STATE OF THE KNOWLEDGE

U.S. WEST COAST NEARSHORE HABITAT USE BY FISH ASSEMBLAGES & SELECT INVERTEBRATES

PMEP

PACIFIC MARINE & ESTUARINE FISH HABITAT PARTNERSHIP

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AUGUST 2022

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Joseph J. Bizzarro,[1] James Selleck,[2] Kate Sherman,[3]
Joan Drinkwin,[2] Van C. Hare,[3] David S. Fox[4]

[1] Cooperative Institute for Marine Ecosystems and Climate, University of California, Santa Cruz. [2] Natural Resources Consultants, Inc. [3] Pacific States Marine Fisheries Commission. [4] Oregon Department of Fish and Wildlife.

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Front cover photo: Schooling fish. (A. Obaza, Paua Marine Research Group)

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PREFACE

This report documents the current state of knowledge of U.S. West Coast nearshore habitat use by fish assemblages and select marine invertebrates. It reports on the compilation of standardized spatial data on nearshore habitats within defined nearshore zones. It reflects a snapshot in time and space, though it should not be interpreted as a current assessment of the extent of species and habitats. Species and habitats shift and move, and the impacts of various natural and anthropogenic stressors constantly influence the distribution of habitats and their use by species. This report reflects what we know now about where habitats are and where they have been and how they are used by fish assemblages and invertebrates. It is designed to provide a big picture of fish habitats throughout the U.S. West Coast: a baseline against which we can investigate changes, shifts, and adaptations. The Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) was prompted to develop this database and produce this report by the growing interest in describing and documenting habitats for nearshore marine species in a consolidated way to allow comparisons and evaluate changes over time along the entire U.S. West Coast.

PMEP is one of 20 nationally recognized fish habitat partnerships under the authority of the National Fish Habitat Partnership. PMEP works collaboratively across Washington, Oregon, and California to conserve, protect, and restore functional, resilient estuarine and nearshore marine ecosystems that support healthy native fish populations. PMEP committees and leadership include federal, tribal, state, academic, and nonprofit organizations throughout its region, engaging leaders in the fields of fish habitat protection, restoration, resource management, and research. This combination of expertise allows PMEP to identify regional priorities for data compilation and assessments, which inform the projects PMEP supports with funding from the National Fish Habitat Partnership and other sources. PMEP embraces ecosystem and process-based approaches to fish habitat restoration, which benefit multiple native fish species, including species of commercial and recreational value. PMEP focuses on estuaries and nearshore marine waters of the U.S. West Coast from Washington to California.

Our historical work on estuaries has included the compilation and standardization of data on estuaries along the U.S. West Coast and important foundational assessments that helped define our work within estuaries, including an assessment of tidal wetland loss, a report on the state of the knowledge of eelgrass, an inventory of West Coast estuaries, and an assessment of the nursery function of these systems for 15 commercially important and estuary-dependent species. The results of the initial assessments iteratively guided further assessment priorities, project funding priorities, and the refinement of strategic planning.

The importance of documenting fish and invertebrate habitat associations in nearshore environments prompted PMEP to extend our historical work on estuarine systems into the marine nearshore by producing this report and associated geodatabase. We identified a knowledge gap in our understanding of large-scale processes and connectivity among species and habitats along the West Coast. The first step in addressing this knowledge gap was consolidating, synthesizing, and providing the best available science on the region's nearshore fishes and their habitats for resource managers, restoration practitioners, and researchers. Select invertebrates were also included as key competitors and/or prey of many of the fish species under consideration. PMEP developed the Nearshore Project with three main objectives:

1. Define and map boundaries for delineating nearshore zones along the U.S. West Coast.
2. Compile and standardize spatial data on nearshore habitats within defined nearshore zones.
3. Produce a state-of-the-knowledge report on U.S. West Coast nearshore fish and invertebrate habitats.

In late 2018, PMEP convened a nearshore working group of academic, government, and nongovernmental organization (NGO) scientists that included experts on nearshore fish habitats along the entire West Coast (see Acknowledgments). This working group advised PMEP on key decision points during geographic information system (GIS) project development and report construction (e.g., depth boundaries for nearshore zones, invertebrate species of interest) and reviewed outlines, datasets, and report drafts. Additionally, a smaller project team guided project-related decisions and timelines. On several occasions, PMEP solicited insights and feedback on the Nearshore Project from its partners and committees, and PMEP asked all partners for spatially interpreted seafloor data that identify nearshore fish and invertebrate habitats.

With continual guidance from this working group, the successful completion of Objectives 1 and 2 resulted in the production of a geodatabase that includes feature classes of nearshore zones, as well as biotic and substrate habitat layers that were utilized to inform the compilation of this report (Objective 3). The companion geodatabase can be accessed at www.pacificfishhabitat.org/data.

This report is the culmination of Objective 3. This report's specific objectives include identifying typical fish assemblages and select invertebrate species within nearshore habitats, identifying data gaps, defining similarities between habitat types and among nearshore regions, and identifying habitat stressors. A thorough literature search and consultation with experts provided the necessary background information to facilitate these objectives. This report

- documents the distribution and abundance of habitat types and associated benthic-demersal and pelagic fish assemblages and select invertebrate species within its defined ecoregions, subregions, and nearshore zones;
- identifies data gaps among habitat types and associated fauna within and among each ecoregion's nearshore zones; and
- describes stressors affecting nearshore habitats at a variety of scales (coast-wide, ecoregion-specific, and state-specific).

The report is organized, for the most part, by PMEP ecoregions: Salish Sea, Pacific Northwest, Central California, and California Bight. Each ecoregion section describes the habitats by nearshore zones, fish assemblages, and invertebrate use. Extensive tables and appendices illustrate this information. Each ecoregion section includes summary points and an "Ecoregion Spotlight" highlighting a unique subject relating to connectivity, biodiversity, or responses to stressors.

Focal marine invertebrates were selected for each ecoregion, with many selected for multiple ecoregions. For this reason, focal invertebrate life history and other general information are provided in one section to avoid duplicating information in each ecoregion section. But ecoregion-specific information is retained in the ecoregion sections.

We standardized habitat data using the Coastal Marine Ecological Classification System (CMECS) wherever possible. Source data that were categorized using a different classification system were crosswalked (i.e., converted) to the most relevant and detailed CMECS ecological unit code. Where original data sources did not have an equivalent classification in CMECS, we proposed a classification to CMECS using the established process.

There were many gaps in the data needed to fully describe fish habitats and their use by fish and invertebrates throughout the U.S. West Coast nearshore zones. There were data gaps in the distribution of habitat types, especially related to areas shallower than 10 m and dominated by wave action (the white zone), faunal beds (e.g., shellfish), and macroalgae (e.g., understory kelps). Some data that does exist was of varying quality, which is reflected in some of the substrate classifications. Additional work to describe the extent of the two remaining CMECS components, Geoform and Water Column, are needed to create a full suite of biotopes describing fish and invertebrate habitats. We identify some future research needs, especially related to effects of climate and ocean change and species connectivity.

We provide a brief overview of the many stressors affecting nearshore fish, invertebrates, and their habitats. The stressors identified include direct human action, indirect effects of human action, and natural, environmental stressors that are not human-induced. These stressors may influence the spatial extent of nearshore fish habitats and the ranges of fish and invertebrates in the future.

The novel efforts made in this report to describe U.S. West Coast habitats, fish, and invertebrates were monumental. The report and accompanying PMEP Nearshore geodatabase give researchers, restoration practitioners, decision-makers, and other stakeholders a searchable repository of the best available science. They are tools to better understand what we know now about these fish and invertebrate habitats and what more we can learn. Still, our efforts thus far have been only an initial approach to compiling and synthesizing existing data sources. More work remains.

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ACRONYMS

A	abundant or anadromous (refer to each table's key)
AT&SML	Active Tectonics & Seafloor Mapping Lab, OSU
BOEM	Bureau of Ocean Energy Management, U.S. Department of the Interior
C	common
CAPG	Canadian Border to Point Grenville
CBCM	Cape Blanco to Cape Mendocino
CC	Central California
CDFW	California Department of Fish and Wildlife
CLCB	Cape Lookout to Cape Blanco
CMECS	Coastal and Marine Ecological Classification Standard
CMPR	Cape Mendocino to Point Reyes
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSMP	California Seafloor Mapping Program
CUSP	Continually Updated Shoreline Product
DEM	Digital Elevation Model
DLCD	Oregon Department of Land Conservation and Development
DPS	Distinct Population Segment
eDNA	environmental DNA
EFH	essential fish habitat
EFH SGH	Essential Fish Habitat Surficial Geologic Habitat
ENSO	El Niño–Southern Oscillation
ESA	U.S. Endangered Species Act
FR	Federal Register
FW	freshwater usage
GGNRA	Golden Gate National Recreation Area
GIS	geographic information system
HAB	harmful algal bloom
HAT	highest astronomical tide
HC	Hood Canal
IUCN	International Union for Conservation of Nature
MEOW	Marine Ecoregions of the World
MHW	mean high water
MLLW	mean lower low water
MPA	marine protected area
MRC	Marine Resources Committee
NA	not applicable
NCPSB	North Central Puget Sound Basin
NGO	nongovernmental organization
NHD	National Hydrography Database
NMFS	National Marine Fisheries Service (a.k.a. NOAA Fisheries)
NOAA	National Oceanographic and Atmospheric Administration
NPS	U.S. National Park Service
NWFSC	Northwest Fisheries Science Center
NWI	National Wetlands Inventory
NWSC	Northwest Straits Commission
PAS	Point Arguello South
PCPV	Point Conception to Palos Verde
PCRG	Pacific Northwest Crab Research Group
PFMC	Pacific Fishery Management Council

PGCL	Point Grenville to Cape Lookout
PISCO	Partnership for Interdisciplinary Studies of Coasts and Oceans
PMEP	Pacific Marine and Estuarine Fish Habitat Partnership
PNW	Pacific Northwest
PRPS	Point Reyes to Point Sur
PSEMP	Puget Sound Ecosystem Monitoring Program
PSPA	Point Sur to Point Arguello
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
PVMX	Palos Verde to Mexican Border
R	rare
REEF	Reef Environmental Education Foundation
ROV	remotely operated vehicle
S	surface depth
SANDAG	San Diego Association of Governments
SCB	Southern California Bight
SCPSB	South Central Puget Sound Basin
SFMI	structure-forming marine invertebrate
SGH	Surficial Geologic Habitat
SJDFB	San Juan de Fuca Basin
SJI	San Juan Islands
SPSB	South Puget Sound Basin
SS	Salish Sea
SSPHAMST	Salish Sea Pacific Herring Assessment and Management Strategy Team
TNC	The Nature Conservancy
UCSC	University of California, Santa Cruz
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WADNR	Washington Department of Natural Resources
WB	Whidbey Basin
WC	water column
WDFW	Washington Department of Fish and Wildlife
YOY	young-of-the-year

Rocks, 06/14/2017. (ODFW)

INTRODUCTION

INTRODUCTION

During the last 20 years, there has been increased interest in describing and conserving habitats for marine species, especially those in nearshore regions, where the impacts of human activities are readily observable. Quantitative, interdisciplinary studies, typically involving marine ecologists, marine geologists, and fisheries scientists, have greatly expanded our understanding of the relationships among marine fishes, invertebrates, and their seafloor habitats (e.g., Yoklavich et al. 2000; Tissot et al. 2007; Baker and Harris 2012; Ventura et al. 2016). On the U.S. West Coast, several regional research programs have emerged to develop a coast-wide network to survey and monitor nearshore marine habitats and their associated fauna. Scientists have sought to provide a baseline condition for monitoring efforts as environmental (e.g., sea surface temperature, salinity, dissolved oxygen, upwelling index) and anthropogenic (e.g., dredging, fishing, coastal development, climate change) stressors continuously interact to alter the distribution and abundance of marine organisms (Ehrlen and Morris 2015). Knowledge of species' habitat associations and environmental tolerances enables scientists and resource managers to better predict and prepare for these changes and to derive conservation policies that reduce adverse impacts. Despite regional efforts, there lacks a single, consolidated database or published synthesis for U.S. West Coast nearshore fish and invertebrate assemblages, and habitat use patterns have not yet been developed.

Determining organisms' distribution and abundance patterns and the factors driving them are fundamental aspects of ecology. Primary among these factors are the habitat requirements and preferences of a species. The physiological needs, environmental tolerances, and habitat associations of a species dictate its potential distribution (Falucci et al. 2012; Tobeña et al. 2016). Negative interactions with other species, such as competition or predation, and impacts from a broad diversity of environmental stressors, such as temperature and salinity, reduce the potential distribution of a species to its realized distribution (Booth 2017; Hattab et al. 2017; Roberts et al. 2020). Interspecies interactions and environmental conditions are dynamic; therefore, distribution and abundance patterns vary spatially and temporally. Habitat associations, by contrast, usually are relatively consistent within the established range of a species but may vary with range expansion due to climate change or invasions of non-native species (Sullivan and Franco 2018).

Regions that share consistent overlapping habitat types result in the general co-occurrence of species with similar habitat requirements and preferences. Groups of species found in a particular habitat or region of interest are often called *biological assemblages* (Stroud et al. 2015). Aspects of assemblage structure, such as species composition, relative abundance, and diversity, can be compared to evaluate spatiotemporal differences within and among biological assemblages and to investigate the abiotic and biological factors that drive those changes (Anderson and Yoklavich 2007; Rapacciuolo and Blois 2019). Estimating species composition and relative abundance within assemblages also can enhance the understanding of ecological interactions and ecosystem processes (Bizzarro et al. 2014).

