observations made in February, April, July, and August in those years.

Within the Santa Monica Bay area, Dall's porpoise group sizes averaged 6.67 individuals (range of 2 to 15) (Bearzi and Saylan 2011). Based on pooled data from 1991 to 2005, the abundance of Dall's porpoise in Southern California was estimated at 727 animals with 85,955 Dall's porpoise estimated for Southern California through Oregon/Washington. Throughout the entire study area, Dall's porpoise density was estimated at 75.53 porpoises/1000 km^2 (Barlow and Forney 2007). Densities were estimated at 21.37 individuals/1000 km^2 and an abundance of 5086 animals within Southern California (Campbell et al. 2015). This is based on CalCOFI cruises surveys conducted from July 2004-November 2013. The surveyed area covered coastal to offshore waters totaling 238,494 km^2 from San Diego to north of Point Conception.

Dwarf Sperm Whale. The dwarf sperm whale is often observed alone or in small groups of 6 to 10 animals. They feed on fish, cephalopods, and crustaceans (NMFS 2019a). Dwarf and pygmy sperm whales are difficult to differentiate at sea, therefore Barlow and Forney presented estimates of *Kogia* spp. abundance and density off the west coast of the U.S. west coast. Based on pooled data from 1991 to 2005, the abundance of *Kogia* spp. in Southern California was estimated at 0.0 animals with 1237 *Kogia* spp. estimated for Southern California through Oregon/Washington. Throughout the entire study area, *Kogia* spp. density was estimated at 1.09 whales/1000 km^2 (Barlow and Forney 2007). The dwarf sperm whale is thought to be more "coastal" than the pygmy sperm whale (NMFS 2019a).

Killer Whale. Killer whales occur in stable social groups of 2 to 15 animals. They consume fish (including sharks), marine mammals, and sea birds (NMFS 2019a). Based on pooled data from 1991 to 2005, the abundance of killer whales in Southern California was estimated at 30 animals, with 810 killer whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, killer whale density was estimated at 0.71 individuals/1000 km^2 (Barlow and Forney 2007). Highest numbers of killer whale observations reported by Whale Alert - West Coast (2018) (Table 12-2) occurred in February (12.5) and January and September (6.2 average each month) based on an average for 2014 through 2018, with no observations made in April, June through August, and October in those years. Most observations made from 1999 through 2018 are north of the northern Channel Islands, and include to near shoreline are of the Santa Barbara Channel (Whale Alert - West Coast 2018).

Long-beaked Common Dolphin. The long-beaked common dolphin primarily inhabits coastal near shore waters; and is commonly encountered in and around the Santa Barbara Channel (Kaplan et al. 2010). The long-beaked common dolphin feeds on small schooling fish, krill, and cephalopods (NMFS 2019b). They usually occur in groups of 100 to 500 individuals, but have been observed in herds of thousands of animals. Within the Santa Monica Bay area (located between the Santa Barbara Channel-East Platforms and the San Pedro Bay Platforms), common dolphin group size (not differentiated for long-beaked or small-beaked common dolphins) averaged 108.84 individuals (range of 1 to 600) (Bearzi and Saylan 2011).

Based on pooled data from 1991 to 2005, the abundance of long-beaked common dolphins in Southern California was estimated at 17,530 animals, with 21,902 long-beaked common dolphins estimated for Southern California through Oregon/Washington. Throughout the entire study area, long-beaked common dolphin density was estimated at 19 individuals/1000 km^2 (Barlow and Forney 2007). Barlow and Forney (2007) also provided values for unclassified common dolphins (undifferentiated long-beaked and short-beaked common dolphins). Their abundance was 4281 animals in Southern California, and 5629 animals throughout the study are. The density was estimated at almost five individuals/1000 km^2. Thousands of long-beaked common dolphins observations are reported monthly by Whale Alert - West Coast (2018) (Table 12-2), with highest numbers occurring May through October. Highest observations of undifferentiated common dolphins occurred April and June through August. Most observations occurred between the northern Channel Island and the mainland, although observations also occurred between Catalina Island and the mainland.

Mesoplodont Beaked Whales. Beaked whales occur off Southern California, primarily in small numbers. They prefer open-ocean habitats on or beyond the continental slope (Kaplan et al. 2010). Six species, likely to occur off Southern California, included in the Mesoplodont Beaked Whale California/Oregon/Washington Stock include: Blainville's beaked whale (*Mesoplodon densirostris*), Perrin's beaked whale (*M. perrini*), lesser (or Peruvian or pygmy) beaked whale (*M. peruvianus*), Stejneger's baked whale (*M. stejnegeri*), gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*) (Caretta et al 2016). Due to the difficulty in distinguishing these species apart at sea, they are treated as one management unit (Kaplan et al. 2010). Baird's beaked whale and Cuvier's beaked whale, which are members of different genera), were previously addressed.

Blainville's beaked whale generally occurs in deep, offshore waters of the continental shelf. It is often associated with steep underwater structures such as banks, submarine canyons, seamounts, and continental slopes (NMFS 2019a). Blainville's beaked whales occur alone or in small social groups of 3 to 7 individuals. It preys on small fish and cephalopods (NMFS 2015k). Gingko-toothed beaked whales inhabit offshore waters, where they probably occur in small groups (Culik 2010). They feed on a variety of fishes and squids, and may also consume crustaceans and echinoderms (WhaleFacts 2017). Hubbs' beaked whale occurs in deep oceanic water. It feeds on squid and some deepwater fish (Taylor et al. 2008). Lesser beaked whales prefer deep offshore waters beyond the continental shelf (Taylor et al. 2008). They primarily feed on squid, shrimp, and fish.

The lesser beaked whale is usually observed in groups of 2 to 4 individuals (WhaleFacts 2017). Perrin's beaked whales have only been observed in offshore waters off California; the species description is based on five stranded animals on the coast of California (Culik 2010). They presumably prefer oceanic waters with depths >3,200 ft (Taylor et al. 2008). Perrin's beaked whale feeds on cephalopods and fish (WhaleFacts 2017). Stejneger's beaked whale prefers cold temperate and subarctic waters. Mostly found in deep, offshore waters from 2500 to 5000 ft, on or beyond the continental slope. Considered rare in Southern California. Stejneger's beaked whale occurs singly or in small groups of 3 to 15 individuals. They feed on small deep-water fish, tunicates, and cephalopods (NMFS 2019a).

Based on pooled data from 1991 to 2005, the abundance of *Mesoplodon* spp. in Southern California was estimated at 132 animals, with 1177 *Mesoplodon* spp. estimated for Southern California through Oregon/Washington. Throughout the entire study area, *Mesoplodon* spp. density was estimated at 1.03 individuals/1000 km^2 (Barlow and Forney 2007).

Northern Right Whale Dolphin. The northern right whale dolphin is usually found in herds of 100 to 200 individuals, but may be upwards of 3000 animals. They feed on small fish and squid (NMFS 2019b). Based on pooled data from 1991 to 2005, the abundance of northern right whale dolphin in Southern California was estimated at 1172 animals, with 11,097 northern right whale dolphins estimated for Southern California through Oregon/Washington. Throughout the entire study area, northern right whale dolphin density was estimated at about 10 individuals/1000 km^2 (Barlow and Forney 2007). No northern right whale dolphin observations are reported for 2014-2018 (Whale Alert - West Coast 2018). However, observations are reported for most years from 1999 thru 2010. Lowest numbers observed were three in December 2010, three in November 2008, two in May 2007, 3 in November 2005, two in November 2004, and two in June 2002. Highest numbers observed were 150 in May 2006, 78 in April 2005, 66 in May 2004, and 200 in January 2004. No observations occurred for summer and fall months (Whale Alert - West Coast 2018). Many of the observations were made in areas out past the Channel Islands, although a number of the observations were made between Santa Rosa and Santa Cruz Islands and the mainland near Santa Barbara.

Pacific White-sided Dolphin. Off California, the Pacific white-sided dolphin most commonly occurs at the outer edge of the continental shelf and slope, infrequently moving into shallow coastal waters (Maxon Consulting 2014). They feed on squid and small schooling fish (NMFS 2019b). Pacific white-sided dolphins generally occur in groups of 10 to 100 individuals, but may occur in schools of thousands of animals. Within the Santa Monica Bay area (located between the Santa Barbara Channel-East Platforms and the San Pedro Bay Platforms), Pacific white-sided dolphin group sizes averaged 17.27 individuals (range of 5 to 45) (Bearzi and Saylan 2011).

Based on pooled data from 1991 to 2005, the abundance of Pacific white-sided dolphins in Southern California was estimated at 2196 animals, with 23,817 Pacific white-sided dolphins estimated for Southern California through Oregon/Washington. Throughout the entire study area, Pacific white-sided dolphin density was estimated at 21 individuals/1000 km^2 (Barlow and Forney 2007). Pacific white-sided dolphin densities were estimated at 52 individuals/1000 km^2 and an abundance of 12,371 animals within Southern California (Campbell et al. 2015). Sightings of Pacific white-sided dolphins included areas that encompass the OCS platforms (Campbell et al. 2015). This is based on CalCOFI cruises surveys conducted from July 2004-November 2013. The surveyed area covered coastal to offshore waters totaling 238,494 km^2 from San Diego to north of Point Conception.

Debich et al. (2017) reported observed peaks in abundance of Pacific white-sided dolphins in the Southern California Bight occurring during spring. Highest numbers of Pacific white-sided dolphin observations reported by Whale Alert - West Coast (2018) (Table 12-2) occurred in March (201) and April (133) based on an average for 2014 through 2018, with no observations made in May, July, and September in those years. Whale Alert - West Coast (2018) observations included shoreline to offshore waters.

Risso's Dolphin. Risso's dolphins occur in groups of 5 to 50 individuals, but average 10 to 30 animals. They have been reported as solitary individuals, in pairs, or loose aggregations that number in the hundreds to thousands. They feed on fish, krill, and cephalopods (NMFS 2019b). Risso's dolphins prefer continental shelf and slope areas (Maxon Consulting 2014).

Based on pooled data from 1991 to 2005, the abundance of Risso's dolphins in Southern California was estimated at 3418 animals, with 11,910 Risso's dolphins estimated for Southern California through Oregon/Washington. Throughout the entire study area, Risso's dolphin density was estimated at about 10 individuals/1000 km^2 (Barlow and Forney 2007). Within the Santa Monica Bay area, Risso's dolphin group sizes have been reported to average about 10 individuals (range of 3 to 29) (Bearzi and Saylan 2011). Highest numbers of Risso's dolphin observations reported by Whale Alert - West Coast (2018) (Table 12-2) occurred in July (73) and August (66) based on an average for 2014 through 2018, with no observations made in February and April in those years. Whale Alert - West Coast (2018) observations included shoreline to offshore waters.

Short-beaked Common Dolphin. The short-beaked common dolphin is the most abundant cetacean in California waters. They primarily inhabit coastal near shore waters, but are widely distributed out to at least 300 nautical miles (nmi) (Kaplan et al. 2010). The short-beaked common dolphin is usually found in groups numbering hundreds of individuals, but have been observed in groups numbering 10,000 or more. They mostly prey on fish and cephalopods (NMFS 2019b).

Based on pooled data from 1991 to 2005, the abundance of short-beaked common dolphins in Southern California was estimated at 165,400 animals with 352,069 short-beaked common dolphins estimated for Southern California through Oregon/Washington. Throughout the entire study area, short-beaked common dolphin density was estimated at 309.35 individuals/1000 km^2 (Barlow and Forney 2007). Barlow and Forney (2007) also provided values for unclassified common dolphins (undifferentiated long-beaked and short-beaked common dolphins). Their abundance was 4281 animals in Southern California and 5629 animals throughout the study are. The density was estimated at 4.95 individuals/1000 km^2.

Short-beaked common dolphin densities have been estimated at about 706 individuals/1000 km^2 and an abundance of 167,988 animals (Campbell et al. 2015). This is based on CalCOFI cruises surveys conducted from July 2004-November 2013. The surveyed area covered coastal to offshore waters totaling 238,494 km^2 from San Diego to north of Point Conception. No coastal sightings of short-beaked common dolphins occurred off Point Conception (the area of the Santa Maria Basin Platforms (Campbell et al. 2015).

Debich et al. (2017) reported observed peaks in abundance of short-beaked common dolphins in the Southern California Bight occurring during summer. Observations numbering in the thousands of short-beaked common dolphins are reported monthly from June through November based on observations made from 2014 through 2018 (Whale Alert – West Coast 2018) (Table 12-2). The lowest average monthly number of observations was 161 in February. Highest observations of undifferentiated common dolphins occurred in April and June through August. Most observations of short-beaked common dolphins occurred between the northern Channel Island and mainland.

Short-finned Pilot Whale. The short-finned pilot whale primarily feeds on cephalopods and fish in moderately deep waters of 1000 ft or more. The short-finned pilot whale occur in groups of 25 to 50 individuals. (NMFS 2019a). Sightings of the short-finned pilot whale off Southern California are rare since 1993 (Kaplan et al. 2010). However, short-finned pilot whales are believed to group during winter off Santa Catalina Island (Maxon Consulting 2014). This island is southwest of the San Pedro Bay Platforms. Hundreds of short-finned pilot whale were observed in June, October, and November 2014 (Kim 2015). Based on pooled data from 1991 to 2005, the abundance of short-finned pilot whales in Southern California was estimated at 118 animals, with 350 short-finned pilot whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, short-finned pilot whale density was estimated at less than one individual/1000 km^2 (Barlow and Forney 2007).

Striped Dolphin. Striped dolphins tend to occur 100 to 300 nmi offshore (Kaplan et al. 2010). The striped dolphin usually occurs in groups of 25 to 100 individuals, but groups of several hundred to thousands of animals are observed. They feed on fish and cephalopods (NMFS 2019b). Based on pooled data from 1991 to 2005, the abundance of striped dolphins in Southern California was estimated at 12,529 animals with 18,976 striped dolphins estimated for Southern California through Oregon/Washington. Throughout the entire study area, striped dolphin density was estimated at about 17 individuals/1000 km^2 (Barlow and Forney 2007).

12.1.2 Cetacea Species Accounts – ESA Listed Species

Blue Whale. The blue whale is a federal endangered species in (USFWS 1970). The primary reason for listing was a severe worldwide population decline due to intensive commercial whaling. The current population worldwide remains unknown; however, the Eastern North Pacific stock, which frequents the waters off California, has been estimated to be about 1,647 individuals (Carretta et al. 2018). Recent population estimates have remained steady within the California Current at between about 1600 to 2000 individuals (Calambokidis and Barlow 2013).

Blue whale are present within the Southern California Bight primarily during the summer and fall, as it is an important foraging area for the species (Širović et al. 2015; Debich et al. 2017). Within the California Current, blue whales feed exclusively on krill (Hazen et al. 2016). Lower numbers of blue whales also occur off California in winter and spring (Kaplan et al. 2010). Based on Whale Alert - West Coast (2018) observations, blues whales are most often observed in the project area in July and August with lowest observations in January through April (Table 12-2). Blue whales a detected more commonly at coastal sites and near the northern Channel Islands. The highest number of daily blue whale B call detections during peak calling months (August through October) occurred north of Santa Rosa-Santa Cruz Islands (coinciding with the area of the Santa Barbara Channel-West Platforms), south of Santa Rosa Island, and off Santa Monica Bay (Širović et al. 2015).

In summer, blue whales occur throughout coastal, shelf, and offshore waters, while in fall they primarily are observed over the western portion of the continental shelf and in offshore waters of Southern California (Campbell et al. 2015). The blue whale is observed throughout the coastal, continental shelf, and offshore waters in the southern portion of the Southern California

OCS Planning Area. In the northern half of the planning area, sightings were made exclusively in offshore waters (Campbell et al. 2015).

Biologically important areas for blue whales, based on high concentration areas of feeding animals, include:

- Point Conception/Arguello, close to the Santa Maria Basin platforms and western portion of the Western Santa Barbara Channel Platforms;
- Santa Barbara Channel and San Miguel, close to the Western Santa Barbara Channel Platforms; and
- Santa Monica Bay to Long Beach, close to the San Pedro Bay Platforms.

Primary occurrence of blue whales at all three of the biologically important areas is from June through October (Calambokidis et al. 2015).

Based on pooled data from 1991 to 2005, the number of blue whales in Southern California was estimated at 842 with 1548 estimated for Southern California through Oregon/Washington. Throughout the entire study area, blue whale density was estimated at slightly more than one whale/1000 km^2 (Barlow and Forney 2007). Blue whale densities were estimated at about one individual/1000 km^2 and an abundance of 217 animals within Southern California (Campbell et al. 2015). This is based on California Cooperative Fisheries Investigations (CalCOFI) cruises surveys conducted from July 2004-November 2013. The surveyed area covered coastal to offshore waters totaling 238,494 km^2 from San Diego to north of Point Conception.

Fin Whale. The fin whale is a federal endangered species in (USFWS 1970). The primary reason for listing was a severe worldwide population decline due to intensive commercial whaling. Critical habitat has not been designated for this species. Fin whales occur in social groups of 2 to 7 individuals (NMFS 2019a). They feed on krill and fish (Calambokidis et al. 2015).

Fin whales may be present year-round off Southern California; they tend to be closer to shore in winter and spring and farther offshore in summer and fall (Douglas et al. 2014). Highest fin whales calls detections were in the central and southern portions of the Southern California Bight (e.g., off Santa Monica Bay, around and west of the southern Channel Islands, and north of San Diego (Širović et al. 2015). Debich et al. (2017) reported observed peaks in abundance of fin whales in the Southern California Bight occurring during summer. Highest numbers of fin whales observations reported by Whale Alert - West Coast (2018) (Table 12-2) occurred in June (average of about 9). Fin whales are sighted within the Santa Barbara Channel, although they generally occur farther offshore and in waters south of the northern Channel Island chain.

Based on pooled data from 1991 to 2005, the abundance of fin whales in Southern California was estimated at 359 animals with 2099 fin whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, fin whale density was estimated at 1.846 whales/1000 km^2 (Barlow and Forney 2007).

Fin whale densities were estimated at almost three individuals/1000 km^2 with an abundance of 650 animals within Southern California (Campbell et al. 2015). This is based on CalCOFI cruises surveys conducted from July 2004-November 2013. The surveyed area covered coastal to offshore waters totaling 238,494 km^2 from San Diego to north of Point Conception.

Humpback Whale. The humpback whale is listed as a federal endangered species (USFWS 1970). The primary reason for listing was a severe worldwide population decline due to intensive commercial whaling. Critical habitat has not been designated for this species. The humpback is now divided into 14 designated population segments (DPS) (USFWS 2016). Individuals from the endangered Central America DPS and threatened Mexico DPS make use of the waters off California as feeding areas (NMFS 2017b). To a limited extent, humpback whales from the Hawaiian DPS (delisted) may also occur seasonally along the California coast (Calambokidis 2016) with several hundred animals foraging in Southern California each year (NMFS 2014).

Humpback whales are most abundant off the U.S. West Coast from spring through fall. Debich et al. (2017) reported observed peaks in abundance of humpback whales in the Southern California Bight occurring during spring. Highest numbers of humpback whale observations reported by Whale Alert - West Coast (2018) (Table 12-2) occurred in May through September, but individuals are observed year-round. During spring, summer, and fall, the largest concentration occurred in relatively shallow waters north of Point Conception. Winter observations occurred in shelf and offshore waters, with several sightings >200 km form shore (Campbell et al. 2015).

Humpback whales mainly eat krill, but also small fish (NMFS 2019a). Biologically important areas for humpback whales are based on high concentration areas of feeding animals. The Santa Barbara Channel-San Miguel biologically important area is the only one of the seven biologically important areas that occur within the project area. Humpback whales primarily occur at this biologically important area from March through September (Calambokidis et al. 2015).

Based on pooled data from 1991 to 2005, the abundance of humpback whales in Southern California was estimated at 36 animals with 942 humpback whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, humpback whale density was estimated at slightly less than one whale/1000 km^2 (Barlow and Forney 2007). Humpback whale densities within Southern California were estimated at slightly more than one individual/1000 km^2 and an abundance of 278 animals (Campbell et al. 2015). This is based on CalCOFI cruises surveys conducted from July 2004-November 2013. The surveyed area covered coastal to offshore waters totaling 238,494 km^2 from San Diego to north of Point Conception.

Sperm Whale. The sperm whale is listed as a federal endangered species (USFWS 1970). The main reason for its listing was due to a severe worldwide population decline due to intensive commercial whaling. No critical habitat is designated for the sperm whale. Sperm whales tend to occur in deep waters (depths >1000 m) in all seasons (Kaplan et al. 2010; Maxon Consulting 2014). Sperm whales consume large squid, sharks, skates, and fishes (NMFS 2019a).

The sperm whale is widely distributed and may be found year round off California with peak abundance from April through mid-June and from the end of August through mid-November (Maxon Consulting 2014). Based on pooled data from 1991 to 2005, the abundance of sperm whales in Southern California was estimated at 607 animals, with 1934 sperm whales estimated for Southern California through Oregon/Washington. Throughout the entire study area, sperm whale density was estimated at almost two individuals/1000 km^2 (Barlow and Forney 2007).

Sporadic sperm whale observations are reported in the Santa Barbara Channel area by Whale Alert - West Coast (2018). One individual has been observed in each of the following months: August 2018, October 2016, September 2009, July 2005, March 2004, June 2002, and August 1991. Two sperm whales were observed in September 2004, July 2004, and July 1992. One observation from March 2004 was near the cluster of OCS platforms of the Santa Barbara Channel nearest to Santa Barbara, More than 50 sperm whales, including mothers and calves, were observed off Orange County in October 2014 (Kim 2015).

12.1.3 Cetacea Species Accounts – Species Unlikely to be Present in Southern California

Harbor Porpoise. The harbor porpoise usually occurs in small groups of 2 to 5 animals. They feed on schooling fish and cephalopods (NMFS 2019b). No harbor porpoise observations are reported for 2014-2018 (Table 12-2). Whale Alert - West Coast (2018) reported one individual observed in October 1999, two observed in July 1992, two observed in July 2004, and ten observed in November 1989. Biologically important areas for two small harbor porpoise populations are located central and northern California that encompass the populations' primary use areas (Calambokidis et al 2015). The most southern of these is the Morro Bay resident biologically important area (for the Morro Bay Stock) which extends from Point Sur to Point Conception and from land to the 200-m isobath. It contains 2044 animals (Calambokidis et al 2015).

North Pacific Right Whale. The northern right whale is listed as a federal endangered species (USFWS 1970). The primary reason for its listing was a severe worldwide population decline due to intensive commercial whaling. In 2008, NMFS reclassified the northern right whale as two separate endangered species – the North Pacific right whale and the North Atlantic right whale (NMFS 2008b). Critical habitat for the North Pacific right whale is located in Alaska (NMFS 2019a). The North Pacific right whale continues to be one of the rarest whale species in the world with the majority of sightings occurring in the Bering Sea and adjacent areas of the Aleutian Islands (NMFS 2013a). Sightings off the coast of California and Mexico are rare, and there is no evidence that these areas were ever highly frequented by North Pacific right whales (Reilly et al. 2008). The North Pacific right whale has been observed off the Channel Islands in 1981, 1990, and 1992 (Kaplan et al. 2010). No North Pacific right whale observations are reported from 1999-2018 by Whale Alert – West Coast (2018).

Sei Whale. The sei whale is listed as a federally endangered species (USFWS 1970). The primary reason for its listing was a severe worldwide population decline due to commercial whaling. Critical habitat is not identified for the species. Sei whales are usually observed alone or in small groups of 2 to 5 animals. They feed on copepods, krill, cephalopods, and small schooling fish (NMFS 2019a).

Only nine confirmed sightings of sei whales were made in California, Oregon and Washington during extensive ship and aerial surveys conducted between 1991 and 2008 (NMFS 2014). Sightings off Southern California and southward are extremely rare (Kaplan et al. 2010). Based on pooled data from 1991 to 2005, the abundance of sei whales in Southern California was estimated at zero animals, with 98 sei whales estimated for Southern California through Oregon/Washington. Throughout the entire study area (California, Washington, and Oregon), sei whale density was estimated at fewer than one whale/1000 km^2 (Barlow and Forney 2007). As Bryde's and sei whales are difficult to distinguish at sea, Barlow and Forney (2007) also gave an estimate of 7 Bryde's/sei whales in Southern California and 18 individuals for the entire study range.

12.2 Seals, Sea Lions, and Sea Otters

Seven species in the order Carnivora have been reported from the Southern California OCS Planning Area. These species include:

- Two species in the family Phocidae (true seals): the northern elephant seal and Pacific harbor seal;
- Four species in the family Otariidae (eared seal): California sea lion , Guadalupe fur seal, northern fur seal; and Steller sea lion;
- One species in the family Mustelidae (otters, weasels, and badgers): southern sea otter.

Seals, sea lions, and southern sea otters occur throughout portions of the Southern California Planning Area. The mainland coastal areas and northern Channel Islands support numerous haulout and rookery sites for five of the seal and sea lion species (Table 12-4).

TABLE 12-4 Seal Haulout and Rookery Sites

Species	Haulout Site	Rookery Site
Pacific harbor seal	Point Conception, Goleta Point, Rincon Point, Point Mugu, Purisima Point, Santa Rosa Island, Santa Cruz Island, Anacapa Island	Rincon Point
California sea lion	San Miguel Island, Santa Rosa Island, Anacapa Island, Santa Cruz Island, offshore platforms	San Miguel Island, Anacapa Island, Santa Cruz Island
Guadalupe fur seal	San Miguel Island	San Miguel Island
Northern elephant seal	San Miguel Island, Santa Rosa Island	Piedras Blancas, Santa Rosa Island
Northern fur seal	San Miguel Island	San Miguel Island

Sources: CMLPAI (2005, 2009).

12.2.1 Seal, Sea Lion, and Sea Otter Species Accounts – Non-ESA Listed Species

California Sea Lion. California sea lions are the most abundant pinniped within the California Current ecosystem. It breeds off the coast of Mexico and Southern California, with mostly males migrating north during the nonbreeding season. The primary breeding grounds in Southern California are the islands of San Nicholas, Santa Barbara, San Clemente, and San Miguel (Kaplan et al. 2010; Orr et al. 2016). Haul-out sites also occur on Santa Catalina Island (Maxon Consulting 2014). The California sea lion forms groups of several hundred individuals onshore. The California sea lion also hauls out to rest on other islands, beaches, and buoys (Kaplan et al. 2010). Those that breed on the Channel Islands typically feed over the continental shelf and remain within 60 mi of the islands (Maxon Consulting 2014). They prey on squid and fish mainly in upwelling areas, and take fish from commercial fishing gear, sport-fishing lines, and at fish passage facilities at dams and rivers (NMFS 2019c). During the nonbreeding season, the California sea lion most often occurs over the continental slope or offshore waters (Maxon Consulting 2014).

An unusual mortality event (UME) of elevated strandings of California sea lion pups and yearlings stranding on the beaches of central and Southern California, particularly from Santa Barbara County to San Diego County, has occurred since 2013. Change in the availability of sea lion prey, especially sardines, which may be associated with El Niño, is a likely contributor to the UME (MacCall et al. 2016). Mothers unable to provide adequate milk, results in premature weaning, forcing the pups to try to feed on their own before they are able, resulting in starvation. From January through May 2015, a total of 3340 California sea lion strandings occurred compared to an average of 315 for the years 2004 through 2012. The current stranding levels are not a major concern for the overall population (e.g., about 0.5% of the population stranded during 2013) (NMFS 2017).

The OCS platforms provide haulout space near foraging areas for California sea lions. The platforms also provide structure and habitat for various invertebrates and fish communities, on which California sea lions (and other species) can foraging (Orr et al. 2016).There were no consistent spatial or seasonal trends in number of California sea lions using the platforms. Fencing and platform activities have tended to limit use of the platforms (Orr et al. 2016).

Pacific Harbor Seal. While the harbor seal is considered nonmigratory, seasonal movements in the hundreds of kilometers have been documented (Kaplan et al. 2010). Harbor seals use rocks, reefs, beaches, and drifting glacial ice as haul out sites. They eat fish, shellfish, and crustaceans (NMFS 2019c). During late May to early June, peak numbers haul-out on land in order to molt. In the late fall and winter, they may be at sea for several weeks to feed (Maxon Consulting 2014). The southern Channel Islands have the largest concentration of harbor seals in California. Harbor seals are year-round residents at most of their haulout sites, but abundance varies seasonally. They are also prevalent in the northern Channel Islands and along portions of the mainland within the project area. While Harbor seals are occasionally observed in waters adjacent to platforms, unlike the California sea lion they have not been observed hauled out on the platforms (Orr et al. 2016).

Northern Elephant Seal. Northern elephant seal breeding season is generally December through March. They spend the most of the remainder of the year in the ocean, where they dive to depths of 1000 to 2500 ft to feed. They prey mostly on squid and fishes including rays and sharks (NMFS 2019c). Adults return to land between March and August to molt (Kaplan et al. 2010). Most sites used for breeding are also used for molting. Large numbers of juveniles also haul out at these sites in fall preceding the breeding season. The northern elephant seal migrates north to feeding grounds twice a year. When not on land, they spend most of their time underwater probably feeding on deepwater benthic species such as rockfish, squid, swell sharks, and ratfish (CMLPAI 2009). The majority of the northern elephant seal population breeds in the Southern California Bight. Small colonies breed and haul-out on Santa Barbara Island with large colonies on San Miguel and San Nicholas Islands and at Piedras Blancas in San Luis Obispo County (Maxon Consulting 2014; Friends of the Elephant Seal 2018). These sites are not located near the offshore platforms. During the nonbreeding season, they mostly range along the coast of Oregon, Washington, and Alaska (Kaplan et al. 2010).

Northern Fur Seal. One of only three breeding sites in the United States for the northern fur seal occurs on San Miguel Island (the other locations are the Pribilof Islands and Bogoslof Island). (A small population has developed on South Farallon Island off the coast of San Francisco, presumably immigrants from San Miguel Island [NMFS 2019c].) The breeding season can range from May to early November. Peak pupping is early July. After the breeding season, the northern fur seal remains pelagic. Southern California is at the southern boundary of its range. Northern fur seals that breed on San Miguel Island tend to remain in the area throughout the year. Major El Niño events have caused declines in the northern fur seal population on San Miguel Island. However, the population began to recover in 1999, and now numbers more than 9,000 individuals. The northern fur seals use the open ocean for foraging and rocky beaches for reproduction. The diet of the northern fur seal includes fish and squid. Feeding may occur around major oceanographic features such as seamounts, canyons, valleys, and along the continental shelf (NMFS 2019c). Aquatic habitats used by the northern fur seal do not tend to coincide with areas of the OCS platforms.

Steller Sea Lion. Steller sea lions that occur in the Southern California OCS Planning Area are from the Eastern Distinct Population Segment that is now delisted (NMFS 2019c). The Steller sea lion is a colonial breeder. They feed on a variety of fishes, bivalves, cephalopods, and gastropods. They may disperse long distances to find prey, but are not known to migrate. Haul outs and rookeries usually consist of beaches, ledges, and rocky reefs (NMFS 2019c). The Channel Islands were a breeding area into the 1980s. Currently, the Steller sea lion does not typically occur on the islands, possibly due to warming temperatures (Kaplan et al. 2010). At sea sightings are concentrated in shallow waters over the continental shelf and upper slope (<400 m) and within 50 km from shore (BOEM 2011). Steller sea lions are occasionally present at Platforms Elly and Habitat during winter months (Orr et al. 2016).

12.2.2 Seal, Sea Lion, and Sea Otter Species Accounts – ESA-Listed Species

Guadalupe Fur Seal. The Guadalupe fur seal is listed as a federal threatened species (NMFS 1985). The main reason for listing was a severe population decline due to hunting. No critical habitat has been prepared for the Guadalupe fur seal. Since their listing, Guadalupe fur seals have significantly increased in numbers. The Guadalupe fur seal is a pelagic species for most of the year. Breeding occurs almost entirely on Isla de Guadalupe, Mexico, from May to July (CMLPAI 2009; NMFS 2019c). In recent years, several Guadalupe fur seals have been consistently observed at San Miguel Island. In 1997, a pup was observed there but no other pups were observed until 2008. Breeding colonies may occur on San Miguel and San Nicolas Islands (Seal Conservation Society 2011).

Guadalupe fur seals are solitary, non-social animals, but males may mate with up to 12 females during the breeding season (NMFS 2019c). They feed in deep waters on krill, squid, and small schooling fish (CMLPAI 2009). Unusual mortality events (UME), in the form of increased strandings of Guadalupe fur seals, have occurred along the entire coast of California, beginning in January 2015 at eight times higher than the historical average. Strandings have continued since 2015 at well above average rates in California. Additionally, Guadalupe fur seal strandings in Oregon and Washington became elevated in 2019. Most stranded animals were malnourished with secondary bacterial and parasitic infections (NMFS 2019d).

Southern Sea Otter. The southern sea otter is listed as a threatened species (USFWS 1977). The primary reasons for listing the southern sea otter were 1) its small population size and limited distribution and 2) the threat of oil spills, pollution, and competition with humans. No critical habitat has been identified for this species. Currently, the range of the mainland population extends from Marin County in the north to Santa Barbara County in the south (USFWS 2017). Since 1998, 15 to 110 southern sea otters per year have occupied areas south of Point Conception (Tinker et al. 2017). In addition, there is a population near San Nicolas Island (Ventura County) located 61 mi from the nearest point of the mainland. The translocated southern sea otter population at San Nicolas Island has increased in recent years. Counts throughout the 1990s generally recorded between 11-21 individuals. Over the last fifteen years, that number has steadily increased to a high count of 104 individuals in 2016 (Tinker and Hatfield 2016). The current 3-year average at San Nicolas Island is 78 individuals, which continues a positive trend of approximately 13% per year (Tinker and Hatfield 2016). The overall 5-year trend for southern sea otters (including both the mainland and San Nicolas Island populations) is 3.2% per year.

Sea otters typically inhabit shallow nearshore waters with rocky or sandy bottoms supporting large populations of benthic invertebrates. Observed densities are higher over rocky (about 5/km^2) than sandy habitat (about 0.8/km^2). In California, otters live in waters less than 18 m deep and rarely move more than 2 km offshore (Riedman and Estes 1990). In California, sea otters rarely eat fish; most of their diet is large invertebrates such as abalone, crabs, and sea urchins (CMLPAI 2009).

Laidre et al. (2001) estimated that 15,961 sea otters could be supported in California. Prior to commercial exploitation, there was an estimated 16,000 to 20,000 sea otters in California (CDFW 1976). In 1990, the population was 1,680 individuals. The population has steadily climbed since then and the most recent spring survey in May 2016 counted 3,511 sea otters, the highest count on record (Tinker and Hatfield 2016). As individual year counts may be highly influenced by survey conditions, the final revised recovery plan for the southern sea otter recommends using the 3-year running average as the official benchmark of the sea otter population status (USFWS 2003). In 2016, the 3-year running average was 3,272 sea otters (Tinker and Hatfield 2016).