Habitat structure and the spatial arrangement and connectivity among habitats can be important predictors of the distribution, abundance, and species composition of marine fish and invertebrate assemblages (Magris and Déstro 2010; Wedding and Yoklavich 2015). Examining landscape patterns in marine environments was historically difficult because of limited visibility and limited access to depths beyond scuba gear's typical limits (deeper than 30 m; Yoklavich and O'Connell 2008; Laidig et al. 2009). However, recent advances in seafloor imaging technologies, such as side-scan sonar and the multibeam echosounder, have enabled the production of high-resolution seafloor maps at greater depths that overlap with traditional fishing grounds (Greene et al. 2007a; Getsiv-Clemons et al. 2012). At shallow subtidal and intertidal depths, lidar systems and drones are utilized to rapidly map the seabed (Jalali et al. 2015; Ventura et al. 2016). Imaging and mapping seafloor habitats are more efficient than sampling species abundances over similar spatial extents. Therefore, once a good understanding of habitat associations and localized densities have been established using traditional fishing methods, remotely operated vehicles (ROVs), or other sampling tools, scientists and resource managers can predict the general distribution and abundance of species and

A diver joins a school of fish. (A. Obaza, Paua Marine Research Group)

assemblage structures, especially for benthic and demersal species with consistent use patterns (Harris and Baker 2012; Pacunski et al. 2020; Lowry et al. 2022). These estimates can then be ground-truthed and refined by the continued use of both traditional and advanced methods strategically and more cost-effectively, helping to identify gradients and breaks in assemblage constituency.

A detailed understanding of habitat associations of marine fishes and invertebrates provides a scientific basis to inform effective long-term monitoring, conservation, and management. A U.S.-wide shift in fishery management strategy occurred in 1996 with the designation of essential fish habitat (EFH) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" via amendments to the Magnuson-Stevens Fishery Conservation and Management Act (U.S. Department of Commerce 1996). Since this designation, the National Oceanographic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NOAA Fisheries) has been working with regional fishery management councils to designate and update EFH for managed species of marine and anadromous fishes and to minimize the adverse effects of anthropogenic impacts on EFH. On the U.S. West Coast, the relevant body is the Pacific Fishery Management Council (PFMC; www.pcouncil.org). Knowledge of marine fish and invertebrate habitat associations also can inform the designation of no-take zones, marine protected areas (MPAs), Habitat Areas of Particular Concern, or other place-based management constructs. These spatial conservation measures are especially common in nearshore regions that are often heavily populated and may incorporate kelp beds, seagrass meadows, or rocky reefs (Wooninck et al. 2008).

Hydrocoral, Southern California Bight. (A. Obaza, Paua Marine Research Group)

METHODS

METHODS

Defining and Mapping Nearshore Zones

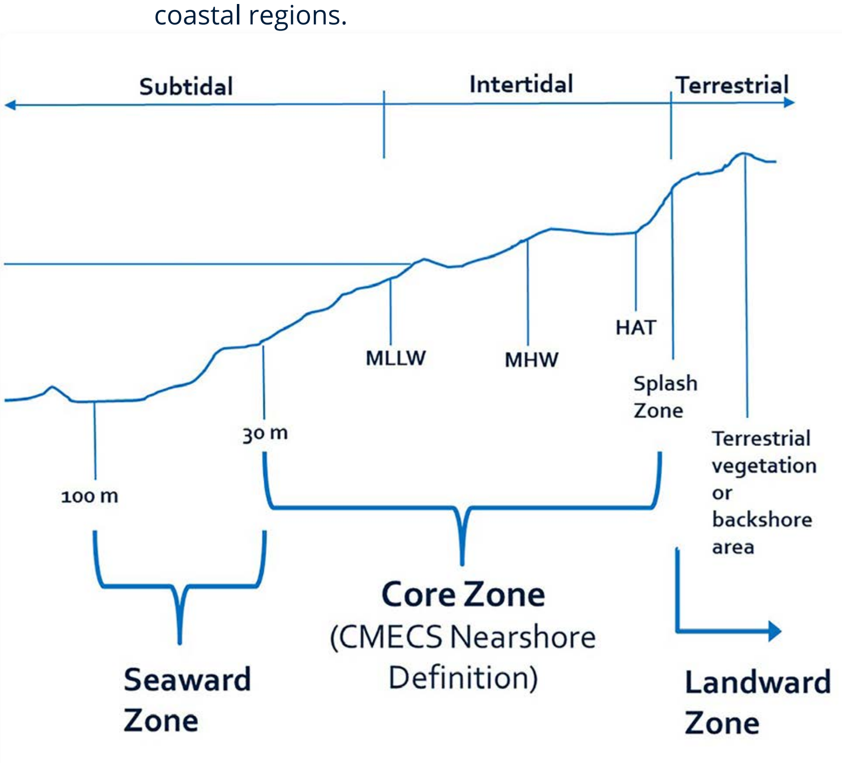
The Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) and the Nearshore Working Group established a definition of nearshore to inform this project and delineate nearshore zones along the entirety of the U.S. West Coast for incorporation into PMEP's spatial data system. Currently, PMEP's spatial data system, consistent with PMEP's full scope (i.e., coastal watersheds out to a −200 m depth in marine waters), includes four ecoregions and 444 estuaries across Washington, Oregon, and California (Appendix 2).

Nearshore zones were defined along an onshore-offshore gradient and in biogeographic ecoregions and subregions. Estuaries were purposely excluded from the nearshore zones because they are covered in prior PMEP reports (Heady et al. 2014; Hughes et al. 2014; Toft et al. 2015) and are often constrained by unique ecosystem stressors. Once the nearshore zones were identified and defined, they were used to develop a geospatial dataset, with available literature and habitat datasets summarized by zone.

Nearshore Definition and Nearshore Zones

For this project, PMEP defined the *nearshore region* as the coastal area from (a) an upper limit of the landward extent that is influenced by the nearshore ecosystem to (b) a −100 m water depth relative to the mean lower low water (MLLW). This area was subdivided into three onshore-offshore *nearshore zones*: Landward Zone, Core Zone, and Seaward Zone (Fig. 1). The *Landward Zone* (onshore) ranges from the top of the splash zone of the intertidal to an upper limit that includes landward influences, excluding estuaries and watersheds but including shoreline features such as riparian vegetation in the backshore, feeder bluffs associated with drift cells, and shoreline development and other urban stressors. The maximum elevation of the Landward Zone will vary based on overall topography and regional shoreline properties. We used the Coastal and Marine Ecological Classification Standard (CMECS) definition of nearshore to define the *Core Zone*, which ranges from the upper limit of the intertidal (splash zone) to a depth of −30 m (Federal Geographic Data Committee 2012). The Core Zone, therefore, comprises the intertidal zone (MLLW to the splash zone) and upper portions of the subtidal zone (MLLW to −30 m), generally including the photic zone. The *Seaward Zone* extends from −30 m to −100 m, which may be relatively close to shore in areas with steep slopes or drop-offs; it encompasses portions of the inner and mid-continental shelf. PMEP's definition of nearshore includes the Seaward Zone because many nearshore fish species have depth ranges extending both inshore and offshore beyond the −30 m CMECS-defined outer boundary

Figure 1. Nearshore zones (Seaward, Core, Landward) defined for this report and associated spatial data, including depth boundaries and orientation with established coastal regions.



Note. The image is not to scale. Abbreviations are defined as follows: MLLW = mean lower low water, MHW = mean high water, HAT = highest astronomical tide, CMECS = Coastal and Marine Ecological Classification Standard. From report author D. Fox.

of the nearshore. Based on a review of relevant fish data, the Nearshore Working Group determined that using an outer depth limit of –100 m encompasses the full depth range of most of these species.

The focus of this project's literature review and data compilation was the Core Zone, but relevant literature and spatial habitat data for the Seaward Zone also were compiled. We did not attempt to compile spatial habitat extent data for the Landward Zone, and fish and invertebrate data were not associated with this region. All areas within PMEP's scope that are deeper than the Seaward Zone (> –100 m depth) are considered part of the Outer Shelf (open coast) or Channel (Salish Sea). Literature and data summaries from these deeper regions were not targeted for collection; however, habitat data from the Seaward Zone that extended deeper than –100 m were included in the regional dataset when relevant. Using these criteria, the entire West Coast region was divided into the three nearshore zones and a fourth zone called the *Outer Shelf or Channel Zone.* Also, political boundaries, including both state and state-water boundaries (3 nautical miles from the shoreline), were included in the attributes of the nearshore zones' datasets.

PMEP identified existing coast-wide and regional datasets to create a new geospatial dataset used to delineate the three nearshore zones and Outer Shelf or Channel Zone. No new datasets were developed for this task. Specific datasets were used to define each nearshore zone boundary, including the 30 m depth contour, 100 m depth contour, and splash zone (Table 1). If data for a boundary were absent or unobtainable, the best available substitute was used. For example, no data were located to define the splash zone; therefore, shoreline data were used instead. Two datasets were applied to define the shoreline for our study region: (1) NOAA's Continually Updated Shoreline Product (CUSP; outer West Coast) and (2) the U.S. Geological Survey (USGS) shoreline (Salish Sea). Both datasets use the mean high water (MHW) to estimate the shoreline, which is seaward of the definition for the upper limit of the Core Zone; however, more precise data at a scale appropriate for this project were unavailable.

West Coast Ecoregions and Subregions

The U.S. West Coast was divided into biogeographic components that include four ecoregions and 18 integrated subregions (Fig. 2). These components all fall within the Temperate Northern Pacific realm and the Cold Temperate Northeast Pacific province, as defined by CMECS (Federal Geographic Data Committee 2012). Ecoregions comprise the U.S. portion of the Salish Sea, Pacific Northwest (i.e., Washington, Oregon, and Northern California), Central California, and the Southern California Bight. These ecoregions align with

Algae at low tide, Cascade Head Marine Reserve, Oregon, 07/02/2019. (ODFW)

boundaries used by PMEP and some regions identified by the PFMC. Plus, they are slightly modified from the Marine Ecoregions of the World (MEOW; Spalding et al. 2007). The Strait of Juan de Fuca is included in the Salish Sea region, as opposed to MEOW's "Washington, Oregon, and Northern California Coast and Shelf" region (the latter of which is referred to as the Pacific

Table 1. Coast-wide and regional datasets used to define nearshore zones in each ecoregion.

Ecoregion	Terrestrial Vegetation/ Backshore Area	Splash Zone (Shoreline)	30m Depth Contour	100m Depth Contour
Salish Sea	NA	NA (NHD Shoreline defined by MHW, NHD Plus V2)	30m Bathymetry Mosaic for WA Salish Sea (NWFSC 2009)	30m Bathymetry Mosaic for WA Salish Sea (NWFSC 2009)
Pacific Northwest	NA	NA (NOAA CUSP, MHW)	100m DEM from 5-Year Review of Pacific Coast Groundfish EFH, 10m contours (OSU 2012)	100m DEM from 5-Year Review of Pacific Coast Groundfish EFH, 10m contours (OSU 2012)
Central California	NA	NA (NOAA CUSP, MHW)	200m DEM, 10m contours (CDFW 2009); 30m Interpreted Bathymetry for California, 5m contours (UCSC 2019)	200m DEM, 10m contours (CDFW 2009); 30m Interpreted Bathymetry for California, 5m contours (UCSC 2019)
Southern California Bight	NA	NA (NOAA CUSP, MHW)	200m DEM, 10m contours (CDFW 2009); 30m Interpreted Bathymetry for California, 5m contours (UCSC 2019)	200m DEM, 10m contours (CDFW 2009); 30m Interpreted Bathymetry for California, 5m contours (UCSC 2019)

Note. NA = not applicable, MHW = mean high water, NHD = National Hydrography Database, NOAA = National Oceanic and Atmospheric Administration, CUSP = Continually Updated Shoreline Product, WA = Washington, DEM = Digital Elevation Model, EFH = essential fish habitat, NWFSC = Northwest Fisheries Science Center, OSU = Oregon State University, CDFW = California Department of Fish and Wildlife, UCSC = University of California, Santa Cruz.

Northwest region in this report). The strait is included in the Salish Sea region to be consistent with recent marine spatial planning efforts and other management definitions of the greater Puget Sound. In the U.S. waters of the Salish Sea, there are seven subregions that align with the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) subregions and with previous efforts by PMEP (Fig. 3). For the three outer coast ecoregions, 10 subregions were defined by existing ecoregional assessment boundaries published by The Nature Conservancy (TNC; Gleason et al. 2004, 2013; Vander Schaaf 2013).

Compilation and Classification of Habitat Data

We compiled spatially interpreted substrate and biotic habitat data throughout the West Coast. Data collection relied on a web-based data search and a call for data to regional experts to obtain relevant existing datasets. No new field studies or data interpolations were conducted for this effort. PMEP used its partner organizations and professional networks, including the Nearshore Working Group, to solicit data and to identify entities that potentially hold relevant data sources. In total, PMEP identified 68 habitat data sources (48 substrate, 14 biotic, and six substrate and biotic).