The primary factors limiting population growth and range expansion in recent years are density-dependent resource limitation (sea otter numbers are in equilibrium with available prey) in much of the central portion of the mainland range and white shark attacks (*Carcharodon carcharias*) in the northern and southern portion of the mainland range (USFWS 2017a). The dramatic increase in southern sea otter mortality from white shark bites in California is probably due to increased availability of white shark prey (seals and sea lions) in the area, which has increased white shark abundance and/or changed white shark behavior or distribution. The attacks on the southern sea otter are non-consumptive bites, as the white sharks do not prey on sea otters (Tinker et al. 2016). This source of mortality represents the biggest threat to continued population growth of the southern sea otter in the Santa Barbara Channel (Tinker et al. 2017).

While the annual spring southern sea otter counts south of Cayucos have increased, there is a recent decreasing 5-year trend of approximately -0.6 percent per year in this region. This decreasing trend is consistent with an increase in shark bite mortality over the last 10 years in this peripheral area of lower population density. Notably, the specific area where the population trend is most negative (from Cayucos to Point Conception) coincides exactly with an area of increased shark bite mortality (Tinker et al. 2016). The lack of population growth at the southern periphery over recent years likely explains the cessation of range expansion, as it is growth at the range ends that typically fuels range expansion (Tinker et al. 2008; Lafferty and Tinker 2014).

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13 AREAS OF SPECIAL CONCERN

This chapter identifies and briefly discusses areas of special concern within the Southern California OCS Planning Area and vicinity. These areas include a number of federally and State managed areas such as Marine Protected Areas (MPAs) and offshore military use areas. There are also several coastal and aquatic reserves managed by nongovernmental organizations along the Pacific coast (BOEMRE 2010). Federally managed MPAs include areas designated as National Marine Sanctuaries (NMSs), National Parks (NPs), National Wildlife Refuges (NWRs), National Estuarine Research Reserves (NERRs), and National Estuary Program (NEP) estuaries. In addition to these types of areas of special concern, the Southern California OCS Planning Area also includes offshore military use areas, and coastal areas along the planning area include a number of State of California protected areas. Critical habitat (as designated under the ESA) for endangered species is discussed in biota-specific sections presented earlier.

13.1 Marine Sanctuaries

The only NMS along the southern Pacific coast is the Channel Islands NMS, designated in 1980 under the National Marine Sanctuaries Act (U.S. Department of Commerce et al. 2009). The Channel Islands NMS is located in the waters surrounding the islands and offshore rocks in the Santa Barbara Channel: San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, Richardson Rock, and Castle Rock (Figure 13-1). The sanctuary covers an area of about 1,110 nautical mi^2 (3,807 km^2) and extends seaward about 6 nautical mi (11 km) from the Channel Islands and offshore rocks.

In 2002, the California Fish and Game established a network of MPAs within the nearshore waters of the sanctuary, and in 2006 and 2007 NOAA expanded the network into the sanctuary's deeper waters (National Ocean Service 2017). The entire MPA network consists of 11 marine reserves (where all fish take and harvest is prohibited) and two marine conservation areas (where limited take of lobster and pelagic fish is allowed). The Channel Island NMS supports a diversity of marine life and habitats, unique and productive oceanographic processes and ecosystems, and culturally significant resources such as submerged cultural artifacts and shipwrecks (U.S. Department of Commerce et al. 2009).

Located along the central California Coast, the Monterey Bay NMS extends from San Francisco to Cambria in San Luis Obispo County. The Monterey Bay NMS covers an area of about 4,600 nm^2 (15,780 km^2) and includes Marine reserves and marine conservation areas.

13.2 National Parks

The Channel Islands NP encompasses an area of over 380 mi^2 (1,000 km^2), and includes five islands off the southern coast of California (San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, and Santa Barbara Island) and the seaward waters for one nautical mile beyond the islands (Figure 13-2). The park has both terrestrial and aquatic habitats (e.g., kelp forests, seagrass beds, rock reefs and canyons, pelagic waters, coastal marshes and lagoons, sand beaches, sea cliffs, and rocky intertidal benches). Ecological resources in the park include seal, sea lion, and seabird rookeries, and at least 26 species of cetaceans have been reported from its waters. Archaeological and cultural resources (spanning more than 10,000 years) are also present (BOEMRE 2010).

Other sensitive areas managed by the National Park Service include National Monuments and National Recreation Areas. Cabrillo National Monument is located on Point Loma Peninsula, on the Southern California coast just west of San Diego (NPS 2017a). The monument features rocky intertidal habitats, including tidal pools, seal and sea lion habitat, and cultural resources. Santa Monica Mountains National Recreation Area is located west of Los Angeles, with 41 miles (66 km) of coastline extending from Point Mugu to Santa Monica (NPS 2017b). Coastal habitats within the recreation area boundaries include rocky tide pools, sand beaches, lagoons, and salt marshes. Numerous protected areas within the recreation area are managed by state and local agencies.

13.3 National Wildlife Refuges

There are 28 National Wildlife Refuges (NWRs) along the Pacific coast, most of which were established to provide feeding, resting, and wintering areas for migratory waterfowl and shorebirds. Four of these are located off the southern coast of California: (1) Seal Beach, (2) San Diego Bay, (3) San Diego, and (4) Tijuana Slough. Together, these NWRs comprise the San Diego Wildlife Refuge Complex. There are no coastal or offshore NWRs for San Lois Obispo, Santa Barbara, or Ventura Counties.

13.4 National Estuarine Research Reserves

The Tijuana River NERR, one of six NERRs within the Pacific Region, is located on the Southern California coast just to the north of the U.S.–Mexico border and is jointly managed by the California State Park system and the U.S. Fish and Wildlife Service. Established in 1982, the Tijuana River NERR is a saline marsh reserve that encompasses 2,293 acres (9.3 km^2), and is recognized as a wetland of international importance (NOAA 2017). It is home to eight threatened and endangered species, including the Light-footed Clapper Rail and the California Least Tern.

13.5 National Estuary Program

Of the six estuaries established under the NEP in the Pacific region, one is located along the Southern California coast and one along the central coast. The Santa Monica Bay NEP was established off Los Angeles County in 1988 to improve water quality, conserve and rehabilitate natural resources, and protect the Bay’s benefits and values (Santa Monica Bay Restoration Commission 2008). The Santa Monica Bay ecosystem includes a wide diversity of habitats such as sandy and rocky intertidal habitats, lagoons, saltmarsh, and mudflats, with a watershed that encompasses 414 mi^2 (1,072 km^2). Sensitive resources within the estuary include threatened and endangered species, such as the California least tern; western snowy plover; the green, leatherback, loggerhead, and olive Ridley sea turtles; and steelhead (BOEMRE 2010).

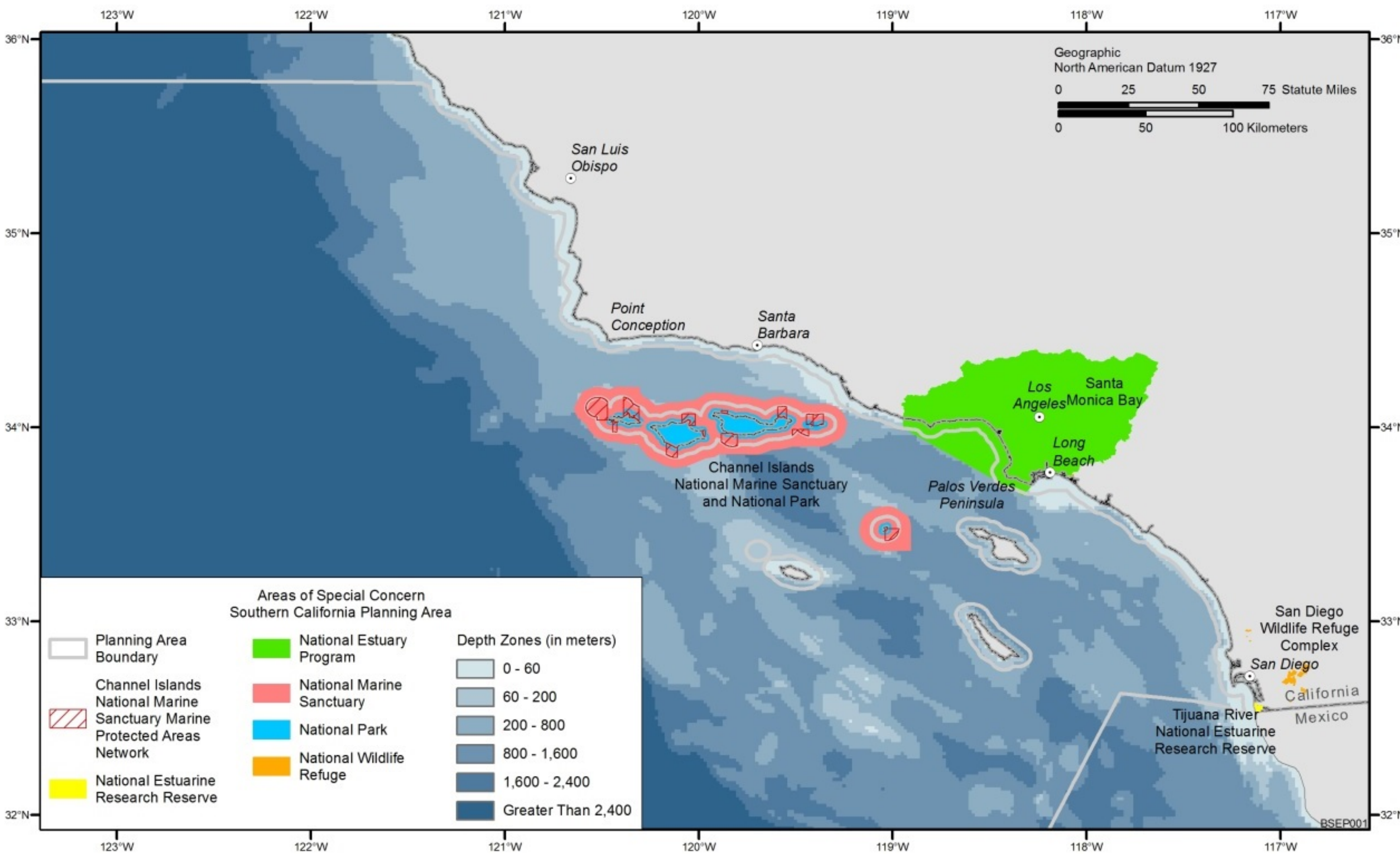

FIGURE 13-1 Federally Managed Marine Protected Areas along the Southern California Coast

The Morro Bay National Estuary Program was established in 1994 in San Luis Obispo County to protect and restore the Morro Bay Estuary. Sensitive resources within the 2,300-ac estuary include a wide range of wetlands, creeks, salt and freshwater marshes, intertidal mud flats, and eelgrass beds. The priority issues for the estuary and watershed are accelerated sedimentation, bacterial contamination, elevated nutrient levels, toxic pollutants, scarce freshwater resources, preserving biodiversity, and environmentally balanced uses (Morro Bay National Estuary Program 2017).

13.6 Military Use Areas

Military use areas, established in numerous areas off all U.S. coastlines, are used by the U.S. Air Force, Navy, Marine Corps, and Special Operations Forces to conduct various testing and training missions. Military activities can be quite varied but normally consist of air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and antisubmarine training, and air force exercises. Numerous military use areas exist in the Southern California OCS Planning Area and adjacent coastal areas (Figure 13-2).

The Point Mugu Sea Range is a region in the southern Pacific region used intensively for military-related operations. The Point Mugu Sea Range encompasses 36,000 mi^2 (93,240 km^2) of ocean and controlled airspace, is about 200 mi (322 km) long (north to south), and extends west into the Pacific Ocean from its nearest point at the mainland coast (3 mi [5 km] at Ventura County) out to about 180 mi (290 km) offshore (Figure 13-2). There are four OCS platforms (Harvest, Hermosa, Hidalgo, and Irene) located in Military Warning Area W-532; these were installed in 1985 and 1986 and are still in place (BOEMRE 2010). Lessees and platform operators are required to coordinate activities with appropriate military operations to prevent potential conflicts with military training and use activities.

Vandenberg Air Force Base is located in western Santa Barbara County. The base is home to the 30th Space Wing, managing space and missile testing and satellite launches. The 30th Operations Group commands and controls the Western Range, where space launch missions are conducted. Three coastal beaches on the base provide habitat for ESA-listed species. Navy Fleet and Marine Corps amphibious training occurs almost daily along the Pacific coast, with activity varying from unit-level training to full-scale carrier/expeditionary strike group operations and certification.

Marine Corps Base Camp Pendleton, the Corps' largest West Coast expeditionary training facility, encompasses more than 125,000 acres of Southern California terrain. The base is located approximately 38 miles north of downtown San Diego in North County and 82 miles south of Los Angeles. Camp Pendleton is one of the Department of Defense's busiest installations and offers a broad spectrum of training facilities for many active and reserve Marine, Army and Navy units, as well as national, state and local agencies.

For some of the military use areas, the U.S. Army Corps of Engineers has established surface danger zones and restricted areas used for a variety of hazardous operations (Figure 13-2). These danger zones may be closed to the public on a fulltime or intermittent basis. A restricted area is a defined water area for the purpose of prohibiting or limiting public access.

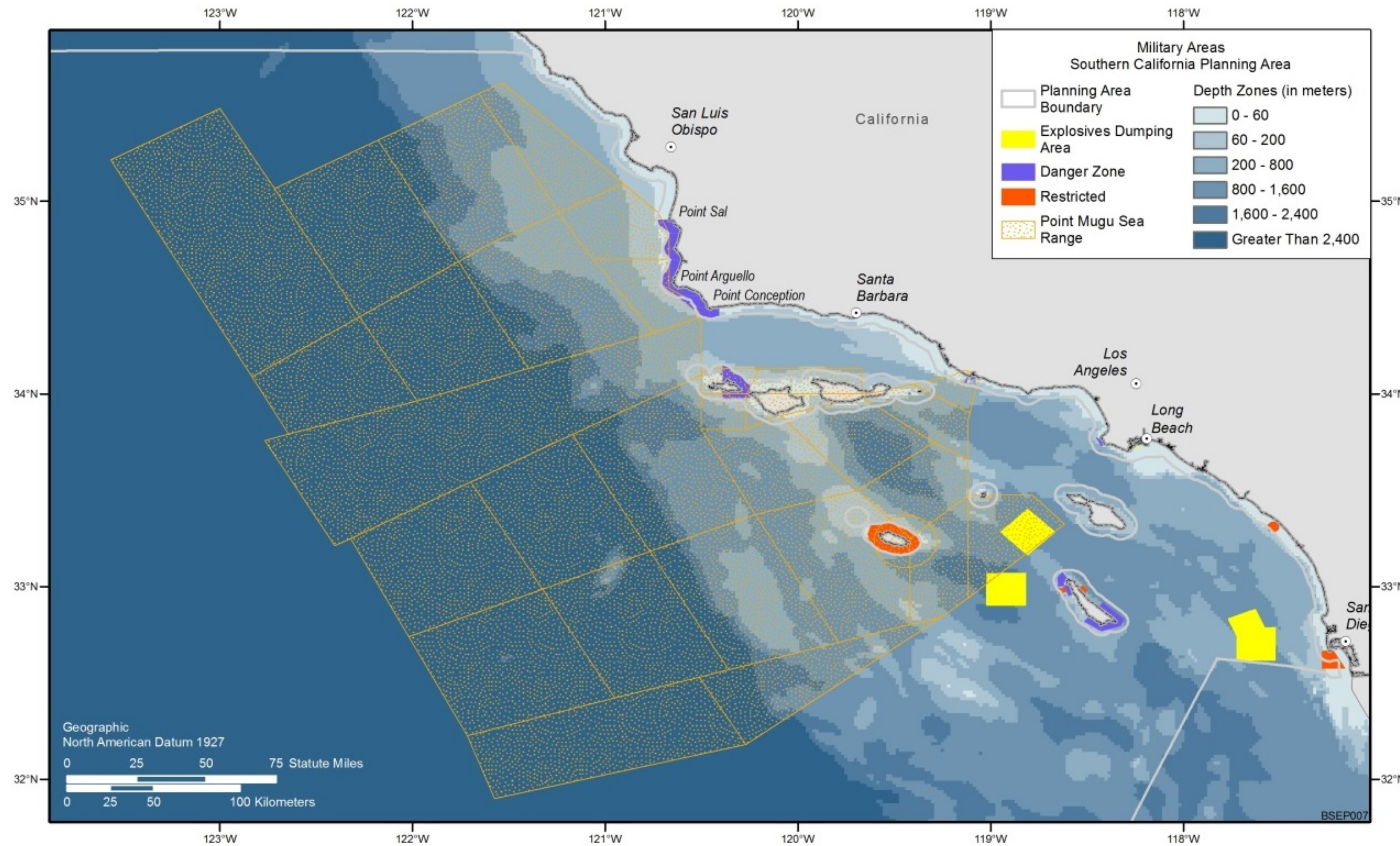

FIGURE 13-2 Military Use Areas along the Southern California Coast

Restricted areas generally provide security for government property and/or protection to the public from the risks of damage or injury arising from the government's use of that area.