Priority was placed on datasets with a large spatial footprint that consistently mapped a habitat feature, or features, for large segments of the coast (e.g., 10s to 100s of kilometers). We focused on spatially referenced data, specifically in vector (polygon) or raster (rectangular pixel grid) format, depicting the extent of substrate and biotic habitats. Preference was given to field-collected data and interpretations of field data. Digitized data from expert opinion was accepted when a task focused on mapping the extent of a particular habitat. Index polygons iden-

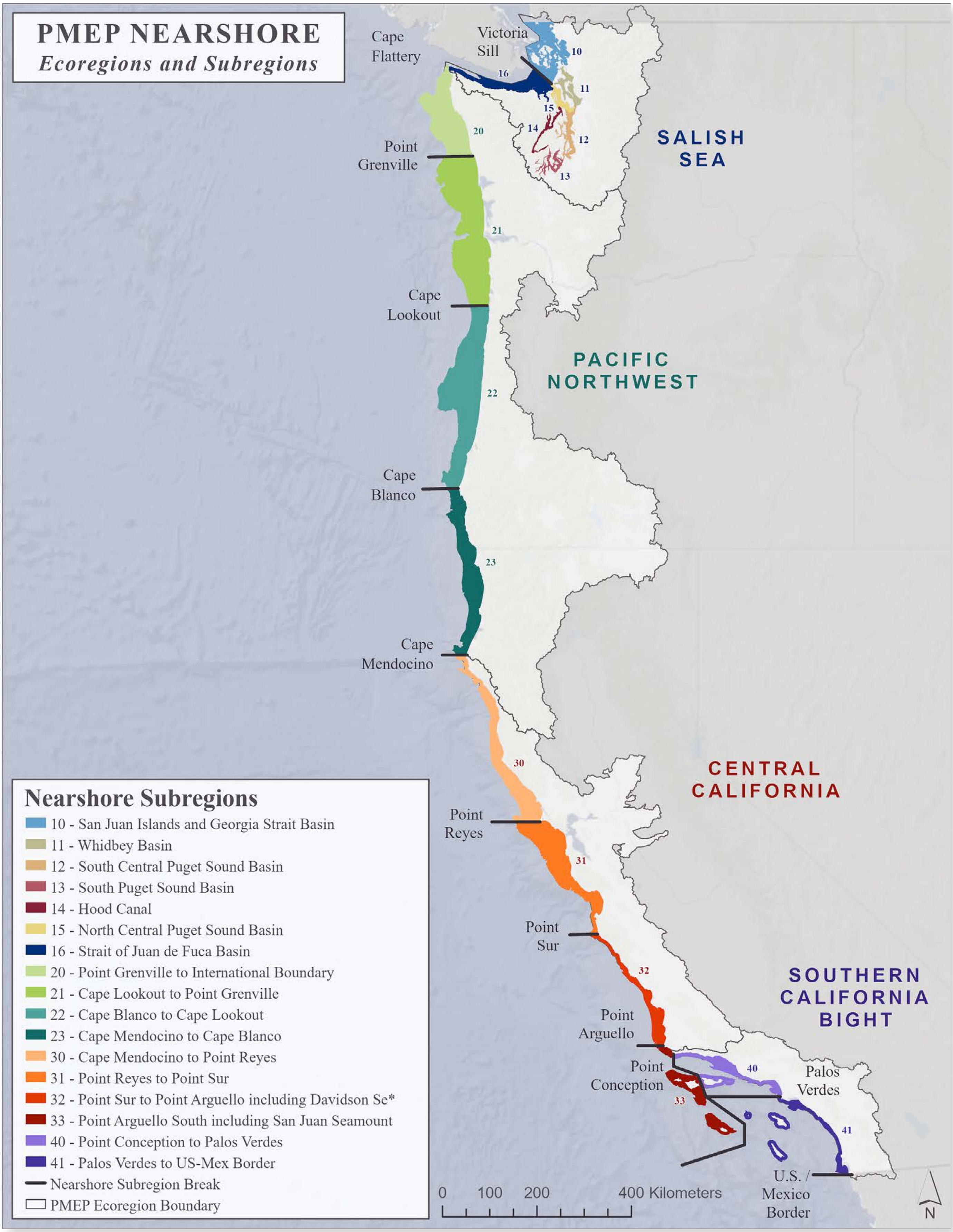


Figure 2. Biogeographic designations for the Nearshore Project, including PMEP ecoregions and subregions.

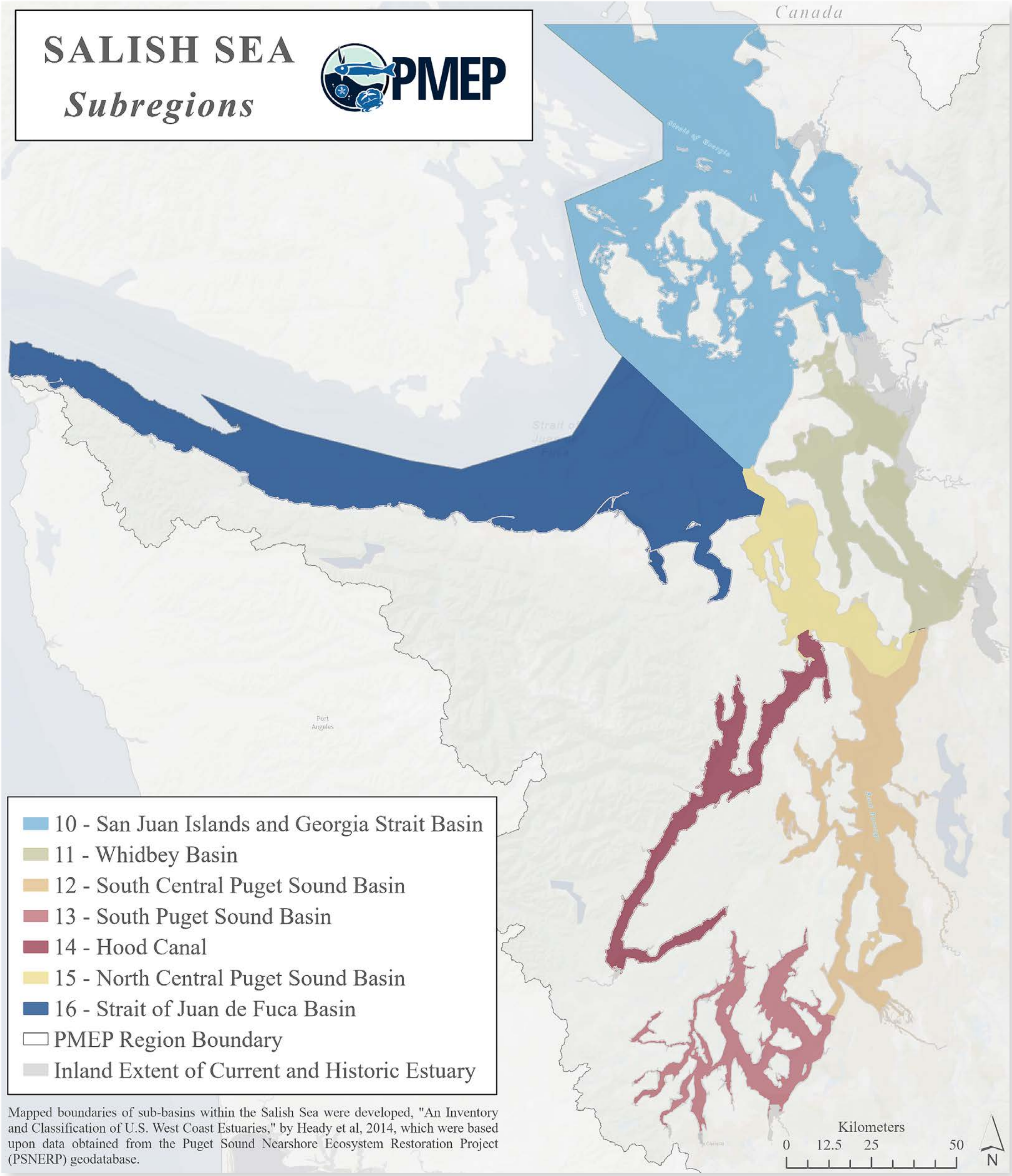


Figure 3. Biogeographic designations for the Salish Sea, including PMEP ecoregions and subregions.

tifying the potential for habitat, such as management areas, were not accepted. In addition, modeled data were accepted and used when no other suitable, field-collected dataset was available.

We standardized the classification of the individual datasets using CMECS, Version 4. CMECS is endorsed by the Federal Geographic Data Committee, is recommended by NOAA as the federal data standard recommended, and has been used extensively for the characterization and management of nearshore and offshore waters in the United States. There are six elements of the standard that represent different aspects of the seascape (water column, geoform, substrate, biotic communities, biogeographic setting, and aquatic setting). Due to time and data limitations, this project focused on two of the four components (substrate and biotic communities) and two settings (aquatic and biogeographic). Future mapping phases can work to complete the two remaining components (what the CMECS calls Water Column Component and Geoform Component).

Source data that were categorized using a different classification system were crosswalked (i.e., converted) to the most relevant and detailed CMECS ecological unit code. See Appendix 3 for CMECS ecological units identified in the development of the CMECS Substrate and Biotic Component feature classes. Habitat units in our geodatabase were based on a modified version of CMECS substrate subclass and biotic subclass groups. When available, previously developed crosswalks were utilized (Goodwin et al. 2016). Otherwise, we developed newly generated crosswalks using habitat type definitions, and experts reviewed them for accuracy. These newly developed crosswalks are available by request through the GIS team (gis@psmfc.org) at the Pacific States Marine Fisheries Commission, or in the metadata for the biotic and substrate habitat datasets. The main classification systems used by source datasets included:

1. Seafloor Character Map (California Coast State Waters Mapping Project; Cochrane 2008)
2. Seafloor Habitats (Greene et al. 1999)
3. Surficial Geologic Habitat, SGH V4.0 (Bureau of Ocean Energy Management [BOEM] Outer Continental Shelf Study; Goldfinger et al. 2014)
4. A Marine and Estuarine Habitat Classification System for Washington State (Dethier 1990)
    a. Slight modifications to this system were made by the Skagit River Systems Cooperative in 2000.
5. CMECS (Federal Geographic Data Committee 2012)
6. Ocean Imaging Nearshore Substrate Habitat Mapping Classifications (Svejkovsky 2014)

Geodatabase of Substrate and Biotic Habitat Data

Substrate datasets for the Core and Seaward Zones were compiled, crosswalked, standardized, and merged to create a single vector-based feature class (i.e., habitat polygons) depicting seafloor habitat data for the West Coast. Located and submitted datasets were compiled and uploaded in an ArcGIS Pro geodatabase for processing. Each dataset was adjusted to a common projection (West Coast Custom Mercator, as created by NOAA's Northwest Fisheries Science Center) and given a standardized set of attributes (including PMEP region, nearshore zone, state, source habitat type, detailed CMECS habitat name, and CMECS category). Most of the source datasets were in polygon format; however, if they were in raster format, they were converted to vector using an ArcGIS Pro raster-to-polygon tool. Since substrate data are collected using a focused spatial footprint and then classified, the best available dataset for a location was determined and used in the merged habitat dataset. Only existing datasets were used in this effort, and no additional interpretations of habitat were conducted. Any areas within PMEP's scope that did not have existing substrate habitat were categorized as *Unclassified*. In total, 54 substrate datasets were used to create the final product.

Biotic datasets for the Core and Seaward Zones were compiled, crosswalked, standardized, and merged by biotic ecological unit. Each dataset was reprojected in ArcGIS into a common projection and given a standardized set of attributes (including PMEP region, nearshore zone, state, source habitat type, detailed CMECS habitat name, and CMECS category). If source datasets were in the raster format, they were converted to the vector format using an ArcGIS Pro raster-to-polygon tool. If multiple years of data were available for a particular habitat category at the same location, the data were combined to depict the maximum observed extent of a particular habitat type.

Each unique biotic ecological unit dataset was then merged to create a single feature class stored in a geodatabase depicting biotic seafloor habitat for the West Coast. When spatial overlap of different biotic units occurred (e.g., macroalgae and eelgrass), each unit was noted in a separate attribute within the dataset. The final ecological unit chosen to represent a polygon with overlapping habitat types was the highest level of the CMECS component that signifies all included ecological units. For example, if macroalgae and eelgrass co-occurred in an area, the final ecological unit classification would be *aquatic vegetation bed*. This classification incorporates the subclass *benthic macroalgae* and the community *eelgrass*. Any areas within PMEP's scope that did not have existing biotic habitat data were categorized as *unclassified*. The resulting biotic component dataset can be filtered to represent the maximum observed extent for each ecological unit based on available spatial data for a particular area. In total, 20 datasets were identified and compiled to create the final product.

From the source data, PMEP summarized substrate and biotic extent data into the following six categories:

1. CMECS ecological unit
2. PMEP habitat category
3. PMEP nearshore zone
4. PMEP nearshore subregion
5. State
6. Presence within state waters

Compiling and Synthesizing Biological Information

Defining Fish Assemblages

Documenting habitat associations of nearshore fishes is one of the foci of this report. Fish fauna is considered at the assemblage level. This approach enables an assessment of changes in habitat-specific assemblage structure (e.g., species composition, relative abundance, diversity) by depth and latitude. An *assemblage* is a group of co-occurring populations of species that, typically, are taxonomically related (Stroud et al. 2015). By comparison, a *community* is a group of co-occurring, interacting populations of differing taxa (Stroud et al. 2015). Habitat-specific fish assemblages were defined for intertidal and subtidal waters of the Core Zones and for the Seaward Zones of each ecoregion. *Bottom-oriented* (i.e., benthic and demersal) and *pelagic* (i.e., midwater to surface waters) fish assemblages were treated distinctly. Each species was only included in a single assemblage. Therefore, when a species' vertical distribution included pelagic and benthic waters (e.g., Pacific Spiny Dogfish, Pacific Hake), it was assigned to the portion of the water column where it was more commonly documented. Comparisons between Core and Seaward assemblages and selected species were made among ecoregions to assess the combined effects of depth and latitude.

Fish species (ichthyofauna) and assemblages were selected for each ecoregion based on a systematic, qualitative process. Established fishes that occur within the nearshore zones of each ecoregion were selected from among all known marine and estuarine fishes that have been documented off the U.S. West Coast (Love et al. 2021) and in the Salish Sea (Pietsch and Orr 2019) using the following procedure:

Initially, all fishes with at least one documented record within this study's geographic range (Mexico to Canada) and depth range (0–100 m) were identified. Fishes that were recorded only once or twice in an ecoregion, typically during anomalous oceanic conditions or possibly by misidentification, were then excluded from the list. Oceanic, mesopelagic, purely freshwater or estuarine, and deepwater species with more sparse records also were excluded.

This report uses the term *established fishes* to refer to the remaining species on the list. The established fish fauna, therefore, can be considered those species that occupy nearshore environments of at least one ecoregion either seasonally or year-round. Thus, the next step in defining the nearshore zones' established fishes was to use relevant primary literature to clarify ambiguities in regional and depth occurrence. Depth, geographic range data, and habitat associations were combined across life history stages to provide generalized information for each species. For example, a species that occupies eelgrass meadows as a juvenile before recruiting to mudflats as an adult was considered to have a primary association with both habitat types. Relative abundance (abundant, common, or rare) and habitat associations were initially estimated based on field guides and then refined with primary literature and catch or survey data. Species that lacked adequate distribution and abundance information for evaluation were considered rare, though this could represent bias in sampling or reporting methods (i.e., taxonomic generalization in survey records) as much as a true rarity of occurrence.

Finally, bottom-fish species were assigned to a habitat category based on documented primary use of soft, hard, and biotic habitat types (as described above); therefore, habitat categories for assemblages included *soft bottom*, *soft bottom biotic*, *hard bottom*, *hard bottom biotic*, *hard and soft bottom*, *pelagic*, and *habitat generalists* (primary use of at least one soft, hard, and biotic habitat). The designation of substrate types into soft and hard categories was based on a review of seafloor habitat classification in the study region and the biological relevance of these categories to benthic and demersal fishes. Because habitat types were chosen to reflect the considerations and distinctions of the relevant scientific literature, they do not subscribe to the CMECS categories used to classify substrate types for this project's GIS component.

Lingcod, a benthic species in all four ecoregions that is a habitat generalist. 10/05/2018. (ODFW)

Seafloor hardness has been inconsistently defined between geologists (Greene et al. 2007b; Goldfinger et al. 2014), spatial modelers (Young et al. 2010; Wedding and Yoklavich 2015), and biologists (Love et al. 2009; Henderson et al. 2020). Geologists typically include gravel, pebble, and cobble with soft substrates because these grain sizes are often indistinguishable from sands and muds on seafloor imagery that lacks hardness information (e.g., side-scan sonar backscatter) or is of low resolution. In contrast, biologists often record grain sizes ranging from gravel to cobble as hard substrates based on direct visual observations because many species interact differently with them than with mud and sand (i.e., do not burrow or tunnel). Shifts in fish habitat preference resulting from growth-based length or life history stages from mud or sand to gravel or pebble habitats have been commonly documented among soft-bottom-associated fishes (e.g., Starry Flounder documented by Orcutt 1950; Love 2011. Big Skate by Bizzarro et al. 2014. Pacific Sand Lance by Bizzarro et al. 2016). Furthermore, grains the size of pebbles and larger support different biological communities, including attached sessile macroinvertebrates, than smaller grain sizes (Wilson et al. 1987).

In this study, gravel and pebble categories were grouped and considered as soft bottom habitats because (1) they are often indistinguishable from imagery or direct observations; (2) the grain sizes of gravel and pebble overlap among commonly used scales (Wentworth 1922; Krumbein 1934; International Organization for Standardization 2002); and (3) they are commonly used by larger (or older) individuals of species that also use sand and mud habitats when at smaller (or younger) sizes. Shell hash has been commonly defined as soft substrate in both mapping (Greene et al. 2007b) and seafloor video observations (Yoklavich et al. 2002; Pacunski et al. 2020), but it is sometimes placed into a "transitional" category termed *mixed*, with pebble and small cobble (Lowry et al. 2022). Soft bottom habitats, therefore, included mud, sand, gravel (pebble), and shell hash, whereas hard bottom habitats comprised cobble, boulder, and bedrock of various reliefs. Fishes characterized as inhabiting mixed substrate types were assigned to the primary substrate types among soft and hard categories.

The fourth step in the process of defining fishes for each ecoregion's nearshore zones focused on biotic habitats. Biotic habitats included structure-forming marine invertebrates (e.g. corals, sponges, bivalve beds), kelp, other types of macroalgae, and seagrasses. Biotic habitats were not considered in isolation since they typically are attached to a soft or hard substrate type. The absence of information for a habitat type does not preclude a species from potentially using that habitat but instead reflects the information available in the reviewed literature. The fish assemblages described in this report were based on these habitat categories in both the Core and Seaward Zones. Each assemblage includes the fish species categorized in this report as either abundant or common in the corresponding habitat category.

The Ecology of Marine Fishes: California and Adjacent Waters (Allen et al. 2006) provided important information for this report and includes complementary characterizations of fish assemblages among three ecoregions (Southern California Bight, Central California, and the southern portion of the Pacific Northwest). A quantitative assessment of marine habitats and associated fishes throughout California was conducted by Allen and Pondella (2006), using relative abundance information from ichthyofaunal studies and cluster analysis. Whereas the habitat categories used for this report's assemblages were based on nearshore depth zone distinctions and fish occurrence among general seafloor habitats (soft, hard, biotic), Allen and Pondella (2006) defined a broader suite of habitat types (15) and associated fish assemblages (42). Nine additional chapters present qualitative descriptions of marine habitats, divided among soft, hard, and pelagic categories, and characterize associated fish assemblages. Although a direct comparison to this literature is beyond the scope of this report, interested readers seeking more detailed information on the California-based ecoregions should consult the relevant chapters of Allen et al. (2006).

Choosing Focal Invertebrate Species

Marine invertebrates were selected for inclusion in our assessment on a species-specific basis for each ecoregion. Selection criteria included ecosystem importance, management (or fishery) importance, and population depletion based on threatened or endangered status under the U.S. Endangered Species Act (ESA) or by authority of state laws. Therefore, an invertebrate may range across several ecoregions but only be considered a focal species in a subset of them. Invertebrate species were selected independently for each ecoregion to capture specific biogeographic considerations. In total, 28 invertebrate species, consisting of seven crustaceans, seven echinoderms, and 14 molluscs were chosen for inclusion (Table 2). The number of selected invertebrates was similar among ecoregions, ranging from 13 to 17 species (Table 2). Individual invertebrate species descriptions are included in this report's Invertebrate Descriptions section, and focal ecoregions for each species are identified. Ecoregion-specific information about invertebrate distribution and habitat use are included in the report's marine ecoregion sections: Salish Sea, Pacific Northwest, Central California, and Southern California Bight.

Literature Mining

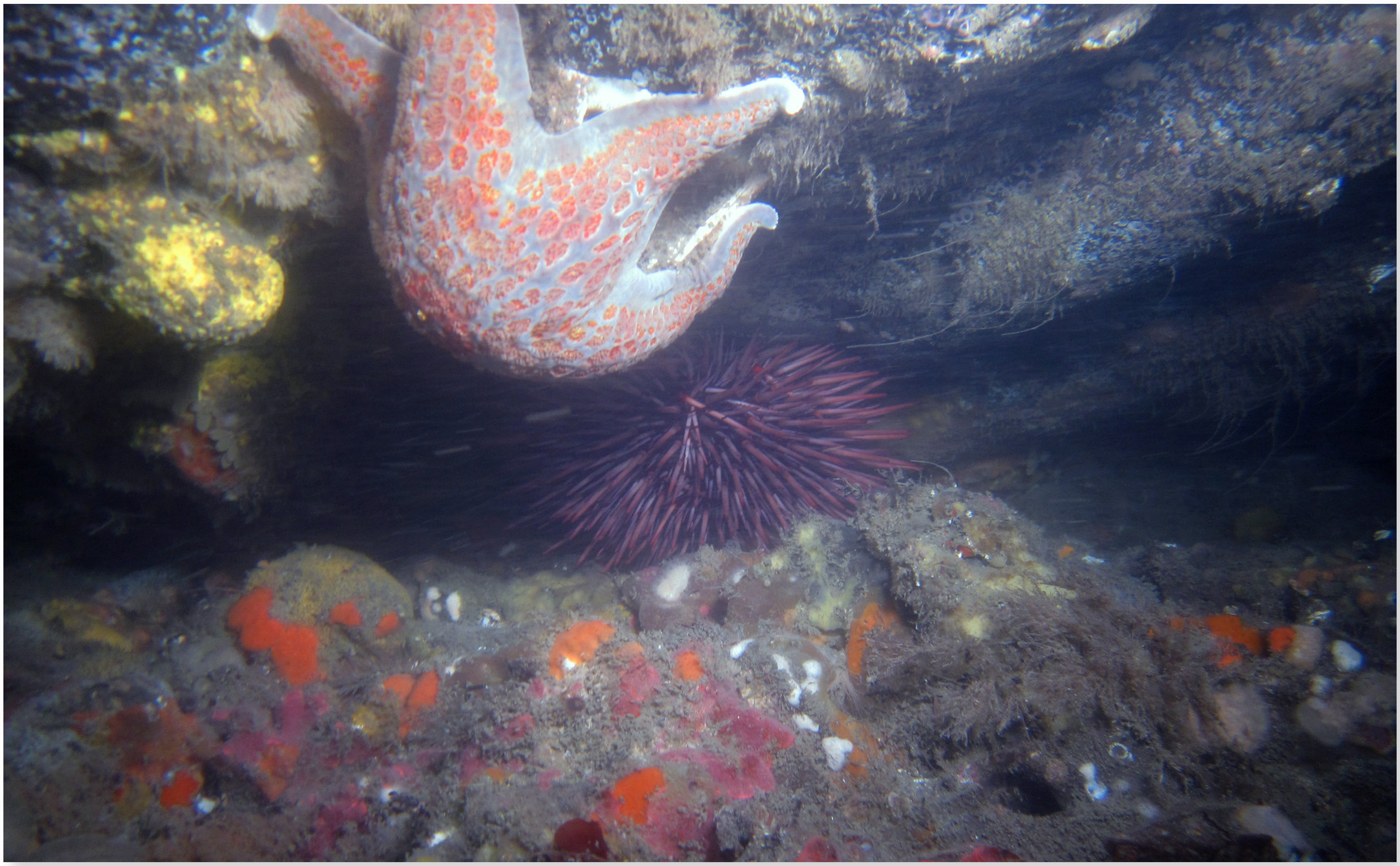
The first step in the literature mining process was to consult with members of the PMEP Nearshore Working Group, PMEP Science & Data Committee, PMEP Steering Committee, and GIS staff from the Pacific States Marine Fisheries Commission. The primary goals of this effort were to obtain (1) a list of contacts who might provide fish and invertebrate habitat information, (2) relevant literature produced by PMEP and its staff, and (3) products from Objective 1 (define and map nearshore zones) to inform literature mining efforts.

Once information from these groups was assembled, a comprehensive literature search was conducted to compile the depth- and habitat-specific information on each ecoregion's fish assemblages, selected invertebrates, and stressors in nearshore habitats. Relevant literature (e.g., peer-reviewed publications, student theses, technical reports) was identified by (1) searching bibliographic databases (e.g., Aquatic Science and Fisheries Abstracts, BIOSIS, Web of Science, Zoological Record); (2) cross-referencing citations from compiled literature;

Table 2. Invertebrate focal species by ecoregion, as selected by PMEP and the Nearshore Working Group.

Species	Higher Taxon	SS	PNW	CC	SCB
Black Abalone (*Haliotis cracherodii*)	Mollusca			X	X
California Market Squid (*Doryteuthis opalescens*)	Mollusca	X	X	X	X
Geoduck (*Panopea generosa*)	Mollusca	X			
Giant Pacific Octopus (*Enteroctopus dofleini*)	Mollusca	X	X	X	
Green Abalone (*Haliotis fulgens*)	Mollusca				X
Olympia Oyster (*Ostrea lurida*)	Mollusca	X			
Owl Limpet (*Lottia gigantea*)	Mollusca			X	X
Pink Abalone (*Haliotis corrugata*)	Mollusca				X
Pinto Abalone (*Haliotis kamtschatkana*)	Mollusca	X	X	X	
Pismo Clam (*Tivela stultorum*)	Mollusca			X	X
Razor Clam (*Siliqua patula*)	Mollusca		X		
Red Abalone (*Haliotis rufescens*)	Mollusca		X	X	X
Red Octopus (*Octopus rubescens*)	Mollusca	X	X	X	X
White Abalone (*Haliotis sorenseni*)	Mollusca				X
Dungeness Crab (*Metacarcinus magister*)	Crustacea	X	X	X	
Ghost Shrimp (*Neotrypaea californiensis*)	Crustacea	X			
Mud Shrimp (*Upogebia pugettensis*)	Crustacea	X			
Pacific Sand Crab (*Emerita analoga*)	Crustacea		X	X	X
Red Rock Crab (*Cancer productus*)	Crustacea	X	X	X	X
Spiny Lobster (*Panulirus interruptus*)	Crustacea				X
Spot Prawn (*Pandalus platyceros*)	Crustacea	X			
California Sea Cucumber (*Apostichopus californicus*)	Echinodermata	X			
Green Sea Urchin (*Strongylocentrotus droebachiensis*)	Echinodermata	X			
Ochre Sea Star (*Pisaster ochraceus*)	Echinodermata	X	X	X	X
Purple Sea Urchin (*Strongylocentrotus purpuratus*)	Echinodermata	X	X	X	X
Red Sea Urchin (*Mesocentrotus franciscanus*)	Echinodermata	X	X	X	X
Sunflower Sea Star (*Pycnopodia helianthoides*)	Echinodermata	X	X	X	
Warty Sea Cucumber (*Apostichopus parvimensis*)	Echinodermata				X

Note. Focal species were selected based on a combination of ecosystem importance, management (fishery) importance, and population status (federal- and state-listed endangered species were prioritized). SS = Salish Sea, PNW = Pacific Northwest, CC = Central California, and SCB = Southern California Bight. Focal invertebrate species for each ecoregion are indicated (X).



Leather Star & Purple Urchin, 06/22/2010. (ODFW)

(3) obtaining recommendations from experts, including academics, state and federal government scientists, and NGO employees; (4) performing an online search of technical reports (e.g., TNC ecoregional assessments, National Marine Sanctuary publications); and (5) directly requesting gray literature and technical reports, especially from state agencies, as this information is difficult to locate through online searches. Two additional sources, NOAA Fisheries' Habitat Use Database (NMFS 2013) and Love et al. (2021), which provide geographic range and depth information for all documented marine and estuarine fishes off the U.S. West Coast, were referenced for fish distribution and habitat information.

PMEP generated a list of contemporary stressors on nearshore marine habitats with input from the Nearshore Working Group and PMEP partners. Also, we communicated with state and federal resource managers from California, Oregon, and Washington and gleaned input from PMEP partners to inform an assessment of these stressors.

Literature Synthesis

Literature concerning nearshore fish assemblages, fish and invertebrate habitats, and stressors was incorporated into a bibliographic data manager. These references were labeled with keywords for queries and grouping purposes and then reviewed and synthesized for Core and Seaward Zones in each ecoregion. This structured approach formed the basis of this report's organization and helped to inform spatial databases and habitat associations.