13.7 California State Protected Areas

There are 50 State-designated MPAs along the southern Pacific coast (from Point Conception to the U.S.–Mexico border), covering about 356 mi^2 of ocean, estuary, and offshore rock/island waters , and 9 State-designated MPAs along the central California coast (from the Monterey County line to Point Conception) (Figure 13-3) (CDFW 2016, 2017). These designations have been in effect in State waters since January 1, 2012, and include the following:

- 23 State marine reserves, which prohibit damage or take of all marine resources (living, geological, or cultural);
- 25 State marine conservation areas, which may allow some recreational and/or commercial take of marine resources;
- 10 State marine conservation areas, which generally prohibit the take of marine resources (living, geological, or cultural), but allow some ongoing permitted activities such as dredging to continue; and
- One State marine recreational management area, which limits recreational and commercial take of marine resources while allowing for legal waterfowl hunting to occur.

In addition, two special closure areas, designated by the California Fish and Game Commission and managed within the California MPA network, prohibit access or restrict boating activities in waters adjacent to seabird rookeries or marine mammal haul-out sites.

13.8 References

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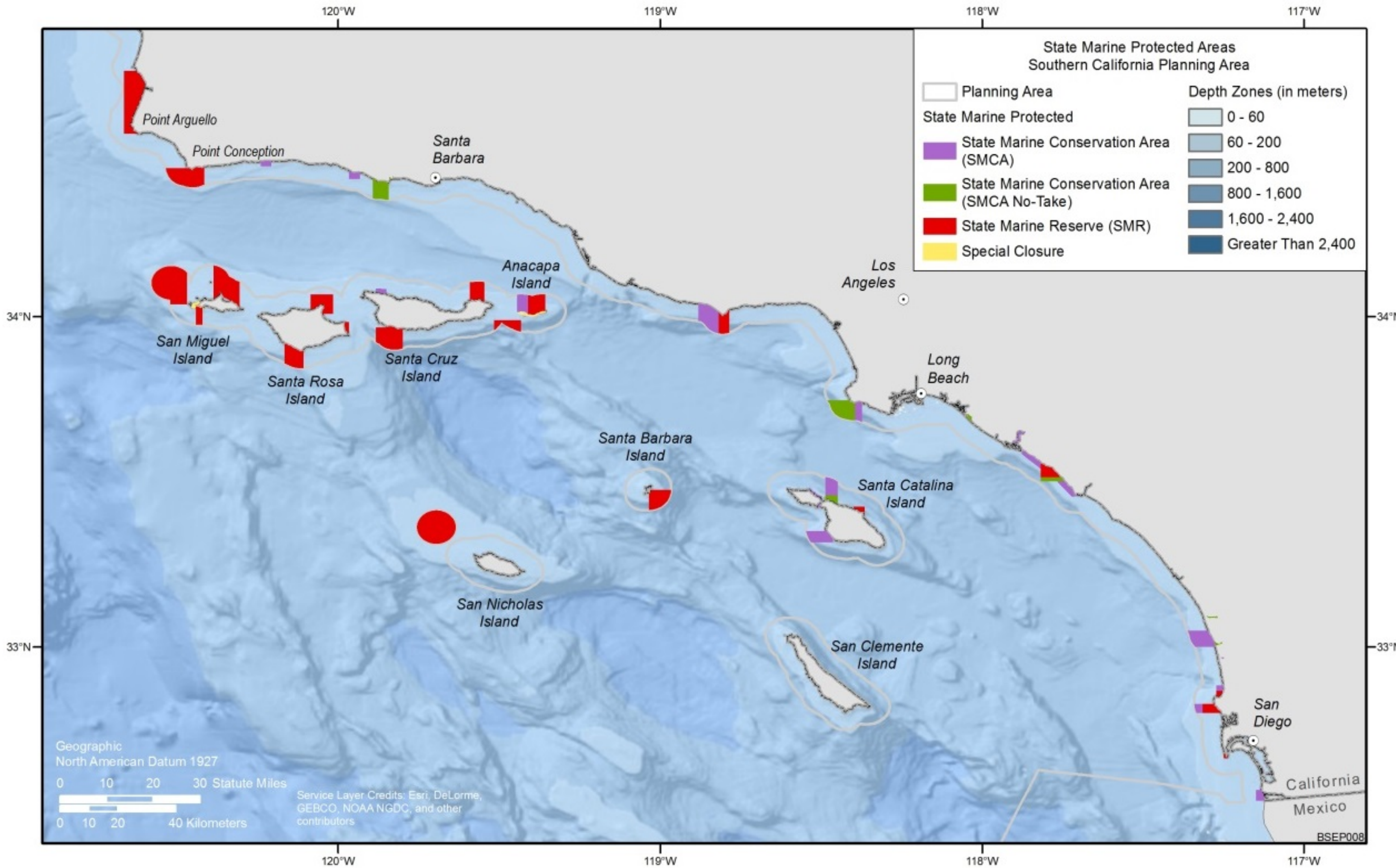

FIGURE 13-3 State-Designated MPAs along the Southern California Coast

14 CULTURAL RESOURCES

This chapter discusses the cultural resources that occur within the Southern California Planning Area and its five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). Then following sections discuss the archeological and historic contexts of the area, as well as the types of cultural resources known to occur in the area.

Cultural resources are typically categorized as archeological resources, historic and pre-contact structures, cultural landscapes, traditional cultural properties, ethnographic resources, and museum collections. These include submerged resources like shipwrecks, submarines, aircraft, barges, sunken navigational equipment such as buoys, man-made infrastructure, and inundated pre-contact archaeological sites. Many natural resources, such as plants and plant gathering areas, water sources, minerals, animals, and other ecological resources, are also considered cultural resources, as they are integral to the identity of Native American Tribes in various ways. Cultural resources may contain a visual component that contributes to one's capacity to use or enjoy a place of cultural importance. This includes, but is not limited to:

- Impacts on a tribal member's ability to perform or participate in a traditional ceremony;
- A trail enthusiast's ability to hike along a National Historic Trail route and experience the setting of those who traversed the trail during its period of significance;
- A driver's visual experience along a scenic byway; or
- A researcher's ability to search for answers to landscape-level questions because the landscape no longer looks the same.

Cultural resources are managed under a variety of laws and regulations including the Archaeological and Historic Preservation Act of 1974 (AHPA), the Archaeological Resource Protection Act (ARPA) of 1979, the Native American and Graves Protection and Repatriation Act (NAGPRA) of 1990, the Natural Historic Preservation Act (NHPA) of 1966 as amended in 2006, the American Indian Religious Freedom Act of 1978, the Submerged Lands Act of 1953, the Abandoned Shipwreck Act of 1987, and the Sunken Military Craft Act of 2004.

Historic properties are a subset of cultural resources. Historic properties are defined in the NHPA (54 U.S.C. § 300308) as any "prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places, including artifacts, records, and material remains relating to the district, site, building, structure, or object." Section 106 of the NHPA mandates that federal agencies must take into account the effects of their actions on historic properties listed on or eligible for inclusion on the National Register of Historic Places (NRHP). Historic properties can be either man-made or natural physical features associated with human activity and, in most cases, are finite, unique, fragile, and nonrenewable. For example, historic properties can include traditional cultural properties (TCPs), which are properties that are important to a community's practices and beliefs and that are necessary for maintaining the community's cultural identity.

Under the NHPA, the American Indian Religious Freedom Act, and Executive Order 13007, federal agencies are also required to consider the effects of their actions on sites, areas, and other resources (e.g., plants) that are of cultural and religious significance to Native Americans, Native Alaskans, and Native Hawaiians. Native American graves, funerary objects, sacred objects, or objects of cultural patrimony are protected by NAGPRA.

14.1 Archaeological Context

14.1.1 Terminal Pleistocene/Early Holocene (14,000 to 8,000 BP[15])

The earliest discovered California coastal sites are found on the Northern Channel Islands of Southern California. Sites in this time period date between 13,000 and 12,000 BP (Erlandson et al. 2007; Arnold et al. 2004; Erlandson 1997). Sites from this period in the Channel Islands are found mostly on island shores, indicating a dependence on the marine environment.

Early Holocene sites on the islands are mostly associated with the Paleo coastal tradition (Moratto 1984; Erlandson et al. 2007). The Paleo coastal tradition mirrors the Paleo Indian tradition with an abundance of flaked stone tool types and distinctive lithic technology. However, additional components such as marine focused tools like pitted stones, asphaltum, shell spoons and ornaments, pointed-bone objects, eccentric crescents, spire-removed *Olivella* beads, cordage and basketry made from sea grasses, and bonefish gorges are also common artifacts of this time period (Connolly et al. 1995; Rick et al. 2005; Vellanoweth et al. 2002, 2003). Shellfish harvesting and fishing were the main food procurement strategies (Erlandson 1994; Erlandson et al. 2007); however, the types of sea creatures harvested often depended on the marine environment immediately surrounding each island (Rick et al. 2005). The Arlington Springs site on Santa Rosa Island provides the earliest evidence for human occupation on the islands (Johnson et al. 2002; Orr 1962). A date of approximately 13,000-11,500 CAL BP[16] has been assigned to the two femora once found eroding out of a hillside, making this skeleton possibly the oldest person known on the west coast (Johnson et al. 2002; Erlandson et al. 2007; Arnold et al. 2004; Orr 1962). There is a significant increase in island coastal occupation seen soon after the Arlington Springs site, dating between 12,000 to 10,000 BP.

Daisy Cave [CA-SMI-261[17]] on San Miguel Island is a multi-component site spanning early through Late Holocene. Shell middens from this site date to approximately 11,600-8,500 BP (Erlandson et al. 1996). Shell middens at Seal Cave [CA-SMI-604], another multi-component cave site on San Miguel Island, date to approximately 10,200-9,100 CAL BP (Rick et al. 2003).

Early Holocene occupations are evident on the southern Channel Islands. Two

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[15] BP = Before Present. Standard practice sets ‘present’ as January 1, 1950. It is most often used for dates established by means other than radiocarbon dating, such as when dating stratigraphy.

[16] CAL BP = abbreviation for "Calibrated Years Before Present (BP)" or "Calendar Years Before Present." Signifies that the raw radiocarbon date cited has been corrected using current methodologies such as tree ring data.

[17] Trinomial site number assigned by the California Historic Resources Information Center for historical resources in the state.

multi-component sites, Eel Point and Punta Arena on San Clemente Island, provide us with evidence of occupation as early as 9,000-8,000 CAL BP for Eel Point (Cassidy et al. 2004) and 8,920-7,650 CAL BP for Punta Arena (Glassow 1980; Erlandson 1994). These sites exhibit evidence of hearths, houses, and shell middens spanning the entire Holocene. A large habitation site [CA-SNI-339] on the eastern end of San Nicolas Island dates to 8,510-8,350 CAL BP and currently serves as the island's oldest site (Martz 2005).

Evidence from early Channel Island sites, such as Arlington Springs [CA-SRI-173] and Daisy Cave [CA-SMI-261], suggests that paleo coastal peoples may have descended from different cultural entities than Paleo Indian peoples on the mainland (Rick et al. 2001; Erlandson et al. 1996, 2007). Some researchers believe that Channel Island and Inland Paleo-Indian sites are related (MorattoMoratto 1984). However, this belief is difficult to prove due to the high sea level rise during the late Pleistocene era, which destroyed several Paleo coastal sites (Moratto 1984; Erlandson et al. 2007).

Large numbers of sites dating between 10,000 to 8,000 BP are present on the entire California Coast and the majority are found in Southern California (Erlandson et al. 2007; Arnold et al. 2004; Erlandson 1997). Most of these sites are associated with the Milling Stone Horizon. The Milling Stone Horizon is an archaeological period in California involving extensive use of manos and other grinding technology. The interval is a subset of the Archaic Period; specifically, Milling Stone is usually applied to the periods 9,950 to 6,950 BP and 3,950 to 1,450 BP. Artifacts attributed to this culture consist of flake tools, milling slabs, hand stones, crude core and cobble-core tools, crescents, side-notched projectile points, and rare contracting-stemmed projectile points; a small number of sites include low quantities of ground stone artifacts (Jones et al. 2007; Erlandson et al. 2007; Erlandson 1997).

Important sites attributed to the Milling Stone Horizon include the Diablo Canyon site [CA-SLO-2 and CA-ORA-64] and the Cross Creek site [CA-SL-1797]. There is an increase in sites along the coastline that date between 9,000 and 8,000 BP (Erlandson et al. 2007). However, a large number of sites are most likely submerged due to rising sea levels (BOEM 2013).

Throughout the Early Pleistocene through the early Holocene, various forms of flora became available to the inhabitants of the coast (Byrd and Raab 2007; Glassow et al. 2007; Erlandson 1997). Spanning back as early as 12,000 BP there is much evidence of shellfish gathering along the mainland estuaries and bays (Erlandson et al. 2007; Arnold et al. 2004). Subsistence strategies diversify over the later period of the Pleistocene into the early Holocene, and plant gathering along with small mammal and bird hunting had become a focus in subsistence in both mainland and island paleocoastal sites (Erlandson et al. 2007). Shell beads were traded among mainland and islander paleocoastal Indians and may illustrate one of the first regional exchange systems flourishing in the early Holocene period (Byrd and Raab 2007; Glassow et al. 2007; Moratto 1994).

14.1.2 Middle Holocene (8000 to 3000 BP)

The Middle Holocene was a time of great cultural and environmental change for the people of the Channel Islands and coastal California. The islands were used more intensely as sea level stabilized, allowing marine species to burgeon and prosper (Kennett 2005; Rick et al. 2005). Habitation sites expanded to all areas of the islands and inhabitants of the islands began to rely on productive marine habitats for subsistence. There began an intense trading system with other islanders and the mainland due to an increase in population and a more sedentary lifestyle (Scalise 1994; Arnold 1992; Vellanoweth et al. 2002). Flaked stone technology advanced with the appearance of projectile points and the introduction of contracting stem and smaller side-notched variations (Erlandson 1997; Glassow et al. 2007; Jones & Stokes Associates 2007).

There is evidence of an increase in static settlements illustrated by the construction of formal cemeteries and small clusters of subterranean house construction on San Clemente Island. The earliest evidence for permanent housing on the islands is found on San Clemente Island at the Nursery Site [CA-SCLI-1215]. Whale rib bones found in conjunction with house floors, post molds, storage pits, and hearths provide evidence of whalebone houses dating between 3,670 and 4,570 CAL BP at Eel Point [CA-SCLI-43] (Salls et al. 1993; Raab 1997; Byrd and Raab 2007; Arnold et al. 2004; Glassow et al. 2007). Asphaltum basketry impressions and tarring pebbles found on San Nicolas and San Miguel islands reveal evidence of a more sedentary lifestyle as well as the earliest evidence for coiled and twined basketry on the islands (Braje et al. 2005; Vellanoweth 1996). Large cemeteries on San Clemente and San Miguel islands date to the Middle Holocene and offer additional evidence for increased sedentary life (Orr 1968).

There was an intensification of fishing throughout the Middle Holocene. Sites like Little Harbor on Santa Catalina Island (Raab et al. 1995), Bird Blind on San Nicolas Island (Vellanoweth and Erlandson 1999), and Eel Point on San Clemente Island (Vellanoweth 1996) provide archaeological evidence of near-shore and coastal species of fish and sea mammals but leave no evidence of new technologies for procurement until almost the very end of the Holocene. Again, shellfish species made up the majority of food and varied across the channel, with the northern Channel Islands yielding more coldwater species of abalone, mussels, and other shellfish, and the southern Channel Islands yielding more warm-water species (Raab 1997; Raab et al. 1994). Diets were supplemented with nearshore birds, kelp bed fish species, and wild plants which were used and traded from the mainland (Raab 1997). Marine mammals were also an important part of diet and hunting seemed to reach its peak during this time with the sites of Little Harbor and Eel Point on San Clemente Island and Thousand Springs on San Nicolas Island containing an abundance of whale, dolphin, elephant seal, and sea otter bones (Porcasi and Fujita 2000).

Evidence for exchange between the Channel Islands and the mainland increases in Middle Holocene deposits. Steatite (soapstone) from Catalina Island was manufactured into beads, bowls, effigies, and an array of other items, and has been found at sites on the northern and southern Channel Islands as well as the mainland (Vellanoweth 1996). Franciscan chert, fused shale, temblor range chert and Vandenberg chert from the mainland are found on the northern Channel Islands (Munns and Arnold 2002); while chert cores and microdrills from Santa Cruz Island appear on the mainland (Arnold et al. 1997). As the variety of *Olivella* shell beads increased, these beads became progressively more desired on the islands and mainland (Gibson 1992; Rick et al. 2005). *Olivella* shell beads have been extremely useful in identifying exchange relationships and chronological change. However, the *Olivella* grooved rectangular

(OGR) bead has been particularly crucial in identifying routes of exchange. A number of researchers have used this bead along with some other artifacts to identify a trading sphere known as the Southern Channel Islands Interaction Sphere (Bennyhoff and Heizer 1958; Bennyhoff and Hughes 1987; Gibson 1976; Howard and Raab 1993; Vellanoweth 2001; Vellanoweth et al. 2003).

OGR beads have been found at sites on San Clemente, San Nicolas, and Santa Catalina islands in coastal Southern California, and into the Great Basin, and based on radiocarbon dates from associated strata, the interaction sphere may have been in progress as early as 5,250 BP (Howard and Raab 1993) Additionally, accelerator mass spectrometry (AMS) testing of OGR beads from seven different sites along the southern coast mainland and the southern islands produced dates of 5,380 to 4,960 BP (Vellanoweth 2001). OGR beads are not found at any northern island sites, occurring only in areas once occupied historically by Uto-Aztecan speakers, suggesting cultural, linguistic, and socioeconomic affiliation (Howard and Raab 1993; Vellanoweth 2001).