Little anemone, 04/27/2008. (ODFW)

INVERTEBRATE DESCRIPTIONS

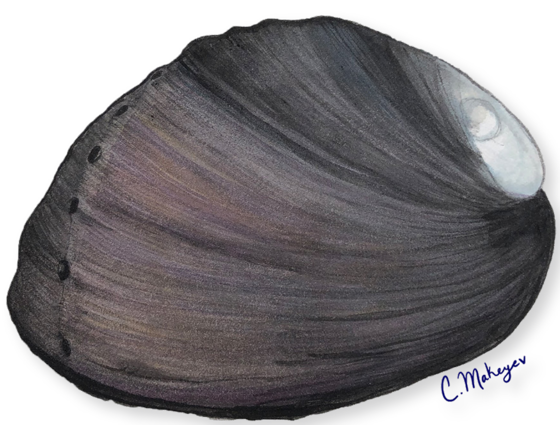
INVERTEBRATE DESCRIPTIONS

As stated in the introduction, the primary objectives of this project have been to define and map the U.S. West Coast's nearshore zones, compile and standardize related spatial data, and report on the zones' fish and invertebrate habitats. Before we delve into habitat descriptions, this section offers brief descriptions of the focal invertebrates selected. Many of the invertebrates described below were selected as focal species in multiple ecoregions. To avoid duplicating information for each species in each ecoregion, we provide general descriptions of the invertebrates, including ranges and habitat associations. Ecoregion-specific information is provided as appropriate in the following ecoregion sections.

Molluscs

Black Abalone *(Haliotis cracherodii)* – Focal Invertebrate in the Central California and Southern California Bight Ecoregions

Black Abalone inhabit rocky substrate from the upper intertidal zone to a 6 m depth but are most common in the mid to low intertidal (Ault et al. 1985). They range from Point Arena, California, to southern Baja California, with unconfirmed sightings as far north as Coos Bay, Oregon (Cox 1962). Relatively small, Black Abalone (< 90 mm shell length) primarily live under boulders and in crevices and actively search for food, whereas larger individuals (> 90 mm shell length) are more sedentary on and under large rocks and in crevices (Ault et al. 1985). Historically, adult Black Abalone (maximum shell length = 215 mm; Ault et al. 1985) played important roles in determining community structure, maintained favorable habitat for conspecific recruitment, and preferred habitat dominated by bare rock and coralline algae instead of softer algae and macroinvertebrates (Raimondi et al. 2015). Southern California Black Abalone populations appear to be genetically isolated (i.e., Allee effect; Stierhoff et al. 2012), suggesting that larval dispersal is limited, and natural recovery of collapsed populations is unlikely (Gruenthal and Burton 2008). Black Abalone populations have severely declined in the past several decades and have been listed as endangered under the federal ESA since 2009 (NOAA, 2009; 74 FR 1937).



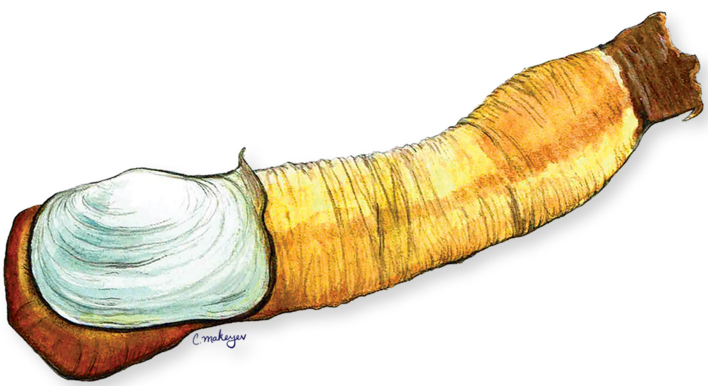
Black Abalone (*Haliotis cracherodii*). (C. Makeyev)

California Market Squid *(Doryteuthis opalescens)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, Central California, and Southern California Bight Ecoregions

The California Market Squid is common in coastal waters but also highly migratory, traveling up to 322 km offshore (Hochberg and Shulman 2007; Zeidberg 2013). California Market Squid often undergo diel movements, moving offshore to depths of up to 500 m during the day and shoaling in nearshore surface waters to hunt at night (Zeidberg 2013). It is primarily a pelagic species but can be found throughout the water column at continental shelf depths. Like many other loliginid squids, the California Market Squid deposits egg cases on the seafloor. Off California, deposition sites typically occur on sand bottoms at depths of 20–70 m that correspond to temperatures of 10–12 °C (Zeidberg et al. 2011), and congregating squids attract a broad range of predators, including Pacific Spiny Dogfish, skates, and pinnipeds. When it is locally abundant, the California Market Squid supports commercial and recreational fisheries.

Owl Limpet *(Lottia gigantea)* – Focal Invertebrate in the Central California and Southern California Bight Ecoregions

The Owl Limpet is one of the largest limpets in North America, reaching a shell length greater than 100 mm (Kido and Murray 2003). It inhabits wave-exposed mid and upper rocky intertidal coastlines from Northern California (39.4° N) to southern Baja California (26.1° N), where it grazes on algae and territorially defends home ranges from conspecifics and other shelled molluscs (Fenberg 2013). These grazing activities can alter the structure of associated intertidal communities (Kido and Murray 2003). Although pelagic larvae typically metamorphose after five days following a single winter spawning event, they can be transported up to 350 km by the northward-flowing Davidson Current (Fenberg et al. 2010). The historical Owl Limpet population extended farther north (41.74° N) but has contracted over approximately the last 50 years, probably because of limited recruitment in Northern California (Fenberg and Rivadeneira 2011). Owl Limpets are important prey for the American Black Oystercatcher, *Haematopus brachmani*. The ecological role of Owl Limpets is strongly influenced by body size, as large limpets can effectively control and engineer much larger territories (~1,000 cm^2; Sagarin et al. 2007).



Geoduck (*Panopea generosa*). (C. Makeyev)

Geoduck *(Panopea generosa)* – Focal Invertebrate in the Salish Sea Ecoregion

The Geoduck is the largest infaunal clam in the world (> 3 kg, Goodwin and Pease 1987) and among the longest-living animals (to 168 years, Bureau et al. 2002). It is mainly found in intertidal and subtidal waters from southern Alaska to northern Mexico, though it has been reported to a depth of 110 m (Goodwin and Pease 1989). In Puget Sound, Geoducks are most abundant between 19–24 m (Goodwin and Pease 1991). Metamorphosed larvae begin to burrow soon after settlement and can reach depths of 60 cm within two years. They are reproductively active by the age of three (Valdopalas et al. 2015), at which point they remain stationary for the rest of their lives, often more than 1 m below the seafloor (Goodwin and Pease 1989). In deep infaunal sediments, adult Geoducks have an effective refuge from predation. Geoducks occupy substrates ranging from mud to gravel but most commonly occur on sand or a mixture of sand and mud (Goodwin and Pease 1991). Geoducks support a lucrative commercial fishery in the Salish Sea Ecoregion and are recreationally harvested throughout their range.

Giant Pacific Octopus *(Enteroctopus dofleini)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, and Central California Ecoregions

The Giant Pacific Octopus is the world's largest octopus, and it is found throughout temperate and boreal waters of the North Pacific, from intertidal depths to at least 1,500 m. Fifty-kilogram specimens have been commonly reported, and it reaches a maximum size of at least 180 kg (High 1976; Jereb et al. 2016). The Giant Pacific Octopus inhabits rocky substrates with boulders and interstitial spaces where it refuges in dens up to 94% of the time (Scheel and Bisson 2012). Adults especially prefer boulder habitats associated with dense kelp cover (Scheel 2002). The Giant Pacific Octopus leaves its den to hunt, most often during nighttime hours (Hartwick et al. 1988). Dens serve as habitat for fishes, sea stars, and crabs, with some of these organisms competing for den space and gaining food subsides through scavenging (Hartwick and Thorarinsson 1978).

Green Abalone *(Haliotis fulgens)* – Focal Invertebrate in the Southern California Bight Ecoregion

The Green Abalone ranges from Point Conception, California, to Bahia Magdelena, Mexico, including offshore islands (Pilsbury 1890; Cox 1962). It is associated with warmer ocean temperatures than the other selected abalone species. The growth and survival of Green Abalone larvae are optimal at 20-23 °C, but settled juveniles are tolerant of a broader temperature range (12–30 °C; Leighton 1974). Larger juvenile and adult Green Abalone are commonly associated with temperatures of 22.8–25.5 °C, grow fastest from 24.6–26.0 °C, and reach their thermal maxima at 33.6 °C (Leighton 1974; Díaz et al. 2006). The Green Abalone is strongly associated with low wave exposure and subtidal depths less than 5 m

(Calderon et al. 2019) but can be found to at least 15 m deep, with the lower depth limit set by a combination of wave energy and food resources (i.e., red algae; Tutschulte 1976; Ault et al. 1985). Juveniles of all developmental stages and adults routinely co-occur in the same depths and habitats.

Green Abalone are most abundant in waters with strong currents, crevices for refuge, and coralline algae (Tutschulte 1976). Small juveniles (3–13 mm) are found under small rocks, pebbles, and flat stones covered with coralline algae, whereas larger juveniles (15–90 mm) are found under larger rocks with overlapping edges (Calderon et al. 2019). Older juveniles and adults are more mobile than early juveniles in search of food and shelter (Ault et al. 1985). Although they once supported substantial recreational and commercial fisheries, the Green Abalone abundance is estimated to be approximately 1% of pre-fishery density (Rogers-Bennett et al. 2002). Remaining populations mostly consist of solitary individuals, which may not be able to breed because of reproductive isolation (i.e., Allee effect; Taniguchi et al. 2013). Adult survival appears to have a greater impact on population size than decreased recruitment (Aalto et al. 2020). Unlike most similar species, Green Abalone are highly resistant to the synergistic effects of thermal stress and Withering Syndrome (Vilchis et al. 2005; Moore et al. 2009).

Olympia Oyster *(Ostrea lurida)* – Focal Invertebrate in the Salish Sea Ecoregion

The Olympia Oyster is the only native oyster species in the eastern North Pacific. It was once abundant in estuaries from southeast Alaska to Baja California, Mexico (McGraw 2009); however, it declined dramatically throughout its range during the last century and is now largely restricted to isolated populations in low intertidal zones (Harvey et al. 2010). Overharvesting, coastal development, pollution, sedimentation, competition with introduced oysters, and predation by non-native species all have contributed to observed declines (McGraw 2009). The Olympia Oyster is relatively small, with adults ranging from 2–6 cm but commonly reaching greater than 5 cm in the Salish Sea (Baker 1995). It recruits to any hard substrate, including small rocks in muddy regions, but exhibits the greatest survivorship when attached to its own shells (Baker 1995; White et al. 2009). Adult populations have been reported up to 71 m in depth but are rarely found below the upper subtidal. This species often occurs in clumps, bordered by landward mudflats and seaward eelgrass beds (Couch and Hassler 1989). The recovery of the Olympia Oyster has been hampered by the removal of dense subtidal native oyster shell accumulations during exploitation, by direct competition from exotic species, and by the addition of introduced oyster shell settlement substrate in the intertidal zone (Trimble et al. 2009).

Pink Abalone *(Haliotis corrugata)* – Focal Invertebrate in the Southern California Bight Ecoregion

Pink Abalone adults typically are associated with Giant Kelp and understory kelps on bedrock containing boulders (Coates et al. 2013). Pink Abalone prefer sheltered waters where they feed mainly on kelp and drift algae, with juveniles primarily active at night and adults showing no diel activity trend (Tutschulte and Connell 1988). Pink Abalone are found in deeper waters than Green Abalone, ranging from 6–36 m, and have more limited movements (Gotshall 2005; Coates et al. 2013). Pink Abalone temperature and habitat preferences are like those of Green Abalone. Optimal growth and survival of larvae occur at 18–21 °C, but juveniles are tolerant of a broader temperature range (12–30 °C; Leighton 1974). Large juvenile and adult Pink Abalone prefer temperatures of 25.0 °C and reach their thermal maxima at 32.0 °C (Leighton 1974; Díaz et al. 2006; Medina Romo et al. 2010). Small juveniles (3–13 mm) are found under small rocks, pebbles, and flat stones covered with coralline algae, whereas larger juveniles (15–90 mm shell length) are found under larger rocks with overlapping edges (Carreón-Palau et al. 2003). Withering Syndrome–induced mortality occurs at higher temperatures for Pink Abalone (18.8 °C) than for Red Abalone or Pinto Abalone (Crosson and Friedman 2018).

Pinto Abalone *(Haliotis kamtschatkana)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, Central California, and Southern California Bight Ecoregions

The Pinto Abalone is the northernmost haliotid species and the predominant abalone species in the Salish Sea

(Woodby et al. 2000a). It inhabits subtidal depths shallower than 40 m and is most abundant from the intertidal to 10 m (Rothaus et al. 2008). Early juveniles associate with macroalgae, boulders, and sea urchin barrens where crustose coralline algae are abundant (Sloan and Breen 1988). These complex habitats apparently afford some measure of protection from predators, such as sea stars and crabs (Griffiths and Gosselin 2008). Larger juveniles and adults commonly associate with rocky seafloors, especially those with attached coralline algae, kelp, or other benthic macroalgae (Tomasick and Holmes 2003; Rogers-Bennett et al. 2011). Once widely distributed in the eastern North Pacific, the Pinto Abalone population was badly overexploited and has not recovered. The species was evaluated for listing under the ESA in 2014, but listing was determined to be unwarranted (79 FR 77998). State-level restrictions on harvest have been in place since the 1990s, and the species has been listed as endangered in Washington since 2019 (Carson and Ulrich 2019). The species is also listed as endangered under the Canadian Species at Risk Act in British Columbia (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2009). The Pinto Abalone requires a minimum density of individuals to congregate for successful spawning (Carson et al. 2019).

Pismo Clam *(Tivela stultorum)* – Focal Invertebrate in the Central California Ecoregion

The Pismo Clam is a large, extremely long-lived bivalve, reaching a maximum shell length of 187 mm and a maximum age of 53 years (Pattison and Lampson 2008). It was historically reported from Half Moon Bay, California, to Socorro Island, Mexico (18.77° N) but is no longer found north of Monterey Bay (Fitch 1950; Pattison and Lampson 2008). The occurrence of Pismo Clams is largely restricted to low intertidal and shallow subtidal regions of fine-grained sand beaches that remain terraced (i.e., flat) throughout the year (Thaker 2011). Densities are greatest in regions that have extensive upwelling of nutrient-rich waters that support phytoplankton blooms (Shaw and Hassler 1989). Pismo Clams are not good burrowers, nor are they highly mobile (Shaw and Hassler 1989). They are periodically dislodged from the sand and swept seaward before they can reorient and dig into the sediment. This process results in size and age zonation, with smaller and generally younger clams located higher in the intertidal zone and larger/older clams commonly encountered to depths of 10 m and extending to a maximum depth of 25 m (Pattison and Lampson 2008; Thaker 2011).

Razor Clam *(Siliqua patula)* – Focal Invertebrate in the Pacific Northwest Ecoregion

The Razor Clam occupies intertidal and subtidal habitats (to ~55 m depth) from the eastern Aleutian Islands, Alaska, to Central California, but it is most abundant in intertidal regions of exposed, sandy beaches along the outer Washington and northern Oregon coasts (Lassuy and Simons 1989; Bowen et al. 2020). Razor Clams burrow into sand substrates flushed with seawater, which buffers them from a variety of environmental stressors in the intertidal, such as temperature fluctuations, exposure, and wave energy (Miller and Dowd 2019). The Razor Clam is considered a bioindicator species of nearshore health and is susceptible to high levels of domoic acids associated with harmful algal blooms (HABs), which are expected to increase along the West Coast in association with ocean warming (Bowen et al. 2020; Ekstrom et al. 2020). Razor Clams also undergo periodic die-offs likely caused by bacterial gills disease (Travis et al. 2021). Therefore, recent research efforts have focused on developing assays to rapidly assess Razor Clam health and improving management decisions regarding fishing closures (Wekell et al. 2002; Bowen et al. 2020; Ekstrom et al. 2020).

Red Abalone *(Haliotis rufescens)* – Focal Invertebrate in the Pacific Northwest, Central California, and Southern California Bight Ecoregions

The Red Abalone is the largest abalone in the world, reaching a maximum shell length of 311 mm (Geibel et al. 2010). It ranges from Sunset Bay, Oregon, to Bahia San Bartolome, Baja California, from the lower intertidal to at least 180 m depth (Tegner 1989). This is a cool water abalone species mainly found in California between Shelter Cove and Point Conception in association with areas of high upwelling (Ault et al. 1985; Geibel et al. 2010). Red Abalone occupy deeper depths toward tropical areas (i.e., tropical submergence); populations in Northern California are mainly distributed from the low intertidal to 6 m, whereas those in Southern California are found subtidally to 40 m (Ault et al. 1985). Postlarvae, juvenile, and adult Red Abalone occupy rock substrates with adequate algal cover for grazing (Ault et al. 1985). Small Red Abalone (< 20 mm shell length) shelter under coralline algae-encrusted cobbles or boulders, whereas larger individuals (20-80 mm) mainly occupy crevices (Ault et al. 1985; Rogers-Bennett et al. 2016a). Individuals of either size may also shelter under sea urchin spines (e.g., Red Sea Urchin; Rogers-Bennett et al. 2011). Large (> 80 mm shell length) individuals are commonly found among exposed rock habitats with dense algal growth. Most Red Abalone adults commonly move among nearshore habitats (Ault and DeMartini 1987). Movements are related to foraging, especially in kelp stands, whereas some individuals remain sedentary and exist on drift algae subsidies (Ault et al. 1985; Ault and DeMartini 1987). Among abalones, Red Abalone are moderately susceptible to Withering Syndrome (Crosson et al. 2014). The severity of infection is more common at higher temperatures and is directly correlated with decreased feeding, growth, and reproductive rates (Vilchis 2005; Crosson et al. 2014). For these reasons, populations in Southern California have been impacted by this disease more than those of Northern California.

Red Octopus *(Octopus rubescens)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, Central California, and Southern California Bight Ecoregions

In contrast to the Giant Pacific Octopus, the Red Octopus is a small species, reaching a maximum weight of only 0.4 kg (Anderson et al. 1999). It is the most common octopus in the eastern North Pacific (Hochberg 1998). The Red Octopus is abundant in intertidal waters from Northern California to Alaska but can range to depths of 300 m (Hochberg and Shulman 2007). It uses a variety of small, hard items (e.g., large barnacle tests, gastropod shells) for dens, including bottles and cans, as commonly reported for the Puget Sound population (Anderson et al. 1999). This species has been observed on a variety of habitat types, including rocky reefs, sand and mud seafloors, and kelp beds, as well as under stones in the low intertidal (Ricketts and Calvin 1985; Hochberg and Shulman 2007).

White Abalone *(Haliotis sorenseni)* – Focal Invertebrate in the Southern California Bight Ecoregion

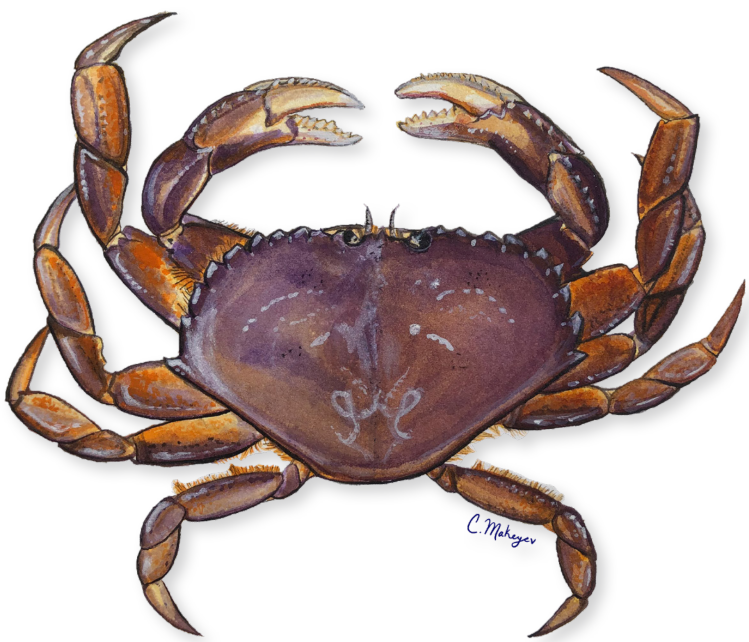
The White Abalone is the deepest dwelling abalone species off the U.S. West Coast, occupying depths of 5–66 m (Lafferty et al. 2004; Stierhoff et al. 2012). Optimal depth has been inconsistently reported (e.g., Tutschulte 1976; Butler et al. 2006; Lafferty et al. 2004) and appears to vary based on environmental conditions and ecological relationships. The White Abalone is mainly associated with rocky reef habitats and boulder habitats, often in the vicinity of sand (Cochrane et al. 2005; Lafferty et al. 2004). They often adhere to drift kelp, which could result in long-distance movements (> 100 km) far beyond the typical range of larval transport (McCormick et al. 2008). Based on laboratory experiments, juvenile survival is greatest at 12 °C and lowest at 18 °C, with 100% mortality below 9 °C or above 21 °C (McCormick et al. 2016). The historical distribution of White Abalone extended from Morro Bay, California, to Punta Rompiente, Baja California Sur, Mexico (27.72° N, -115.00° W), but the species has suffered severe declines and local extirpations throughout its range (Butler et al. 2006; Kawana et al. 2019).

The White Abalone was the first marine invertebrate listed under the ESA and was conferred endangered status in 2001 (66 FR 29046). Low population numbers and its more sedentary behavior relative to Green Abalone and Pink Abalone result in severe Allee effects that inhibit reproductive success (Rogers-Bennett et al. 2016b; Stierhoff et al. 2012). Additionally, White Abalone has the highest susceptibility and lowest resistance to Withering Syndrome of all tested abalone species (Crossan and Friedman 2018).

Crustaceans

Dungeness Crab *(Metacarcinus magister)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, and Central California Ecoregions

The Dungeness Crab ranges from the Aleutian Islands, Alaska, to Point Conception, California, and supports major fisheries over most of its distribution (Blaine et al. 2020). This species is common from the intertidal zone to depths of 90 m and reaches a maximum depth of 230 m (Hankin and Warner 2001). Dungeness Crab have a complex multiphase life history, occupying three distinct marine habitats. After hatching in the winter, larvae spend up to five months in the water column subjected to vast ranges of conditions as they are transported along circulation pathways. Young-of-the-year (YOY) Dungeness Crabs recruit to intertidal and shallow subtidal regions of Puget Sound and other Pacific Northwest estuaries during May–September and are most abundant on complex habitats, such as shell hash, mixed sand, gravel and cobble, eelgrass, and substrates with attached macroalgae (Dinnel et al. 1987; Dumbauld et al. 1993; Fernandez et al. 1993; McMillan et al. 1995).



Dungeness Crab (*Metacarcinus magister*). (C. Makeyev)

These complex habitats, however, limit nocturnal foraging onto tidal flats, and young crabs move to shallow sand or mud channels after the first year of growth (Dinnel et al. 1987; Holsman et al. 2006). Adults move to a deeper, broader depth range. They are most abundant on soft substrates but can be found on almost any bottom type (Dinnel et al. 1988). Most individuals emigrate from estuary nurseries after one to two years as subadults or newly mature adults (Stevens and Armstrong 1984; McMillan et al. 1995); however, there are resident populations in some areas of Puget Sound (Dethier 2006) in combination with recruitment from oceanic sources (Dinnel et al. 1993). Dungeness Crab reach sexual maturity between two to three years, and males reach a harvestable size for fisheries four to five years after initial settlement. Although invasive European Green Crabs (*Carcinus maenas*) outcompete Dungeness Crabs of similar size (McDonald et al. 2001), the much larger Dungeness Crab has appeared to limit Green Crab distributions in the past to shallow portions of estuaries and beaches throughout British Columbia (Gillespie et al. 2015).

Ghost Shrimp *(Neotrypaea californiensis)* – Focal Invertebrate in the Salish Sea Ecoregion

The Ghost Shrimp constructs and maintains a poorly defined, highly branching burrow up to 80 cm below the seafloor, where it spends the majority of its life feeding on detritus in the sediment or in circulating water (Morris et al. 1980; Bertics et al. 2012). Ghost Shrimp may occur in dense aggregations, or shrimp beds, in mud or sand flats of upper and mid-intertidal regions (Kuris et al. 2007). Ghost Shrimp beds exhibit relatively low diversity and productivity compared to other seafloor habitats, such as seagrasses and Mud Shrimp beds (Ferraro and Cole 2007, 2012). Ghost Shrimp are, however, consistently more abundant than Mud Shrimp in similar habitats of Willapa Bay (Dumbauld et al. 1996). Juvenile Ghost Shrimp recruit to the same soft bottom intertidal habitats used by adults (Feldman et al. 1997; Dumbauld and Bosley 2018). This species is outcompeted for space by seagrass and can only achieve long-term coexistence through disturbance (Berkenbusch et al. 2007; Castorani and Baskett 2020). Ghost Shrimp are ecosystem engineers; their burrowing activities can influence benthic community structure by oxygenating, suspending, and destabilizing sediments and by altering habitat suitability (Dumbauld and Echeverria 2003; Bosley et al. 2017). Ghost Shrimp burrowing activity is particularly harmful to bivalves, which may be suffocated or buried by suspended or destabilized sediment (Borin et al. 2017). This species is an important food source for a diverse group of predators that forage on mudflats during high tides, including Gray Whales (*Eschrichtius robustus*; Dunham and Duffus 2001), Green Sturgeon (*Acipenser medirostris*; Borin et al. 2017), and Staghorn Sculpin (*Leptocottus armatus*; Posey 1986). While Ghost Shrimp occur in all ecoregions, they are restricted to estuaries in the outer coast ecoregions (i.e., not in the nearshore), so they are only a focal species for the Salish Sea Ecoregion.

Mud Shrimp *(Upogebia pugettensis)* – Focal Invertebrate in the Salish Sea Ecoregion

The Mud Shrimp builds permanent U-shaped burrows with firm walls cemented by mucous secretions up to a meter below the seafloor in the low to mid-intertidal of protected and low-energy shorelines (Kuris et al. 2007; Dumbauld et al. 2011). Mud Shrimp burrows are created in mud or muddy sand and may have enlarged sections, side chambers, and two or three openings. Juveniles recruit almost exclusively to adult habitats (Dumbauld and Bosley 2018). Mud Shrimp are suspension feeders that draw water into their tunnels and graze on phytoplankton and detritus (Hornig et al. 1989; Griffen et al. 2004). Like Ghost Shrimp, their burrowing and filtering behaviors make them ecosystem engineers especially influential in structuring community composition in benthic intertidal mudflats of the Pacific Northwest (Repetto and Griffin 2011; Asson et al. 2017). Mud Shrimp beds exhibit relatively high diversity and productivity compared to other seafloor habitats, such as soft sediment seafloors and Ghost Shrimp beds (Ferarro and Cole 2007, 2012). Mud Shrimp, which once blanketed intertidal estuarine habitats at densities of up to 300 individuals per square meter (Repetto and Griffin 2011), have declined drastically since 1998 in association with intense infestations of the introduced Asian isopod parasite, *Orthione griffenis* (Asson et al. 2017). Notable declines have occurred between California and British Columbia, with population collapses in Willapa Bay, Washington, and extirpation in several California embayments (Dumbauld et al. 2011). While Mud Shrimp occur in all ecoregions, they are restricted to estuaries in the outer coast ecoregions (i.e., not in the nearshore), so they are only a focal species for the Salish Sea Ecoregion.