Prior to 6,500 BP, the people of the early period of the mainland paleocoastal occupation lived in grassland and sagebrush communities on elevated landforms found away from the present shoreline (Vellanoweth and Altschul 2002). Mainland sites are mostly associated with the Milling Stone Horizon. Notable sites include the Sand Bluff site [CA-SCR-7], the Diablo Canyon site, [CA-SBA-552], the Kelly site [CA-SDI-9649], and the Harris site [CA-SDI-149] (Hildebrandt 2007; Erlandson 1997).

As many as 75 paleocoastal sites are found dating to about 7,500 BP on the California coast. These sites occur in two large clusters surrounding the coastline. One cluster is at the northern and western Santa Barbara coast and includes the north coast of Santa Rosa and San Miguel islands. The other cluster is found around ancient lagoons of San Diego County (USACE 2003).

Other sites are present (Ventura, Los Angeles, and Orange counties) but have questionable time period occupations (Breschini et al. 1992). These sites include Malaga Cove site [CA-LAN-139], La Brea Tar Pits site [CA-LAN-159], the Haverty or Angeles Mesa site [CA-LAN-171], the Los Angeles Man site [CA-LAN-172], and the Villa Pacifica site [CA-LAN-271], all of which are estimated to be older than 7,000 BP (U.S. Army Corps of Engineers 2003).

Shellfish continue to be an integral part of all paleocoastal Indians diets although the introduction of terrestrial mammals, birds, and estuarine and pelagic fish became a part of all paleocoastal Indian diets. Particularly on the mainland, plant resources involved in agricultural endeavors are reflected with the appearance of the mortar and pestle tools (Erlandson 1997; Glassow 1999; Glassow et al. 2007; Moratto 1984).

Linguistic data may demonstrate two major migrations to the California coast by groups from western North America. The Penutian-speaking peoples and Shoshone speaking peoples began migrating to the Southern California coast from the Great Basin between 4,000 and 3,000 BP (Shipley 1978; Erlandson 1997). This may explain the change in technologies and settlement patterns associated with this time (BOEM 2013).

14.1.3 Late Holocene (3000 BP to Contact)

The most extreme change for the inhabitants of the Channel Islands took place during the Late Holocene. People were now living in large settlements with social and political hierarchies (Carneiro 1970). New bead types, new fishing technologies, the plank canoe, and the bow and arrow are among a few new developments that indicate technological advancement during this time (Arnold et al. 2004; Erlandson 1997).

One of the major developments in the Late Holocene was the introduction of hereditary leadership and large-scale interregional exchange. Sites along the coast of Santa Cruz Island indicate that late Holocene occupations may have been settled around coastal villages with specialized camps located further inland (Munns and Arnold 2002). The northern San Miguel and Santa Rosa islands also exhibit evidence of the growth of coastal village habitations, although the people of these islands were not sedentary until after 650 AD (Kennett and Conlee 2002). In contrast, there are almost no sites on the interior of San Miguel Island in the latter half of the Late Holocene (Kennett and Conlee 2002).

Although there has been minimal research on the southern Channel Islands, there is evidence for some large sedentary village sites. For example, on San Clemente Island, the Nursery Site exhibits evidence of houses and a late Holocene cemetery, while the Lemon Tank site shows evidence of ritual human and animal burials (Raab et al. 1994). On San Nicolas Island, all parts of the island have habitation sites, with many residential areas located in the dunes area of the island (Vellanoweth 1995). The Tule Creek Village site [CA-SNI-25] site in particular seems to be a large village with hearths, dog and fox burials, and a variety of faunal and artifact assemblages associated with the Late Holocene (Vellanoweth 1998; Vellanoweth et al. 2008). Although Santa Catalina Island possesses some of the most well documented sites in the southern Channel Islands, knowledge of these Late Holocene sites is extremely poor. Most research has centered on steatite procurement. Some Late Holocene sites that are associated with steatite procurement have been identified, but little else is known (Raab and Howard 2002).

Subsistence strategies in the Late Holocene changed with the increase in population and a more sedentary lifestyle. As in the Middle Holocene, food choice varied from island to island. On Santa Rosa and San Miguel islands, shellfish were the most important source of food until 650 AD, after which fishing became an integral subsistence strategy (Kennett and Kennett 2000; Kennett and Conlee 2002; Rick 2004). This dietary change may have been due to the advent of the J-shaped fishhook (Kennett and Kennett 2000; Kennett and Conlee 2002) and the plank canoe (Arnold 1995, 2001), making it easier to obtain near-shore and open-water fish.

On San Miguel Island, the increase in pinniped bones throughout archaeological sites dating to around 1,500 CAL BP suggests that sea mammals may have been an equally important source of food (Kennett 2005). This may have been short lived, however, as pinniped bones seem to decrease after 1,500 CAL BP (Kennett 2005). On Santa Cruz Island, fishing seemed to be the most important food procurement strategy with very little sea mammal hunting taking place (Colton 2002; Colten and Arnold 1998; Munns and Arnold 2002). A similar pattern can also be seen at Eel Point on San Clemente Island, where sea mammal hunting and shellfish harvesting declined and fishing and sea otter hunting increased (Porcasi and Fujita 2000; Raab et al. 2002). Birds seem to have been a less important part of the diet at this time than in the Early and Middle Holocene (Porcasi 1999); however, marine bird remains have been found in faunal assemblages at sites on San Miguel and Santa Cruz Islands (Colten 2002; Rick 2004).

Preliminary diet reconstruction analyses from San Nicolas Island have shown a variety of results. While shellfish were the most important part of the diet at a number of sites, fish may have been more important at other sites. This variability has been attributed to site location and erosion patterns of the island. For example, because of their fragile nature, fish bones may be destroyed at a higher rate at some sites due to their higher exposure to erosion (Vellanoweth et al. 2002). In contrast, shells are known to be a more resilient and often last longer in the record, especially at sites that are consistently battered by wind, sand, and water. Conversely, this could be evidence of specific resource processing at some sites; however, more comprehensive studies are needed to support this hypothesis (Vellanoweth et al. 2002).

Very few archaeobotanical studies have been conducted on the Channel Islands; however, a comprehensive study of botanical remains from Santa Cruz Island conducted in 2001 has provided us with an insight into plant subsistence. Analyses of float samples from across the island have revealed that local and imported plants were being used in the Late Holocene, including a number of seeds not native to the island such as the California black walnut (*Juglans californica*) and seeds from the fig-marigold family (Aizoaceaea) (Martin and Popper 2001). Species native to the island include Goosefoot (*Chenopodium* spp.), gourd (Cucurbitaceae), cashew or sumac (Anacardiaceae), milkweed (Asclepidaceae), and coastal prickly pear (*Opuntia littoralis*). These plants most likely were used as supplemental food, as well as for fuel, medicine, textiles, and ritual roles. Soil samples from (CA-SNI-351) on San Nicolas Island have yielded a few items most likely imported from the mainland and include wild cucumber (Marah sp.), red maids (Calandrinia spp.), legume (Fabaceae), manzanita (*Arcostaphylos* spp.), blue or huckleberry (*Vaccinium* spp.) and cluster-lily (*Brodiaea* spp.) (Thomas 1994). Most of these items seem to be imported from the mainland. Additionally, analysis of a pollen wash from a piece of groundstone has suggested it was used to process cheno-am and Poaceae seeds were most likely used to supplement the diet (Cummings 1993).

Technological advances reached their zenith in the Late Holocene, culminating in prized items like the plank canoe and single-piece fishhooks, which improved fishing practices (Arnold 1995, 2001; Munns and Arnold 2002). Distinct lithic assemblages have been noted on various Channel Islands such as San Nicolas, Santa Cruz, San Miguel and Anacapa (Arnold 1985, 1993; Arnold et al. 2001; Preziosi 2001; Rosenthal 1996; Rozaire 1993; Thomas-Barnett 2004). Craft specialization and large-scale trade also prevailed at this time (Arnold 2001; Arnold et al. 2002; Arnold and Graesch 2001; Preziosi 2001) with most of the items made on the Channel Islands being traded to the mainland for food.

The plank canoe (called the tomol by the Chumash and the tee'at by the Gabrielino-Tongva) was in high use by 1,150-950 BP (Arnold 1995, 2001; Munns and Arnold 2002). There is no doubt that the invention of this watercraft forever changed the lives of the people of the Channel Islands. According to ethnographic resources (Hudson 1977; Johnson et al. 2002), the plank canoe was controlled by a group of elite individuals known as the "Brotherhood of the Tomol." A similar organization was known for the Gabrielino-Tongva and the Tee'at. It is believed this group restricted knowledge of the construction methods of the plank canoe in order to regulate trade relationships between the islands and the mainland (Arnold 1987, 2001; Arnold and Munns 1994; McCawley 2002).

According to Arnold and Graesch (2001), shell bead production became increasingly localized and more intense after 900 BP in the northern Channel Islands. Evidence for large-scale bead manufacture has been documented on Santa Cruz and Santa Rosa islands, making them the premier manufacturers of *Olivella* shell beads in the late Holocene (Arnold 1995, 2001; Arnold and Munns 1994; Kennett 1998). In addition, a large microdrill industry appeared on Santa Cruz Island around the same time period (Arnold et al. 2001; Preziosi 2001). No island chert flakes or cores have been found in sites with shell working components after the Middle Late Transitional period (Arnold and Graesch 2001). Most flakes, cores, and other microdrill manufacturing debris has been found in areas immediately outside of the quarries, indicating the Chumash probably controlled access to the quarries after 800 BP (Arnold and Graesch 2001). After 1300 AD, micro blades are common at coastal sites on Santa Rosa and San Miguel islands (Kennett 1998). The exponential increase in bead detritus and microdrills in late period sites on these islands indicates a massive increase in, and concentration on, bead production. Beads and mortar and pestle quantities also increased around 1,300 to 1,000000000 BP on islands such as San Miguel Island. The condition of these artifacts indicates they were possibly manufactured for export or that they were being used to process imported acorns (Conlee 2000; Kennett and Conlee 2002). Steatite trade continued on Santa Catalina Island (Howard 2002) and seeds and acorns continued to be traded from the mainland as well (Martin and Popper, 2001).

The most concrete evidence of human occupation of the entire California coast occurs during the late Holocene period (Moratto 1984; Glassow 1999; Arnold et al. 2004; Erlandson 1997). Cultural complexity and population levels increase during this period. Adaptive food procurement strategies such as a broadening of diet to include both coastal and terrestrial resources is seen at the Elkhorn Slough site (CA-MNT-229) on the central cost of California (Dietz et al. 1988; Patch and Jones 1984). By the late Holocene there is evidence of fully developed fishing and marine mammal hunting along the entire California coast (Erlandson 1997; Moratto 1984; Arnold et al. 2004). Plant resources such as acorns and grasses appear to have been important to southern coast populations (Byrd and Raab 2007; Glassow 1999; Moratto 1984). Technological construction of plank canoes are found on the southern and central California coasts around 1500 BP. These construction styles demonstrate complex social organizations and ranking developed (Arnold and Bernard 2005). Steatite disk beads (Jones & Stokes Associates 2007) along with basketry items (Arnold et al. 2004) appear and increase in numbers along the Southern California coast.

14.2 Historic Context

This section provides a brief history beginning with the Spanish exploration and continuing into the expansion of the U.S. territory in the Southern California region. More information involving Native American prehistoric and historic background is found in Appendix A.

14.2.1 European Settlement and Exploration

Juan Rodriguez Cabrillo arrived in present day San Diego in 1542 and expertly documented the American Indian presence along the Southern California coast (King 1978). Cabrillo found few riches after exploring the coast of Southern California. Consequently, little exploration and Spanish settlement of Southern California occurred over the next 60 years. It was not until 1602, that an expedition led by Sebastian Vizcaino in search of seaports along the California coast, established the names of what are now the cities of San Diego, Santa Barbara, and Monterey. European occupation resulted in the spread of disease and various types of invasive species that poorly affected tribes in the area (Crosby 2004).

Almost two centuries later, Spanish settlements increased with the establishment of 21 Spanish missions in the 1770s. Europeans absorbed several Southern California tribes into these missions with the goal of establishing a serf-like relationship and teaching Native Americans Catholicism, the Spanish language, and skills in farming (Heizer 1978). Spanish land grants were distributed amongst missions to be used as Ranchos in which cattle, sheep, and horses could be raised. These territories were owned by the Spanish crown and used by Spanish settlers (Aviña 1976). As a result, the population of Southern California's First Nations dwindled from 310,000 in the 1700s to approximately 20,000 in the early 1900s (c.f., Cook 1978; Castillo 1978; Kroeber 1925).

In 1774 and 1776, Juan Bautista de Anza established the first overland trail in Southern California, which led to the establishment of the first non-Native settlement at San Francisco Bay (NPS 2018). Throughout Spanish occupation, numerous states and territories were influenced in ways such as place names, Spanish farming techniques, language, religion, and cultural values (Oakland Museum of California 2018).

14.2.2 Mexican Settlement and Exploration

Mexican-born Spaniards of lower rank, known as Criollos, Mexican Indigenous, and the Mestizos of Mexican-Indigenous decent were under Spanish rule for about 300 years in the area of present-day Mexico. On September 16, 1810, Miguel Hidalgo y Costilla, a Catholic priest, issued the "Cry of Dolores," a rally cry that declared war against the Spanish colonial empire. Criollos, Mexican Indigenous, and Mestizos fought in the Mexican War of Independence for over ten years. In 1821, the treaty of Córdoba established Mexico as an independent constitutional monarchy under Agustin de Iturbide (Bell 2016). The Mexican Indigenous and Mestizos were excluded from this treaty (U.S. National Archives and Records Administration 2018).

Mexico assumed authority over Southern California, along with its missions, and moved toward expansion and settlement of the state. Mexican land grants were heavily distributed to individual Mexican citizens to occupy the newly acquired California territory. These plots of land were referred to as Ranchos and were to be used for farming crops and raising various farm animals. This was the peak time of the rancho period, which lasted from as early as Spanish mission establishment until the end of the Gold Rush (Aviña 1976).

By 1834, Mexican authorities took steps towards secularizing the mission system. The Mexican government wanted the remaining mission Indians to become Mexican citizens and work on established ranchos. Tribal groups that conceded to this plan were given poor plots of land that were later sold or taken by the Mexican government and awarded to citizens of non-native descent. Those that failed to become Mexican citizens were later harassed by surrounding populations and Mexican government officials (Heizer 1978).

The Mexican-American War erupted in 1846 as American citizens began to move westward. The Treaty of Guadalupe Hidalgo brought an end to the Mexican-American War in 1848. Under the treaty, Mexico ceded 55 percent of its territory to the United States. The territory consisted of parts of Arizona, California, New Mexico, Texas, Colorado, Nevada, and Utah. The treaty also established the Rio Grande as the southern boundary between the United States and Mexico (U.S. National Archives and Records Administration 2018).

14.2.3 U.S. Expansion

Soon after the Treaty of Guadalupe Hidalgo was signed, the discovery of gold on the American River in California's Sierra Nevada foothills drastically changed the state's landscape. A population boom resulted from the Gold Rush and transformed San Francisco into a major urban center (Starr 2005). The Gold Rush dramatically increased maritime traffic all along the Southern California coast (Kyle et al. 2002; Starr 2005).

The California fishing industry grew tremendously in the latter half of the 19th century. Finnish and Portuguese immigrants played a large role in its expansion as the lure of the California Gold Rush resulted in a large influx of Finish fishermen to the California coastline (Kero 1974; Genealogical Society of Finland 2004). Finish men mainly worked in gold fields, fruit farms, and fished along the San Diego coastline; and women predominantly worked as maids in wealthy families or were employed by the textile industry (Kero 1974; Genealogical Society of Finland 2004). Portuguese sailors established themselves in Monterey in 1855 and practiced whaling operations along the coastline of California. For example, as many as 14 whaling stations developed between Crescent City and San Diego during the 1870s. The Whaler's Cabin at Point Lobos, south of Carmel, was established by Azorean Portuguese whalers in 1861. The cabin was later converted into a museum and is currently listed on the NRHP (Bohme 1956; Gearhart et al. 1990; Point Lobos Foundation 2010).

As a result of the growing fishing industry, maritime traffic increased and the Federal government intervened to improve coastline safety. Consequently, lighthouses are the most prevalent nineteenth century structures found on the Pacific coastline. In Southern California, the U.S. Army Corps of Engineers constructed lighthouses at Point Loma (San Diego, 1855), Fort Point (1864), Point Fermin (San Pedro, 1874) and Piedras Blancas. Life-saving stations were established by the U.S. Life-Saving Service in 1891, some of which continue to stand (Gearhart et al. 1990; NPS 2019a).

Compared to the northern coast of California, Southern California has far fewer built-environment historical resources dating to the nineteenth century. San Francisco stunted the economic development of both San Diego and Los Angeles in terms of creating an urban market for building materials, food harvesting, and cultivation along the coast. However, the economic standing of the Southern California coast began to boom after the completion of the transcontinental railroad in 1869. The construction of the major railroad lines connected the city centers of San Diego, San Francisco, and Monterey. In 1886, the Southern Pacific Railroad later extended a rail line from Los Angeles to Santa Barbara which further increased tourism (Cole 2006). An example of a depot constructed at this time is the Carlsbad Depot in San Diego County. This 131-year-old building is listed on the NRHP (Cratty 1993; Rawls and Bean 2003).

In Southern California, and in Los Angeles in particular, population growth far surpassed any other coastal region of the three westernmost mainland states. Between 1900 and 1940, the population of Los Angeles County grew from 170,000 to 2,700,000, encouraging more and more development near and at the Southern California coast (Lotchin 1992).

14.3 Cultural Resource Types Present in the Planning Area

This section provides a brief description of potential cultural resources that can be found in the planning area.

Archaeological Sites. An archaeological site is any place where physical remains of past human activities exist. There are several different types of archaeological sites. Archaeological sites found within the OCS planning area consist of permanent Native American villages, temporary camps, rock shelters, trails, lithic scatters, rock art petroglyphs, and pictographs. Historic sites in the planning area include, for example, underwater shipwrecks, military sites, mills, factories, and battlefields (Society for American Archaeology 2018).

Archaeological Districts. An archaeological district is defined as more than one archaeological site connected historically by a group of similar characteristics such as a similar theme, function, or time. Sites do not have to be connected. The Crystal Cove archaeological district in Orange County is one example of a well-documented archaeological district (BOEM 2013).

Village Sites. It was rare for families to create permanent settlements throughout the Pleistocene era. Rather, on the Pacific coast villages were often located where families gathered to trade and socialize. It was common for families to gather in specific areas during winter months. Structures built in a village included semi-subterranean pit houses, plank houses, sweat lodges used throughout ceremonial rituals, menstrual huts, and specialized processing facilities (ICF et al., 2013). Well known village sites along the Southern California Coast include a series of archaeological sites in the Ballona wetlands (Altschul et al. 2003). Excavation of the Ballona sites (CA-LAN-62, CA-LAN-54, CA-LAN-193, CA-LAN-211, and CA-LAN-2768) uncovered highly developed middens, a wide range of artifacts and faunal remains, and a large cemetery (Peck 1947; Van Horn and Murray 1984).

Rock Shelters. A rock shelter is a concavity within a rock surface evidencing human use (California Office of Historic Preservation 1995). Rock shelters are found in large outcroppings of exposed rock and served a number of purposes. Commonly, rock shelters were used as places of short-term occupation while performing resource harvesting activities, but they may have been used as cache locations where gear or resources were stored. An example of a prominent rock shelter found along the coast of Southern California is CA-SBA-609 (ICF et al., 2013).

Petroglyphs/ Pictographs. Petroglyphs are a site type that contains a stone surface which has been scored by humans in a patterned manner for a purpose other than material processing; while a pictograph is a site type that includes any design painted on a rock surface (California Office of Historic Preservation 1995). Rock art is typically discovered on outcroppings of rock that are easily seen. Tribes in Southern California used rock art for navigation, storytelling and spiritual purposes (ICF et al., 2013). The Chumash Nation historically participated in rock art ceremonies for ritual, religious, and cosmological purposes (Heizer 1978).

Shell Middens/Mounds. Shell middens and mounds are typically comprised of refuse, consisting mostly of disposed food-related materials. Throughout the Pacific coast, invertebrates were the most commonly utilized food source by Native Americans in the area and are typically found in middens along the coast. Fully intact artifacts are quite rare in shell middens and mound deposits. Shell middens and mounds illustrate long-term occupation and short-term camps that experience seasonal harvesting in the area (ICF et al., 2013).

Trails/Linear Features. A trail is designed to facilitate the transportation of people and vehicles. It is a linear pathway either depressed, elevated, or on ground level (California Office of Historic Preservation 1995). Trails found in the OCS planning area were important for both Native American and later European and American mobility. Earlier built trails were well known routes utilized in social excursions, hunting, and trade (ICF et al., 2013). Trails often have a visual component to them and key points along a trail may have once offered advantageous viewpoints of the surrounding area, including a view of the coast and Pacific Ocean.

Historic Maritime Routes. A historic maritime route is a lane at sea that is regularly used by historical vessels. There are several historic sailing routes that can be found along the coast of California. In 1543, Juan Rodriguez Cabrillo became the first Spanish maritime voyager to reach the coast of what is now the San Diego Bay, California, starting his voyage at Navidad, Mexico (Grays Harbor Historical Seaport 2018). The California Gold Rush began in 1849, and created several historic shipping routes beginning across the world and ending in California. Gold Rush routes included the California via Panama, California via Mexico, California via Nicaragua, California via Cape Horn, and California via China (California Geographic Alliance 2019).

Graves/Burials. A grave is any single or multiple burial locations (California Office of Historic Preservation 1995). Native American graves are known to occur along the Southern California Coast and on the Channel Islands. Native American graves may be found in association with archaeological sites or on their own. Native American graves along the coast of California are typically mound shaped, and are likely to exhibit very different burial patterns depending on the Tribe and associated time period. Native American graves are mostly unmarked, but stacked rock features called cairns sometimes mark burials. Isolated burials are occasionally found. Historic cemeteries are often clearly marked, although there are cases where they are not as a result of battles and warfare. Graves are mostly marked by headstones, crosses or cairns but could also be unmarked. Isolated historic burials are occasionally found, especially along trail segments or near isolated homesteads ICF et al., 2013).

Lithic Scatters. A major characteristic of lithic scatter sites is a scatter of chipped or flaked stone resulting from human manipulation (California Office of Historic Preservation 1995). Lithic scatters often signify habitation of villages and work patterns within those villages although they may also represent isolated expedient tool making events. Scatters can also be found near the raw material source where large cobbles were often broken up into more manageable pieces for transport (ICF et al., 2013).

Culturally Modified Trees. Native Americans in Southern California and other places often used tree bark and cambium (the inner bark) for basketry, tools and even subsistence when necessary. The materials were taken from trees in long strips, in small enough sections that the tree was still able to thrive after use. Often, scarring was left behind on trees utilized. These trees are typically found in clusters (ICF et al., 2013) and may be present along the OCS coastline.

Rock Alignments/Rock Cairns. Rock alignments and rock cairns are found in many areas along the Pacific coast. Rock features are typically made of easily accessible stone and were likely used as hunting blinds or drives, trail markers, or for spiritual purposes. The Spirit Jumping-Off Rocks site (P-21-002628) is an example of a linear stone alignment along the northern California coast (ICF et al., 2013).

Hearths and Fire Cracked Rock Features. Hearths and fire-cracked rock features may be found in archaeological sites or as isolated features. These features often consist of clusters of stones and/or perishable items such as animal bone, plant remains, and charcoal (ICF et al., 2013) and may be present along the California coast.

Landscape Modifications. Landscaping is evidence of modification through contouring of the land or planting vegetation (California Office of Historic Preservation 1995). Landscape modifications appear in a variety of forms along the Pacific coastline. A large amount of evidence has indicated that some Native Americans living in the Southern California area modified and manipulated the territory for millennia (ICF et al., 2013).

Quarries. A quarry is a site that contains a source of lithic material with evidence of human usage (California Office of Historic Preservation 1995).

Isolated Artifacts. An isolated artifact is a single or small group of artifacts. In California, isolates are typically defined as a grouping of three or less artifacts. Isolates could be lost items, or may represent a singular event (ICF et al., 2013).

Caches. A cache is a site containing a natural or constructed feature used for storing food or goods (California Office of Historic Preservation 1995). Caches contain any group of items and can include a tool kit, or even a group of weapons or tools used in hunting (ICF et al., 2013).

Fish Weirs/Traps. Fish weirs and traps are a very common cultural resource found along the Pacific coast, especially in Southern California. They consist of materials such as wooden stakes, brush, or stone. Fish weirs and traps work by creating a barrier that fish are unable to escape (ICF et al., 2013).

Traditional Cultural Properties (TCP). TCP's are rooted in a traditional community's history and are important in maintaining the continuing cultural identity of a particular culture (Parker and King 1998). A TCP is a historic property that is eligible for inclusion in the NRHP based on its association with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living culture (Parker and King 1998). TCP locations are often kept confidential because they may contain spiritual or religious elements of importance. Therefore, any further information regarding TCPs should be gathered through proper government-to-government consultation.

Historic Buildings and Structures. Historic buildings and structures consist of built features of architectural and historical interest at a local, regional or national level. A building or structure may be considered historic if designed by a well-known architect or if it was the location of an important cultural, political or social event. A building or structure may also be historic because it signifies patterns of settlement and trade; incorporates local materials and methods in construction; embodies a distinctive architectural style; or is associated with an individual who is important to history at the local, regional or national level. A historic building must also retain its architectural integrity to be considered significant and may stand alone or it may be part of a larger historic district.

One rule for defining a historic property is to use the 50-year rule established by the NPS. Under this definition, a property is not considered historic unless it is at least 50 years old. However, a 50-year old building is not automatically considered historic and there are properties that may be considered historic even though they are younger than 50-years old.

Historic buildings and structures are found throughout the Southern California Planning Area and include, but are not limited to homes, businesses, hospitals, schools, research facilities, homesteads, agricultural properties, churches, restaurants, hotels, government buildings, commercial buildings, industrial buildings and facilities, military bases and facilities, lighthouses, coastal resorts, piers, bridges and railroads, and Spanish Missions. A map of all publicly-listed buildings on the NRHP within the Southern California Planning Area can be found on the NRHP website (ICF et al., 2013; NPS 2019b).

Submerged Cultural Resources. There is evidence of a steady increase in sea levels as a result of glacial reduction starting at about 18,000 years ago and continuing to about 7,500 years ago. Due to an increase in water levels, many paleo Indian and archaic period sites are submerged along the Southern California coast. Researchers believe that the encroaching ocean aided in the preservation of such sites with the reworking and redisposition of sediments. It is estimated, that these preserved sites may be located along the mainland shore and back barrier deposits behind large, nearshore islands, estuaries, and parcels of coastal floodplains (U.S. Department of the Navy 2018).

Around 92 isolated artifacts were recovered from 33 underwater ocean locations with almost all artifacts found around the Santa Barbara County coast (Hudson 1977). About 110 submerged artifacts and sites from the archaic and paleo Indian period were discovered in Southern California ocean basins. The majority of these finds were isolated. Common cultural materials found offshore in San Diego County include stone bowls and mortars (Masters and Schneider, 2000). Almost all artifacts found consist of a stone material due to their durable characteristics (Hudson 1977). There are likely many unknown pre-contact submerged archaeological sites along the coast of the Southern California Planning Area.

Historic and contemporary submerged resources include pleasure crafts, sport and commercial fishing vessels, and cargo and military vessels, among others (U.S. Department of the Navy 2018). Various databases of shipwrecks have been developed to track shipwreck locations, including the Automated Wreck and Obstruction Information System Database (AWOIS) (NOAA Office of Coast Survey 2019). This database identifies many different types of vessels, ranging in size and structure, which were lost off the Southern California coast. There are likely many other unknown submerged resources as well.

The earliest known shipwrecks off the Southern California coast began with Spanish exploration in the early 1500s and continued into the commercialization of the coastline during the 19th and 20th centuries (U.S. Department of the Navy 2018). The AWOIS lists approximately 310 wrecks off the coast of San Diego, Orange, Los Angeles, and Ventura Counties (NOAA Office of Coast Survey 2019). In 1990, the Mineral Management Service (predecessor agency to BOEM) conducted a study that found 4,676 shipwrecks off the coast of California, with 876 wrecks found just in Southern California (Gearhart et al. 1990).

In 2013, the Bureau of Ocean and Energy Management (BOEM) updated the 1990 study and identified a total of 206 shipwrecks, mostly vessels, off the port of Los Angeles and spanning from a period of 1883-1988 (ICF et al.,2013). A total of 180 shipwrecks were reported between 1936-1988 and 23 shipwrecks were reported between 1883-1918 in the Port of Los Angeles. Vessel accident causality reports from San Luis Obispo County identified three shipwrecks dating from 1932-1947. In 2013, Heather MacFarlane, a maritime archaeological consultant, who has a large collection of shipwreck sources gained from many years of work along the coast of California, indicated that her records show a total of 601 shipwrecks, with 518 unique records, meaning they have not been identified through other shipwreck databases (BOEM 2013).

There are various submerged boats off the bay of Silver Strand peninsula in San Diego County. On the ocean side of the peninsula, there are three shipwrecks located near the Silver Strand Training Complex (U.S. Department of the Navy 2018). These vessels include a three- or four-masted sailing vessel, a submarine, which was decommissioned and sunk in 1945, and a vessel that sank in 1943. A military aircraft and a sunken sailboat are found offshore, south of the Silver Strand Training Complex and west of the city of Imperial Beach (U.S. Department of the Navy 2018). Unknown vessels are recorded in the shallow waters at the middle of San Diego Bay, at the northern end of Delta South Beach, and at the mouth of Fiddler’s Cove. These boats have not been identified to a specific time period or cultural association (U.S. Department of the Navy 2018).

The San Diego Deepening at Tenth Avenue Marine Terminal Project (EDAW 2005) identified 24 cultural resources located around the San Diego Bay which included schooners, barges, a submarine, clippers, gas and oil screws, a yacht, a bark, a ferry, a ship, and a steamer (EDAW 2005). Other identified submerged built structures included an 1887 marine utility cable and a sunken Ford Model T (EDAW 2005).

14.4 Known Submerged Resources and Lighthouses

This section identifies known submerged resources specifically throughout the Santa Maria, Santa Barbara Channel, and San Pedro Basins as well as the number of lighthouses along the coastline of each basin.

S**anta Maria Basin**. Approximately 25 submerged resources may be located in the waters of Santa Maria Basin. Most of these are shipwrecks but could include pleasure crafts, sport and commercial fishing boats, and cargo and military vessels (NOAA Office of Coast Survey 2019). There are also four lighthouses located on the coastline along the Santa Maria Basin (Conservation Biology Institute 2018).

Santa Barbara Channel. Approximately 60 reported submerged resources may be located in the waters of the Santa Barbara-Ventura Basin. Most of these are shipwrecks but could include pleasure crafts, sport and commercial fishing boats, and cargo and military vessels (NOAA Office of Coast Survey 2019). Four lighthouses are also located on the coastline along the Santa Barbara-Ventura Basin (Conservation Biology Institute 2018).

San Pedro Basin. Over 100 reported shipwrecks may be located in the waters of San Pedro Basin. Most of these are shipwrecks but could include pleasure crafts, sport and commercial fishing boats, and cargo and military vessels (NOAA Office of Coast Survey 2019). Four lighthouses are located on the coastline along the San Pedro Basin (Conservation Biology Institute 2018).

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15 COMMERCIAL AND RECREATIONAL FISHING

This chapter presents an overview of the recreational and commercial fishing that occurs on the Southern California Planning area and its five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties).

15.1 Commercial Fisheries

Commercial fishing occurs at various locations on the Southern California OCS Planning Area and adjacent coastal areas. The nearshore waters along the coast from Los Angeles to Monterey Counties and the waters just off the Channel Islands contain beds of giant kelp that provide habitats for numerous species of commercially important fish and shellfish species. The majority of fish are caught within these areas. About 64 commercial fish and shellfish species are fished using up to 15 gear types. Fishery seasons are established and regulated by the California Department of Fish and Wildlife (CDFW). Figure 15-1 shows the distribution of fish blocks in the project area, which are used to organize information on commercial fish catch. Fish blocks are 9-by-11-mile rectangles, or approximately 100 square miles of ocean area.

The CDFW reports the total number of pounds of commercial fishery species (comprised of fishes, invertebrates, and kelp) landed in California and the value of those landings annually for six reporting areas along the coast. From north to south, the California commercial fishing reporting areas are Eureka, San Francisco, Monterey, Santa Barbara, Los Angeles, and San Diego. The Santa Barbara reporting area encompasses coastal waters associated with San Luis Obispo, Santa Barbara, and Ventura Counties and includes the ports of Morro Bay, Avila Beach, Oceano, Santa Barbara, Ventura, Oxnard, and Port Hueneme. The Los Angeles reporting area encompasses coastal waters associated with Las Angeles and Orange Counties and includes the ports of Santa Monica, Redondo Beach, San Pedro, Huntington Beach, Dana Point, and Los Angeles. Landing weights and values in the Santa Barbara and Los Angeles reporting areas for the years 2000-2017 are provided in Table 15-1. Nearly all of the landings in the Santa Barbara reporting area are from Santa Barbara, Ventura, Oxnard, and Port Hueneme harbors; nearly all the landings in the Los Angeles reporting area are from the San Pedro, Terminal Island, Long Beach, and Dana Point harbors.

Many species of fish and invertebrates are caught and landed in commercial fisheries off the California coast. The most important species groups are benthic invertebrates, oceanic pelagic (epipelagic) fishes, demersal fish species, and anadromous species. Important invertebrate species include Dungeness crab, spiny lobster, squid, and oysters (oysters are primarily harvested in inland waters). Important targeted fish species include anadromous salmon (primarily Chinook), tuna and swordfish (epipelagic); and sablefish, halibut, and rockfishes (demersal). Many fishers in the area do not fish for just one species, or use only one gear-type. Most switch fisheries during any given year depending on market demand, prices, harvest regulations, weather conditions, and fish availability. During 2017, landings of more than 94 million pounds of fish and invertebrates, with a value of approximately $66 million were reported for the Santa Barbara reporting area and more than 43 million pounds worth approximately $29 million were reported for the Los Angeles reporting area (Table 15-1).