Pacific Sand Crab (or Pacific Mole Crab; *Emerita analoga*) – Focal Invertebrate in the Pacific Northwest, Central California, and Southern California Bight Ecoregions

The Pacific Sand Crab (or Pacific Mole Crab) commonly inhabits exposed, sandy beaches along a disjointed range that includes the Pacific coasts of North and South America. In the northern hemisphere, it occurs in intertidal and occasionally shallow subtidal waters from Kodiak Island, Alaska, to Bahia San Francisquito, Baja California (Bretz et al. 2002). The Pacific Sand Crab inhabits substrates ranging from very fine to very coarse sand. It typically aggregates in dense patches associated with high-productivity regions where it uses its secondary antennae to filter feed while otherwise buried in the swash zone (Fusaro 1980). Larvae recruit to adult habitats with settlement locations influenced by coastal geomorphology and current movements, especially those associated with upwelling (Diehl et al. 2007). This species can burrow rapidly among sediment types, although burrowing in coarse sand is the slowest and most energetically costly (Dugan 2000; Kolluru et al. 2011). The relatively broad substrate associations and effective swimming ability of the Pacific Sand Crab may result in competitive advantages over similar species, resulting in greater relative abundance (Dugan 2000). Because of its widespread occurrence and importance to marine and terrestrial food webs, the Pacific Sand Crab is a popular indicator species used to detect domoic acid, HABs, heavy metals, DDT, and microplastics (Horn et al. 2019).

Red Rock Crab *(Cancer productus)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, Central California, and Southern California Bight Ecoregions

The Red Rock Crab is an important predator that influences marine community structure on medium- and low-energy shorelines from Kodiak Island, Alaska, to Baja California, Mexico (Behrens Yamada and Growth 2016). YOY and early juvenile crabs inhabit intertidal regions with rocky habitats consisting of cobble, fractured bedrock, or rock rubble, often with algal cover (Carroll and Winn 1989; Behrens Yamada and Growth 2016). They often shelter during low tides in these complex habitats or while buried in sand and mud (Kuris et al. 2007). Subadults and adults move to deeper, subtidal waters where they occupy mostly rocky habitats to depths of 91 m (Schmidt 1921; DeFur and McMahon 1984; Gillespie et al. 2015). Like Dungeness Crabs, adults move into the intertidal to forage at high tide (Behrens Yamada and Growth 2016). Both juveniles and adults are abundant in seagrass habitats (Hovel 2003). The Red Rock Crab is an aggressive species that may reduce the abundance of the invasive European Green Crab where it co-occurs (Hunt and Behrens Yamada 2003).

Spiny Lobster *(Panulirus interruptus)* – Focal Invertebrate in the Southern California Bight Ecoregion

The Spiny Lobster is distributed from San Luis Obispo County (~35.0° N) to Isla Santa Margarita, Bahía Magdalena, Mexico (~24.5° N) and reaches its greatest abundance along the central Baja California Peninsula (Vega et al. 1996, Castañeda-Fernández de Lara et al. 2005). It is ecologically important as one of the dominant predators of urchins (Dunn et al. 2017; Samhouri et al. 2019). Spiny Lobster occur in association with rock habitat from the low intertidal to a depth of 100 m (Lindberg 1955) but are also associated with seagrass and surfgrass (Neilson 2011). After a protracted (seven to eight months) oceanic larval phase, postlarvae recruit to shallow, vegetated rock seafloors. Off the coast of Mexico, early juveniles are mainly found intertidally in association with *Phyllospadix* spp. (Castañeda-Fernández de Lara et al. 2005). But primary habitat may vary spatially between macroalgae, seagrass, or rock crevices depending on location and ecological interactions (Castañeda-Fernández de Lara et al. 2005).

Spiny Lobsters generally shelter in refugia during the day and are active at night. These behaviors are more pronounced in early juveniles that are more susceptible to predation (Harrington and Hovel 2016). Spiny Lobster subadults and adults frequently inhabit the same shelter, but solitary individuals also are common (Harrington and Hovel 2016). This species seems to benefit from MPAs, with higher densities and sizes of large individuals reported within reserves (Kay et al. 2012a, 2012b). Spiny Lobsters respond to habitat characteristics at local and regional scales, and rocky habitats containing understory kelp enhance survival (Mai and Hovel 2007). Spiny Lobsters associate with rocky habitats, often including Surfgrass (*Phyllospadix torreyi*) to shelter by day, and with red algae during nighttime foraging excursions (Withy-Allen and Hovel 2013).

Spot Prawn *(Pandalus platyceros)* – Focal Invertebrate in the Salish Sea Ecoregion

The Spot Prawn is a deepwater benthic species found from the Aleutian Islands, Alaska, to San Diego, California, and rarely occurs in nearshore regions (Butler 1980). Its depth range extends from subtidal to continental slope waters (4–487 m; Jacobsen-Stout et al. 2020). In the Salish Sea, the YOY Spot Prawns occupy depths less than 50 m, and the bulk of the population is found in waters greater than 150 m (Britton-Simmons et al. 2012). Adults are most strongly associated with sand or mud seafloors containing boulders, cobbles, or pebbles, especially where drift kelp is abundant (Britton-Simmons et al. 2012; Yoklavich and Greene 2012). Spot Prawns utilize drift kelp directly as a food source and also consume associated small organisms and detritus (Marliave and Roth 1995). They are also commonly associated with dense aggregations of sponges on the outer shelf off Washington (Powell et al. 2018) and with sponge reefs in the Canadian waters of the Strait of Georgia (Dunham et al. 2018). The Spot Prawn supports recreational and commercial fisheries in the Salish Sea and Pacific Northwest Ecoregions (Wargo et al. 2013; Antonelis et al. 2018).

Spot Prawn (*Pandalus platyceros*). (C. Makeyev)

Echinoderms

California Sea Cucumber *(Apostichopus californicus)* – Focal Invertebrate in the Salish Sea Ecoregion

The California Sea Cucumber is the largest sea cucumber in the eastern North Pacific and the target of a lucrative commercial dive fishery throughout its range, from Baja California to the Gulf of Alaska (Carson et al. 2016; Ren et al. 2018). It occurs from intertidal waters to a depth of 249 m but is most common on low-energy seafloors from the shallow subtidal to approximately 70 m (McEuen 1987; Cameron and Frankboner 1989; Britton-Simmons et al. 2012). The California Sea Cucumber occurs on a variety of habitat types but is most abundant on hard seafloors consisting of bedrock, cobble, or boulder or a mixture of sand, gravel, and shell hash (Woodby et al. 2000b; Britton-Simmons et al. 2012). It is also, however, one of the most common species in Geoduck beds, which typically occur on sand or mudflats (Goodwin and Pease 1991). In U.S. waters of the Salish Sea, it is usually harvested in subtidal regions of the San Juan Archipelago, though much greater densities occur in the more turbid waters of Hood Canal (Elahi et al. 2014; Carson et al. 2016). Increasing demand from Asian markets (especially China) is driving interest in commercial aquaculture, and although operations are currently lacking, they are in development (Ren et al. 2018).

Green Sea Urchin *(Strongylocentrotus droebachiensis)* – Focal Invertebrate in the Salish Sea Ecoregion

The Green Sea Urchin is a widely distributed boreal species that influences the distribution and abundance of kelp and other macroalgae through its grazing activities (Scheibling et al. 2020). Although the Salish Sea is near the southern extent of its eastern Pacific distribution, this species is euryhaline and is relatively abundant in southern portions of Puget Sound, where it far outnumbers Red Sea Urchins (Harvey et al. 2010). Its depth range extends from the low intertidal to 300 m, but it is most abundant from shallow subtidal waters to 30 m, which roughly corresponds to the depth range of kelp and other macroalgae (Pearse and Mooi 2007; Scheibling et al. 2020). The Green Sea Urchin is largely a rock-associated species, especially in intertidal and shallow subtidal waters, where it occurs on cobbles, boulders, and rock outcrops (Himmelman 1986). In deeper waters, Green Sea Urchins are generally sparsely distributed on sand and gravel seafloors, where they rely on drift algae (Filbee-Dexter and Scheibling 2012).

Throughout its range, the Green Sea Urchin is usually associated with laminarian kelp. At high population densities, the Green Sea Urchin can destructively graze the kelp to form extensive *sea urchin barrens* that become dominated by coralline algae (Lawrence 1975). Juvenile Green Sea Urchins recruit disproportionally to barrens over kelp beds (Scheibling et al. 2020). Research conducted in the San Juan Archipelago demonstrated that early juvenile Green Sea Urchins are chemically attracted to the red coralline algae *Corallina vancouveriensis*, which appears to enhance juvenile survival by providing a spatial refuge from predatory crabs (Yiu and Feehan 2017). Also, in this region, *Sargassum muticum*, an established invasive brown seaweed, has negatively impacted the population abundance of Green Sea Urchins by reducing the abundance of native kelps on which it prefers to feed (Britton-Simmons 2004). The Green Sea Urchin is an important commercial species harvested from Kodiak Island, Alaska, to Washington, including the Salish Sea (Workman 1999).

California Sea Cucumber (*Apostichopus californicus*). (C. Makeyev)

Ochre Sea Star *(Pisaster ochraceus)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, Central California, and Southern California Bight Ecoregions

The Ochre Sea Star is an extremely important predator on wave-exposed shorelines from the Gulf of Alaska to Baja California. It can substantially influence community structure and dynamics in rocky intertidal environments of these regions (Paine 1966; Menge et al. 1994) but is less common or ecologically influential in subtidal and soft-bottom intertidal habitats (Montecino-Latorre et al. 2016). The Ochre Sea Star hunts in the rocky intertidal during high tides and either retreats to subtidal water during low tide or remains in place to digest captured prey, often in exposed habitats (Robles et al. 1995; Monaco et al. 2015). Foraging excursions into intertidal regions are more extensive during nocturnal high tides because the chance of overheating or desiccation is reduced (Garza and Robles 2010). Newly recruited Ochre Sea Stars are habitat generalists (Sewell and Watson 1993); however, early juveniles are most abundant in complex habitats (e.g., under boulders) where they are less vulnerable to predators. Large juveniles and adults mainly use hard, low-rugosity seafloors with more abundant food resources than complex habitats and rarely occur on sand or mud (Rogers and Elliot 2013).

Sea Star Wasting Disease dramatically reduced Ochre Sea Star populations throughout its range during 2014 and 2015 (Menge et al. 2016). Population numbers of Ochre Sea Stars in the northern Central California and Pacific Northwest regions approached or exceeded pre-Wasting Disease numbers by 2017 (Miner et al. 2018) due largely to strong recruitment waves in 2014-16. Ochre Sea Star biomass remained substantially reduced (< 40%) at Pacific Northwest sites but showed signs of recovery off Central California (Moritsch and Raimondi 2018). Although recruitment has increased, population size remains depressed, and size compositions have shifted to smaller juveniles. Major ecological repercussions of these declines are anticipated but have not yet been well documented (Menge et al. 2016; Murie and Bordeau 2019).

Purple Sea Urchin *(Strongylocentrotus purpuratus)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, Central California, and Southern California Bight Ecoregions

The Purple Sea Urchin commonly occurs from Southeast Alaska to northern Baja California, Mexico, at depths ranging from the intertidal to 160 m (Lambert and Austin 2007). It is most abundant on rocky, exposed shorelines, and larvae recognize turbulent high-energy shorelines as a cue to settle in these habitats (Gaylord et al. 2013). Juveniles are mostly found in higher densities with intertidal adults; however, juveniles also occupy an expanded range of microhabitats in subtidal waters (Clemente et al. 2013). These microhabitats include pits and depressions in rocks created by the grazing of this and other urchin species. Additionally, Purple Sea Urchin settling larvae experience lower mortality on conspecific barrens than nearby kelp beds (Rowley 1989).

Ecological interactions with the much larger and competitively dominant Red Sea Urchin have a profound effect on the distribution of this species. Purple Sea Urchins favor unstable habitats consisting of cobbles and small boulders. In contrast, Red Sea Urchins are the dominant species on stable rock seafloors, such as large boulders and rock outcrops (Schroeter 1977). Purple Sea Urchins prefer sheltered low intertidal and subtidal habitats but rarely utilize them because of direct interference by Red Sea Urchins. As a result, Purple Sea Urchins are more abundant in mid-intertidal regions and exposed low intertidal and subtidal habitats. Purple Sea Urchins do, however, dominate some habitats where Red Sea Urchins are absent because of greater tolerance to desiccation, heat stress, and wave energy (Schroeter 1977). The Purple Sea Urchin is not a commercially important species because of its small size, its inconsistent gonad quality, and difficulties associated with harvesting along wave-exposed rocky shorelines (Workman 1999).

Purple Sea Urchin populations exploded along much of the West Coast following the marine heat wave events of 2015-2016 and the severe declines in Sunflower Sea Stars due to Sea Star Wasting Disease. For example, some subtidal offshore reefs off Oregon experienced over a 100-fold increase in Purple Sea Urchin densities. Much of the population expansion has occurred at subtidal depths previously dominated by Red Sea Urchins. The explosion of Purple Sea Urchins has resulted in significant declines in kelp beds in northern California and southern Oregon (D. Fox, ODFW, pers. comm., July 12, 2022).

Red Sea Urchin *(Mesocentrotus franciscanus)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, Central California, and Southern California Bight Ecoregions

The Red Sea Urchin is a commercially and ecologically important species throughout its eastern North Pacific range from the Gulf of Alaska to southern Baja California, Mexico. It is the world's largest urchin, reaching a diameter of more than 19 cm (with 8 cm spines) and the longest-lived, with a maximum age of 100–200 years (Ebert and Southon 2003). The Red Sea Urchin is most common in subtidal regions but is found to a depth of 200 m (Pearse and Mooi 2007; Britton-Simmons et al. 2012). In the San Juan Islands, it is most abundant at depths of 20–30 m and is not recorded deeper than 110 m (Britton-Simmons et al. 2012). Dense aggregations of new recruits have been reported on foliose red algal turf in barrens and coralline algae in kelp beds, respectively (Rowley 1989). Regardless of settlement habitat, the great majority of YOY and early juveniles are found near or sheltering under adults (Cameron and Schroeter 1980). Adult Red Sea Urchins remain mostly stationary on bedrock substrate, feeding on drift algae that are transported by currents (Britton-Simmons et al. 2012). However, population explosions, which are common for this and other urchin species, or local reductions in drift kelp abundance can cause behavioral shifts, resulting in intensive foraging of nearshore algal beds and the creation of patchy algal landscapes (Rogers-Bennett and Okamoto 2020).