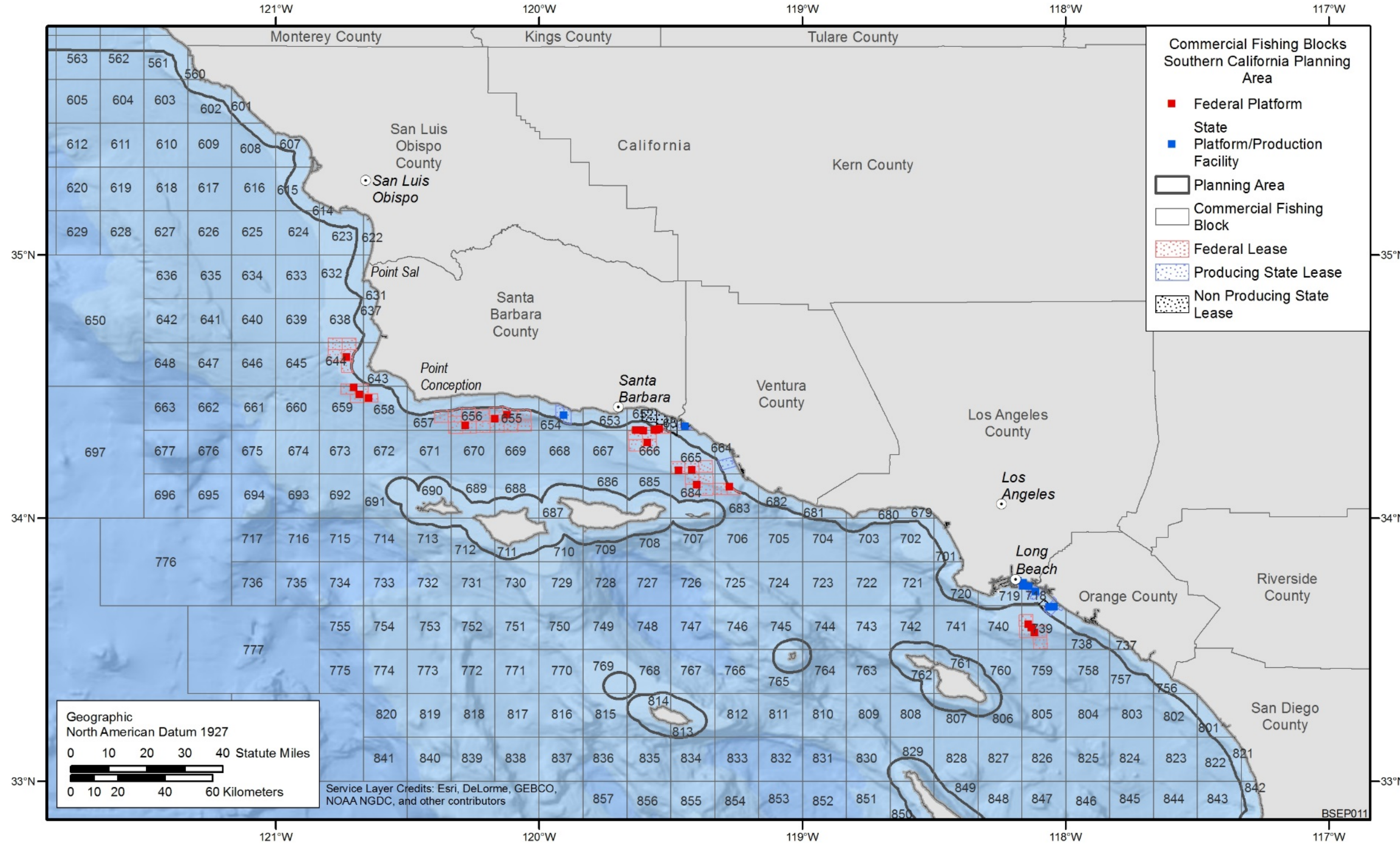

FIGURE 15-1 Commercial Fishing Blocks in the Southern California OCS Planning Area and Vicinity (Source: Perry et al. 2010)

Each species or species group is caught using various methods and gear types. Traps are used for crab, spiny lobster and some demersal fish species; sardines are usually caught in surrounding lamparra or purse nets; tuna are caught on surface troll lines or longlines; rockfishes are generally captured using trawls, set longlines, or trolling rigs; and squid are caught by encircling schools with a round-haul net, such as a purse seine or lampara net. Generally, fishing activities with the highest potential for interactions (or conflicts) with OCS activities (e.g., oil and gas operations) are bottom trawling (potential for snagging on pipelines, cables, and debris) and surface longlining (potential for space-use conflicts with seismic survey vessels and possible entanglement with thrusters on dynamically positioned drillships).

Table 15-1 Annual Reported Landing Weights and Landing Values for the Commercial Fishery in the Santa Barbara and Los Angeles Reporting Areas, 2000-2017

	Santa Barbara Reporting Area		Los Angeles Reporting Area	
Year	Landing Weight (lbs)	Landing Value ($)	Landing Weight (lbs)	Landing Value ($)
2000	171,440,307	27,470,031	254,442,454	40,933,089
2001	109,956,541	17,600,164	218,641,818	31,603,239
2002	62,086,380	17,232,730	170,125,068	23,273,932
2003	60,373,853	22,906,278	88,473,636	18,942,786
2004	77,883,985	24,258,955	92,236,447	18,808,330
2005	70,116,910	23,313,676	139,665,143	28,901,187
2006	50,544,914	18,943,042	165,394,646	32,980,846
2007	101,601,398	33,758,431	142,114,144	21,466,986
2008	55,307,331	28,386,173	124,265,046	25,554,951
2009	147,618,279	49,856,516	114,400,580	31,694,118
2010	139,308,501	49,260,868	187,344,671	41,340,125
2011	134,256,459	48,738,293	158,129,849	43,846,470
2012	76,334,129	37,030,772	162,739,931	47,336,390
2013	111,068,052	50,473,294	115,623,747	37,420,884
2014	82,197,796	44,500,906	55,862,016	24,312,130
2015	49,912,708	34,727,339	15,082,154	11,698,705
2016	43,269,600	39,614,498	36,743,539	21,321,705
2017	94,983,169	65,760,724	43,554,835	29,197,248
Average	93,750,471	33,028,592	137,783,834	30,007,136

Source: CDFW 2018

Seaweeds, especially kelp, are also commercially harvested within the area using bow- or stern-mounted cutting mechanisms and conveyor systems (CDFW 2014a). Commercial harvesting of seaweeds is regulated by the California Fish and Game Commission and the CDFW through the issuance of licenses. Depending upon the status of the kelp resource within a given year, specific kelp beds may be open or closed to commercial harvesting (CDFW 2014a) and may be open or leased by specific harvesters. An average of 7 million pounds of kelp were commercially harvested annually from California waters during the 2006 to 2013 period (CDFW 2014b).

OCS oil and gas activities began off Southern California in the late 1960’s (County of Santa Barbara 2015a). Several reviews have been made of the possible cumulative impacts of these activities on commercial fishing in the region (Van Horn et al. 1988; Bornholdt and Lear, 1995, 1997) and evaluations of mitigation for conflicts between oil and gas activities and commercial fisheries have been conducted (e.g., Centaur Associates, Inc. 1984).

Although OCS operators are required to conduct activities without interfering with fishing activities, there is still a potential for fishers to experienced adverse impacts due to past and present OCS activities in the Pacific Region. This includes space use conflicts, OCS-associated seafloor debris, and reduced catch due to seismic surveys. Among other things, 1978 amendments to the Outer Continental Shelf Lands Act established the Federal Fishermen's Contingency Fund, which compensate commercial fishers for economic and property losses caused by oil and gas obstructions on the U.S. Outer Continental Shelf. The fund was established in the U.S. Treasury as a revolving fund comprised of assessments paid by offshore oil and gas interests. Fishers who can establish that they suffered losses in income due to inability or reduced capacity to fish as a result of the damage sustained may be eligible for compensation for economic loss and property loss or damage (NOAA 2015). The Federal fund does not cover loss or damage to gear that occurs in State waters, unless such loss or damage was caused by an oil and gas project in Federal waters.

In 1988, Santa Barbara County established the Local Fishermen's Contingency Fund that compliments the Federal Fishermen's Contingency Fund. This fund provides loans for timely repair or replacement of damaged or lost fishing gear while claims to the Federal Fishermen's Contingency Fund are being processed and reimburses commercial fishers the costs of such repairs or replacements that occur in State waters due to either State or Federal oil and gas development and related activities (County of Santa Barbara 2015b). Thus, although there may have been moderate impacts from past and present oil and gas activities on the Pacific OCS, the mitigation programs that have been established have effectively minimized these impacts to low or insignificant levels, for the commercial fishing industry as a whole.

15.2 Marine Recreational Fishing

Southern California is a leading recreational fishing area along the west coast, with weather and sea conditions allowing for year-round fishing. Recreational fishing includes hook-and-line fishing from piers and docks, jetties and breakwaters, beaches and banks, private or rental boats, and commercial passenger fishing vessels. Recreational fishing also includes activities such as dive, spear and net fishing. Recreational fishers in Southern California access both nearshore and offshore areas, targeting both bottom fish and mid-water fish species. Boats can either drift with the currents, anchor, or live-boat to remain on the specific spot. The majority of recreational fishing is done by “jigging” baited hooks or lures. Several hooks or lures often occur on a single weighted line. For pelagic species such as salmon, trolling methods are also used.

Recreational fishing catches within the Southern California OCS Planning Area and vicinity are reported separately for three California recreational fishing districts: Central District (San Luis Obispo, Monterey and Santa Cruz Counties), Channel District (Ventura and Santa Barbara Counties), and the South District (San Diego, Orange, and Los Angeles Counties). The top five recreational species for the Central District of California from 2013 through 2017 (based on landing weights) were lingcod, barred surfperch, blue rockfish, vermillion rockfish, and yellowtail rockfish (Table 15-2).

Table 15-2 Estimated Total Catch (Metric Tons) of Fish Reported for Marine Recreational Anglers in the California Central District (San Luis Obispo, Monterey, and Santa Cruz Counties), 2013-2017[a]

	Landing Weights (Metric Tons)						
Species Name	**2013**	**2014**	**2015**	**2016**	**2017**	**Annual Average**	**Percent of 5-yr Total**
Lingcod	86.5	150.4	215.4	216.6	188.7	171.5	23.0
Barred Surfperch	47.6	47.5	64.0	128.4	103.4	78.2	10.5
Blue Rockfish	19.8	48.6	74.5	91.1	85.0	63.8	8.6
Vermilion Rockfish	52.4	41.2	56.0	79.7	80.5	62.0	8.3
Yellowtail Rockfish	30.3	36.1	35.7	49.7	18.0	34.0	4.6
Gopher Rockfish	29.9	22.5	36.2	34.9	41.7	33.1	4.4
Brown Rockfish	37.6	33.1	41.5	21.5	19.1	30.6	4.1
Black Rockfish	24.9	55.0	24.4	18.5	16.0	27.8	3.7
California Halibut	71.3	16.9	23.1	6.7	6.4	24.9	3.3
Rockfish Genus	17.6	76.6	13.7	6.1	0.0	22.8	3.1
Copper Rockfish	19.0	12.9	18.6	24.2	30.9	21.1	2.8
Cabezon	16.0	11.9	18.0	18.2	16.4	16.1	2.2
Pacific Sanddab	7.7	7.5	36.5	12.0	11.1	14.9	2.0
Olive Rockfish	12.4	3.5	10.8	21.9	22.1	14.1	1.9
Pacific (Chub) Mackerel	0.8	2.4	8.5	49.1	7.6	13.7	1.8
Squid Class	49.3	8.0	0.0	0.0	0.0	11.5	1.5
Jacksmelt	3.9	11.8	9.1	17.1	6.8	9.7	1.3
Striped Bass	18.2	2.3	0.0	12.5	8.4	8.3	1.1
Dungeness Crab	0.0	41.4	0.0	0.0	0.0	8.3	1.1

[a] Information for species comprising less than 1 percent of the total 5-year catch is not shown.
Source: Pacific States Marines Fisheries Commission (2018).

The top five recreational landings for the Channel District (which includes the majority of the project area) from 2013 through 2017 (based on landing weights) were barred surfperch, vermilion rockfish, lingcod, bocaccio, and yellowtail (Table 15-3).

Table 15-3 Estimated Total Catch (Metric Tons) of Fish Reported for Marine Recreational Anglers in the California Channel District (Ventura and Santa Barbara Counties), 2013-2017[a]

	Landing Weights (Metric Tons)						
Species Name	**2013**	**2014**	**2015**	**2016**	**2017**	**Annual Average**	**Percent of 5-yr Total**
Barred Surfperch	50.5	34.0	99.1	132.5	49.8	73.2	12.7
Vermilion Rockfish	67.5	68.9	59.0	96.8	72.4	72.9	12.6
Copper Rockfish	40.7	60.3	50.4	65.4	70.1	57.4	9.9
Lingcod	27.5	39.8	38.2	33.1	125.0	52.7	9.1
Bocaccio	39.9	51.2	37.8	42.2	31.4	40.5	7.0
Yellowtail	0.4	7.8	28.0	71.3	70.4	35.6	6.2
White Seabass	27.8	30.8	21.1	18.4	8.7	21.4	3.7
Pacific (Chub) Mackerel	3.2	3.0	13.6	65.5	15.3	20.1	3.5
Ocean Whitefish	14.4	7.4	14.0	9.9	19.1	13.0	2.2
Rockfish Genus	7.4	27.7	20.6	6.0	0.0	12.3	2.1
Pacific Barracuda	30.7	3.4	4.3	5.6	11.7	11.2	1.9
California Halibut	14.1	10.7	9.6	6.8	10.5	10.3	1.8
Blue Rockfish	2.4	1.7	15.9	17.3	12.6	10.0	1.7
California Sheephead	7.3	6.5	14.4	10.5	9.9	9.7	1.7
Pacific Bonito	0.0	0.1	4.0	34.0	8.3	9.3	1.6
Pacific Sardine	24.5	13.2	1.3	0.1	0.2	7.9	1.4
Brown Rockfish	6.8	11.2	11.8	6.4	2.3	7.7	1.3
Kelp Bass	7.3	4.3	9.0	9.4	8.2	7.7	1.3
Pacific Sanddab	11.6	12.3	6.9	4.7	1.7	7.4	1.3
Jacksmelt	6.1	10.6	3.7	6.0	8.6	7.0	1.2
Olive Rockfish	3.5	3.3	8.3	5.0	11.3	6.3	1.1

[a] Information for species comprising less than 1 percent of the total 5-year catch is not shown.
Source: Pacific States Marines Fisheries Commission (2018).

The top five recreational landings from 2013 through 2017 (based on landing weights) for the South District were yellowtail, Pacific mackerel, California scorpionfish, Pacific bonito, and vermillion rockfish (Table 15-4).

Based on catch data for 2015 and 2016, August is the month with the greatest proportion (over 25 percent) of the total annual recreational catch for the two districts; over 66 percent of the total recreational catch occurs during the period from June through September (Figure 15-2).

Table 15-4 Estimated Total Catch (Metric Tons) of Fish Reported for Marine Recreational Anglers in the California South District (San Diego, Orange, and Los Angeles Counties), 2013-2017[a]

	Landing Weights (Metric Tons)						
Species Name	**2013**	**2014**	**2015**	**2016**	**2017**	**Annual Average**	**Percent of 5-yr Total**
Yellowtail	69.2	536.8	750.7	178.5	228.2	352.7	27.2
Pacific (Chub) Mackerel	73.3	118.8	128.9	104.5	177.6	120.6	9.3
California Scorpionfish	104.3	115.6	75.8	67.7	74.4	87.6	6.8
Pacific Bonito	7.0	115.3	112.8	76.7	122.4	86.8	6.7
Vermilion Rockfish	79.1	67.4	74.8	78.1	70.8	74.0	5.7
Kelp Bass	37.6	84.6	57.5	92.5	67.4	67.9	5.2
Bocaccio	71.4	51.6	37.4	26.0	44.4	46.2	3.6
Barred Sandbass	57.8	58.5	56.6	17.6	31.6	44.4	3.4
California Sheephead	53.9	36.4	28.2	30.3	35.5	36.9	2.8
Pacific Sanddab	59.9	58.8	13.8	14.8	19.0	33.3	2.6
Pacific Barracuda	35.7	50.0	37.1	15.7	18.3	31.4	2.4
Ocean Whitefish	16.0	11.5	14.1	32.1	46.8	24.1	1.9
White Seabass	53.9	18.9	6.2	10.7	11.7	20.3	1.6
Squarespot Rockfish	15.1	20.2	18.7	21.5	16.2	18.4	1.4
California Halibut	24.3	16.4	9.9	10.6	17.3	15.7	1.2
Copper Rockfish	14.6	14.6	12.7	17.7	14.0	14.7	1.1
Spotfin Croaker	5.6	9.6	23.2	20.6	9.9	13.8	1.1
Pacific Sardine	48.3	4.7	3.7	2.4	7.8	13.4	1.0
Starry Rockfish	13.2	7.4	7.5	14.8	19.4	12.4	1.0
Lingcod	18.9	8.2	8.0	12.9	13.6	12.3	1.0

[a] Information for species comprising less than 1 percent of the total 5-year catch is not shown.

Source: Pacific States Marines Fisheries Commission (2018).

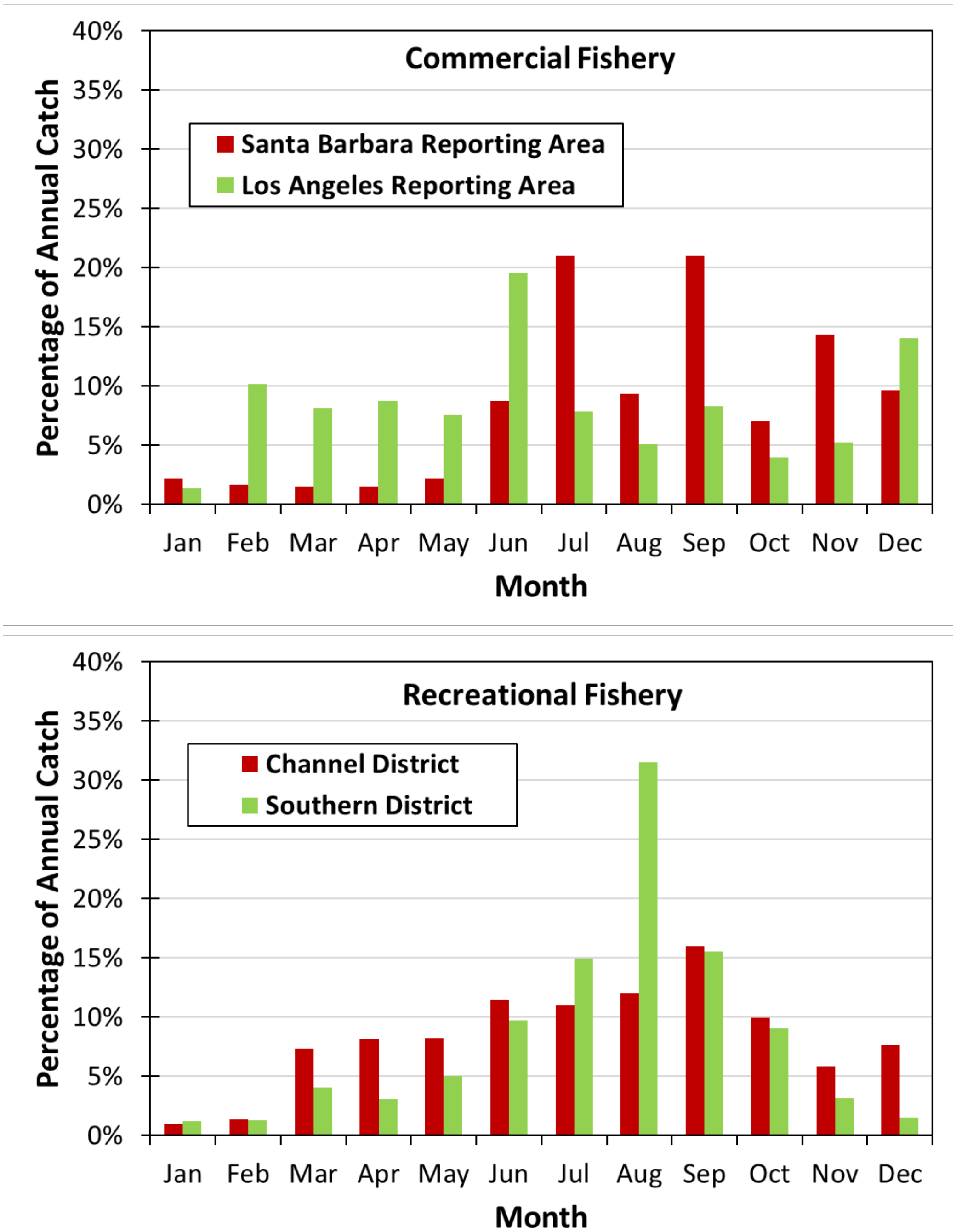

FIGURE 15-2 Monthly Proportions of Combined 2015 and 2016 Annual Commercial (Upper Panel) and Recreational (Lower Panel) Fishery Catch in the Southern California OCS Planning Area and Vicinity (Source: CDFW 2018a; Pacific States Marines Fisheries Commission 2017)

15.3 References

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16 RECREATION AND TOURISM

This chapter presents an overview of the recreation and tourism that occurs on the Southern California Planning area and especially in its five adjacent coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties). The Pacific coastline is an outstanding natural resource, providing an important recreational asset and contributing to the economic success of the region's tourist industry. Many of its parks, reserves, sanctuaries, and marine protected areas are preferred destinations for residents and visitors. The main recreation and tourism activities in the coastal zone include beach recreation, (including swimming and snorkeling), surfing, wind surfing, sightseeing, diving, boating (including canoeing and kayaking), wildlife watching, photography, and recreational fishing (BLM 2005; BOEMRE 2010). Most of these activities occur near established shoreline park, recreation, beach, and public-access sites.

Annual analyses of the economic impacts of travel to and through the counties of California have been conducted for the six counties bordering the Southern California POCS Planning Area (Dean Runyan Associates 2018). Visitor spending in the six coastal counties totaled $54.3 billion in 2017 (Table 16-1).[18] As in previous years, visitor expenditures in 2017 were concentrated in Los Angeles County ($24.4 billion), with large expenditures also in Orange County ($12.6 billion) and San Diego County ($12.4 billion). Travel also results in fiscal impacts in the form of State and local tax revenue. Tax receipts from travel in all the southern coastal counties totaled $4.3 billion in 2014.

TABLE 16-1 Economic Impacts of Travel in Counties of the Southern Pacific Coast ($ million), 2017

County	Visitor Spending at Destination	Total Direct Tax Receipts (State and Local)
San Luis Obispo	$1,682	$151
Santa Barbara	$1,808	$168
Ventura	$1,453	$132
Los Angeles	$24,379	$2,563
Orange	$12,578	$1,103
San Diego	$12,401	$1,077
Total	$54,301	$5,194

Source: Dean Runyan Associates (2016).

Based on data compiled from the U.S. Bureau of Labor Statistics, the NOAA Coastal Services Center (NOEP 2018) estimates employment and wages in the ocean-related sectors in

[18] The estimates for 2017 are considered preliminary (Dean Runyan Associates 2018).

which recreation and tourism occur (Table 16-2). In the central and southern coastal counties, these wages totaled $6.0 billion in 2016, the most recent year for which data are available. Employment is concentrated in San Diego County (96,851 in 2016) and Los Angeles County (54,170 in 2016). The ocean-related recreation and tourism employment for all coastal counties was 235,747 in 2016.

Tourism is a major economic force for coastal counties along the planning area, and any negative changes in tourism would be of major concern. Although few tourism activities are coast-dependent (i.e., cannot occur without access to the coast), the majority are coast-enhanced; it is the coastal orientation of the counties that contributes to the sense of place and the general ambiance so highly valued by visitors to the area.

TABLE 16-2 Employment and Wages in Ocean-Related Recreation and Tourism Sector in the Southern Coastal Counties, 2016

County	Employment	Wages (millions)
San Luis Obispo	8,123	$171.0
Santa Barbara	16,146	$397.0
Ventura	14,369	$299.1
Los Angeles	54,170	$1,416.2
Orange	46,088	$1,170.0
San Diego	96,851	$2,582.9
Total	235,747	

Source: NOEP (2018).

16.1 References

BLM (Bureau of Land Management) 2005. *California Coastal National Monument Resource Management Plan*. U.S. Bureau of Land Management, California Office. Available at: https://eplanning.blm.gov/epl-front-office/projects/nepa/69063/136143/166398/CCNM_rmp-2005.pdf

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17 ENVIRONMENTAL JUSTICE

This chapter presents an overview of the minority and low-income groups that occur in five coastal counties (San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties) adjacent to the Southern California Planning area. Executive Order (E.O.) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires Federal agencies to incorporate environmental justice as part of their missions (*Federal Register* 1994). Specifically, it directs these agencies to address, as appropriate, any disproportionately high and adverse human health or environmental effects of their actions, programs, or policies on minority and low-income populations.

A description of the distribution of minority and low-income groups within the region of influence (ROI) was based on demographic data from the 2017 census estimates (U.S. Census Bureau 2018). The following definitions were used to define minority and low-income population groups:

- ***Minority***. Persons are included in the minority category if they identify themselves as belonging to any of the following groups: (1) Hispanic; (2) Black (not of Hispanic origin) or African American; (3) American Indian or Alaska Native; (4) Asian; or (5) Native Hawaiian or Other Pacific Islander. Persons may classify themselves as having multiple racial origins (up to six racial groups as the basis of their racial origins).

- ***Low-Income***. Individuals who fall below the poverty line are classified as low-income. The poverty line takes into account family size and age of individuals in the family. For any given family below the poverty line, all family members are considered as being below the poverty line for the purposes of the analysis without consideration of individual income variations within the family.

The Council on Environmental Quality (CEQ 1997) guidance states that low-income and minority populations should be identified where either (1) the low-income or minority population of the affected area exceeds 50%, or (2) the low-income or minority population percentage of the affected area is meaningfully greater than the low-income or minority population percentage in the general population or other appropriate unit of geographic analysis. Table 17-1 lists the minority and low-income composition within the counties bordering the Southern California OCS Planning Area based on 2017 census estimates. These five counties are relatively similar among themselves as well as with the state as a whole, as the top three population categories (based on percent contribution of the total population) are the same among the five counties, and when compared to the entire state. The number of persons below the poverty level in the ROI is also comparable to the Statewide level (Table 17-1).

In accordance with state law, the California Environmental Protection Agency and other California state agencies use a more comprehensive set of indicators to identify disadvantaged communities, promote compliance with environmental laws, and administer grants (Office of Environmental Health Hazard Assessment 2010). The CalEnviroScreen screening tool ranks census tracts based on potential exposures to pollutants, adverse environmental conditions, socioeconomic factors, and prevalence of certain health conditions. Coastal disadvantaged communities identified by CalEnviroScreen include tracts north of Vandenberg Air Force Base in central California, in the city of Oxnard, in Los Angeles County, and along the San Diego Bay.

TABLE 17-1 Minority and Low-Income Population Percentage for 2017 within the Region of Influence

	County					
Population Category	**San Luis Obispo**	**Santa Barbara**	**Ventura**	**Los Angeles**	**Orange**	**California**
White alone, not Hispanic or Latino	68.8	44.3	45.2	26.2	40.5	37.2
Hispanic or Latino	22.6	45.6	42.9	48.6	34.2	39.1
Asian alone	4.0	6.0	7.8	15.3	21.0	15.2
Black or African American alone	2.0	2.4	2.3	9.0	2.1	6.5
American Indian and Alaska Native alone	1.4	2.2	1.9	1.4	1.0	1.6
Native Hawaiian and other Pacific Islander alone	0.2	0.2	0.3	0.4	0.4	0.5
Two or more races	3.5	3.7	3.5	3.0	3.5	3.9
Persons below poverty level (2015, all races)	11.0	13.9	9.8	16.3	11.1	14.3

Sources: U.S. Census Bureau (2018).

17.1 References

CEQ (Council on Environmental Quality), 1997, *Considering Cumulative Effects under the National Environmental Policy Act*, Executive Office of the President, Washington, DC.

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18 SOCIOECONOMICS

This chapter presents an overview of the socioeconomic conditions of the coastal counties adjacent to the Southern California OCS Planning Area: San Luis Obispo, Santa Barbara, Ventura, Los Angeles, and Orange Counties. These counties capture the area whose economies are or could be influenced by oil and gas activities in the planning area, and include areas which would provide the work force for future oil and gas activities, areas within which workers would spend their wages and salaries, and the expected location of many of the vendors that would supply materials, equipment, and services for oil and gas activities on the planning area.

18.1 Population

The estimated populations of the five coastal counties adjacent to the Southern California Planning Area are presented in Table 18-1. Between 2010 and 2017, county populations increased from 3.5 to 6.0% over the 7-year time period (U.S. Census Bureau 2018). Population increases ranged from 3.5% for Los Angeles County to 6.0% for Orange County. The Statewide population increased an estimated 6.1% during this time.

TABLE 18-1 County Populations

County	2010	2017 (estimate)	% Change
San Luis Obispo	269,591	283,405	+5.1%
Santa Barbara	423,949	448,150	+5.7%
Ventura	823,391	854,223	+3.7%
Los Angeles	9,818,696	10,163,507	+3.5%
Orange	3,010,265	3,190,400	+6.0%

Sources: U.S. Census Bureau (2018).

18.2 Employment and Income

Civilian Labor Force. The average civilian labor forces in 2017 for the five coastal counties are presented in Table 18-2. In 2017, the employed civilian labor force ranged from almost 137,000 in San Luis Obispo County to more than 4.8 million in Los Angeles County. The unemployment rates at that time or the five counties ranged from 3.5% (Orange County) to 4.7% (Los Angeles County), and were all below the statewide rate of 4.8%.

TABLE 18-2 Average Civilian Labor Force Statistics for 2017

County	Civilian Labor Force Numbers	Number (Percentage)	
		Employed	Unemployed
San Luis Obispo	142,066	136,977	5,089 (3.6)
Santa Barbara	216,954	207,213	9,741 (4.5)
Ventura	426,116	406,976	19,140 (4.5)
Los Angeles	5,123,933	4,883,640	240,293 (4.7)
Orange	1,602,371	1,618,828	56,627 (3.5)

Source: U.S. Bureau of Labor Statistics (2018).

Employment by Industry Sector. Employment by industry sector for 2016 is shown in Table 18-3. Paid employees that were part of the mining, quarrying, and oil and gas extraction sector (including both onshore and offshore production) represented a very small portion of the total paid employees from all sectors, ranging from only 0.02% for Orange County to 0.5% for Santa Barbara County.

TABLE 18-3 Paid Employees, by Employment Sector, 2016

Employment Sector	County				
	San Luis Obispo	Santa Barbara	Ventura	Los Angeles	Orange
Agriculture, forestry, fishing and hunting	192	776	543	482	188
Mining, quarrying, oil and gas extraction	111	697	683	4,175	308
Utilities	1,000-2499	325	963	14,404	3,511
Construction	6,632	7,413	14,065	128,179	93,165
Manufacturing	6,447	14,459	24,647	338,448	149,555
Wholesale and retail trade	16,944	25,927	55,730	680,416	261,063
Transportation and warehousing	2,144	2,656	4,955	163,592	26,068
Finance, insurance, and real estate	4,186	7,229	15,939	248,399	135,569
Services	46,875	75,793	123,945	1,824,550	676,075
Other	20,226	11,626	14,906	469,071	137,100
Total	104,757	146,504	257,011	4,007,163	1,449,828

Personal Income. Total personal income varied considerably among the five counties, ranging from approximately $14.5 million for San Luis Obispo County to $196 million for Orange County (Table 18-4). However, on a per-capita basis, income varied much less among the counties. Per-capita income ranged from approximately $51,400 for San Luis Obispo County to about $62,100 for Orange County. By comparison, the 2016 statewide average was $53,741.

TABLE 18-4 Personal Income, 2016

	Total Personal Income	Population	Per-Capita Income
San Luis Obispo	$14,552,207	282,887	$51,442
Santa Barbara	$25,007,127	446,170	$56,048
Ventura	$47,397,620	849,738	$55,779
Los Angeles	$563,907,868	10,137,915	$55,624
Orange	$196,920,661	3,172,532	$62,071

Source: U.S. Bureau of Economic Analysis (2018).

18.1.3 Housing

Average housing characteristics in 2016 for the five county area are presented in Table 18-5. Reflecting the county population numbers, San Luis Obispo County had the fewest housing units (approximately 121,000 units) while Los Angeles County had the most (slightly more than 3.5 million). Homeowner vacancy rates in 2016 ranged from 0.7% in Ventura County to 1.4% in San Luis Obispo County. In contrast, Ventura County had the highest rental vacancy rate (4.1%) of the five counties, while San Luis Obispo County had the lowest rate (2.6%) (Table 18-5).

TABLE 18-5 2016 Average Housing Characteristics, San Luis Obispo County

	Housing Units			Vacancy Rate (%)	
County	**Total**	**Occupied**	**Vacant**	**Homeowner**	**Rental**
San Luis Obispo	120,866	106,312	14,554	1.4	2.6
Santa Barbara	155,962	142,449	13,513	0.8	2.7
Ventura	286,905	268,091	18,814	0.7	4.1
Los Angeles	3,520,811	3,305,589	215,222	1.1	2.9
Orange	1,090,121	1,032,218	57,903	1.0	3.0

Source: U.S. Census Bureau 2018.

18.1.4 Public Finance

The contribution of oil and gas industry activities, including onshore production, to state and local tax revenues, by county in 2013 and 2015 are shown in Table 18-6.

Table 18-6 State and Local Tax Revenues from the Oil and Gas Industry ($ millions)

	Counties									
	San Luis Obispo		**Santa Barbara**		**Ventura**		**Los Angeles**		**Orange**	
Revenue Source	2013	2015	2013	2015	2013	2015	2013	2015	2013	2015
Sales and excise taxes	112.0	93.6	158.3	128.1	298.4	226.5	3,615.5	2,862.8	1,075.9	920.8
Property taxes	26.4	18.7	41.2	28.0	83.3	41.4	1,032.8	552.7	170.3	117.8
Personal income taxes	7.0	4.6	14.7	13.4	29.9	21.7	312.1	253.8	78.4	54.0
Corporate profits taxes	3.4	1.9	3.1	1.9	6.2	2.9	128.3	89.9	16.3	8.8
Social insurance taxes	1.0	0.7	1.1	1.1	1.7	1.2	24.1	18.2	3.3	2.2
Other taxes	5.8	3.2	9.1	6.3	18.5	9.2	226.2	150.6	38.5	25.4
Fees, fines, and permits	1.7	0.9	3.4	2.3	6.8	3.8	74.5	69.5	17.1	9.7
Total tax revenues	157.4	123.4	230.9	181.1	444.8	306.6	5,413.5	3,997.5	1,399.8	1,138.6

Source: Cooper and Sedgwick 2015; Sedgwick and Mitra 2017

18.6 References

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