Red Sea Urchins have shown population increases in some parts of the West Coast since Sea Star Wasting Disease nearly eliminated their primary predator, Sunflower Sea Stars. The increases have not been nearly as large as in Purple Sea Urchins. Red Sea Urchins are historically harvested in the eastern North Pacific, with most of the production from California, Washington, and British Columbia (Workman 1999). In the Salish Sea, this species is abundant and intensively harvested in San Juan Channel and Haro Strait but rare or absent from Lopez Sound, Rosario Strait, and Hood Canal (Elahi et al. 2014; Carlson et al. 2016).

Sunflower Sea Star *(Pycnopodia helianthoides)* – Focal Invertebrate in the Salish Sea, Pacific Northwest, and Central California Ecoregions

The Sunflower Sea Star ranges from Unalaska (Aleutian Islands) to San Diego, California, but is uncommon south of Carmel Bay, California. The Sunflower Sea Star is an active, voracious predator that influences benthic macroinvertebrate abundance and species composition in subtidal waters (Miner et al. 2018). It is a massive sea star, reaching weights greater than 5 kg and a diameter of 90 cm (Gotshall 2005). YOY and early juveniles mainly inhabit protected sites, often including kelp (Shivji et al. 1983). Adults are habitat generalists and can be found on mud, sand, gravel, boulders, and rock seafloors at depths ranging from the intertidal to at least 120 m (Lambert 2000; Blaine et al. 2020). The Sunflower Sea Star also is a generalist predator capable of moving relatively fast compared to other sea stars (~1 m/s). It consumes echinoids, gastropods, bivalves (which it can dig out of sediment), and crustaceans it encounters as it moves across the seafloor (Mauzey et al. 1968; Brewer and Konar 2005). It forages mainly on subtidal consumers of kelp and kelp detritus (Elliot et al. 2018). The Sunflower Sea Star prefers damaged prey, which it locates using chemical cues (Brewer and Konar 2005), and also acts as a scavenger, consuming the remains of Giant Pacific Octopus kills near their dens (Hartwick and Thorarinsson 1978).

The Sunflower Sea Star is the only widespread sea urchin predator along the Northwest Pacific coast (Duggins 1983). It can exert top-down control on urchins and thereby impact the distribution and abundance of benthic algae (Dayton 1975; Duggins 1983). For instance, a massive decline in the Sunflower Sea Star population off the British Columbia coast from Sea Star Wasting Disease resulted in a corresponding 311% increase in primarily Red Sea Urchins, *Mesocentrotus franciscanus*, and a 30% decline in kelp density (Burt et al. 2018). A similar situation was described in the Salish Sea (Howe Sound, British Columbia) with Green Sea Urchins, *Strongylocentrotus droebachiensis*, and kelp cover (Shultz et al. 2016). In Oregon, there has been a 98% reduction in Sunflower Sea Stars and up to a 100-fold increase in Purple Sea Urchins at some sites, with a corresponding reduction in kelp beds at many sites (Gravem et al.; 2020; Groth, 2022). As a result of population declines resulting from Sea Star Wasting Disease, the Sunflower Sea Star was petitioned for listing under the ESA in 2021, and a status review is currently underway (86 FR 73230).

Warty Sea Cucumber *(Parastichopus parvimensis)* – Focal invertebrate in the Southern California Bight Ecoregion

The Warty Sea Cucumber (maximum resting size = 40 cm total length) ranges from Fort Bragg, California, to Puerto Bartolome, Baja Californian Sur, Mexico (26.67 N˚, -114.83˚ W) at intertidal depths to 70 m. However, it is most commonly found in the shallow subtidal (< 30 m) south of Point Conception (Kalvass 1992; Chávez et al. 2011; Gluyas-Millán et al. 2013). Depth-density relationships are spatially variable and appear to be influenced by the physical and biotic components of benthic habitats (Gluyas-Millán et al. 2013). Warty Sea Cucumbers are typically found in low-energy environments and are most abundant in areas with high organic content (as detritus) for foraging (Mercier et al. 2013). This species utilizes rock and soft sediment habitats but is most abundant on shallow reefs, where it feeds on organic detritus present as a thin veneer (Schroeter et al. 2001).

Kelp in sunbeams. (A. Obaza, Paua Marine Research Group)

SALISH SEA MARINE ECOREGION

SALISH SEA MARINE ECOREGION

The Salish Sea is the largest estuarine system on the West Coast of North America. It spans the U.S.-Canada border, includes 419 islands, and reaches a maximum depth of 720 m (Jervis Inlet, Canada); however, most of the seafloor is contained in waters from 100–200 m deep. In U.S. waters of the Salish Sea, there are a total of seven nearshore subregions: Two are distributed among the Strait of Juan de Fuca Basin and the basin encompassing the San Juan Archipelago and Georgia Strait. An additional five subregions are located in Puget Sound (Fig. 3). The hydrology of the Salish Sea is dynamic and driven by a combination of freshwater input, air temperature, and marine geomorphology. Important to regional hydrology are a complex of fjords and basins, which constrict flow and cause tidal mixing, along with sills, which restrict deepwater flow between fjords. As a result, approximately half of the water in sill regions is recycled. The process of recycling causes materials released in one fjord or basin to be exchanged throughout others before escaping the system, which can take several years (Ebbesmeyer et al. 1988). Approximately 80% of the freshwater input to the Salish Sea is provided by the Fraser River, which flows into the central Strait of Georgia (Pietsch and Orr 2019). However, there are riverine inputs throughout the Salish Sea, including 16 major river deltas in U.S. waters. Although there is relative spatial and temporal variability in salinity, approximately 90% of the water in the Salish Sea is oceanic in origin (Pietsch and Orr 2019).

Distribution and Abundance of CMECS Habitat Types Among Nearshore Zones

The total surface area of U.S. waters in the Salish Sea (also commonly known as Greater Puget Sound) is evenly distributed among nearshore zones and contained within state boundaries (Table 3). Although marine nearshore waters occur dominantly in the Core Zone, areas that overlap with PMEP's current and historic estuary extent contribute 7% to the total area of this zone (Fig. 4, Inset 1). Core Zone waters are common in association with the Strait of Juan de Fuca Basin and in the eastern San Juan Archipelago and Georgia Strait Basin subregion, in Whidbey Basin, and in South Puget Sound (Fig. 4, Inset 2). The mouths of the major river deltas in the eastern Salish Sea, including the Nooksack, Skagit, Stillaguamish, and Snohomish Rivers, include large areas of the Core Zone of the Salish Sea (Fig. 4, Inset 1).

Two-thirds of the PMEP Salish Sea region is characterized as the Seaward Zone or as Channel or Deepwater (Table 3). Seaward Zone waters are common in the central and northern part of the ecoregion, in the southern portion of the Strait of Juan de Fuca Basin (Fig. 4, Inset 3), and in the Southern Puget Sound Basin. Deeper waters occur in channels throughout the western San Juan Archipelago and Georgia Strait Basin, in the Strait of Juan de Fuca Basin, in the South Central and South Puget Sound Basins (Fig. 4, Inset 4), and in Hood Canal.

Habitat Data Source Summary

For the U.S. waters of the Salish Sea, we compiled existing seafloor substrate and sediment data from five sources (Appendix 4, region SS). Most of the region's substrate classification came from the TNC Benthic Substrate dataset, which is an existing compilation of substrate data developed for use in Washington's Marine Spatial Planning Process (Dataset 9 in Appendix 4). On the eastern boundary of the Salish Sea, two intertidal habitat inventories in North Puget Sound, Possession Sound, Port Susan, and Skagit County provided high-quality data for the intertidal areas of the Core Zone (Datasets 5 & 7 in Appendix 4). These datasets used ground-truthed data and photos' field annotations in conjunction with photointerpretation of color infrared aerial photographs to classify a suite of substrate habitats. These datasets also had the most comprehensive information on anthropogenic substrate in the region. The National Wetlands Inventory (NWI), which classified substrate using a combination of imagery interpretation and ground-truthing, was used for classification throughout the region's intertidal zones where other datasets had gaps (Dataset 21 in Appendix 4). The modeled Bloch Marine Substrate dataset contributed data where there were any additional data gaps, particularly in the San Juan Archipelago, including northwest regions of San Juan and Whidbey Islands, and around Cypress, Guemes, Sinclair, and Decatur Islands. However, this dataset is of lower quality than the other datasets for the region (Dataset 8 in Appendix 4). In the

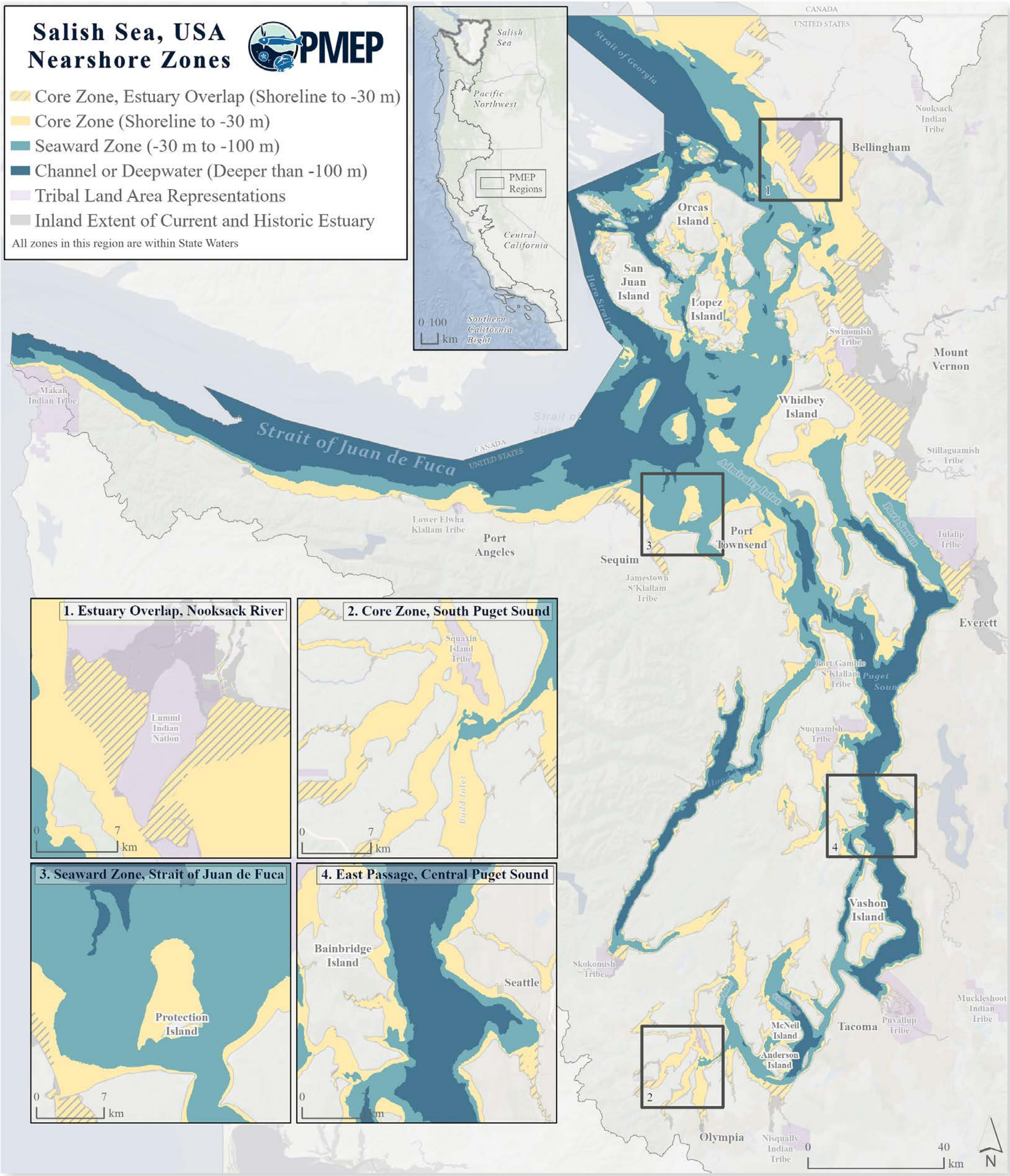


Figure 4. Distribution of nearshore zones and adjacent offshore and inshore regions in the Salish Sea Ecoregion.

Table 3. Total area and relative percentage of CMECS Aquatic Setting types in U.S. waters, defining the PMEP Scope Boundary within the nearshore zones of the Salish Sea.

Nearshore Zone	CMECS Aquatic Setting	Area (ha)	Area (%)
Core Zone	2.0 Estuarine	49,737	7.0%
	3.1 Marine Nearshore	191,789	26.9%
Subtotal		**241,527**	**33.9%**
Seaward Zone	3.2 Marine Offshore	236,773	33.2%
Subtotal		**236,773**	**33.2%**
Channel / Deepwater	3.3 Oceanic	234,696	32.9%
Subtotal		**234,696**	**32.9%**
Total		**712,996**	**100.0%**

Salish Sea, less than 1% of the Core and Seaward Zones remained unclassified due to a lack of substrate data.

We compiled biotic habitat datasets from 12 sources in the Salish Sea. The PMEP Estuary Extent data and the NWI include biotic data features throughout the Salish Sea. The data were generally concentrated in areas considered *estuary overlap* but also considered part of the Core Zone for this effort (Datasets 15 & 21).

There were five datasets with data for the extent of the region's canopy-forming macroalgae beds (kelp). A dataset from BOEM was a composite of canopy-forming kelp data from 1989 to 2014, showing the maximum observed extent of kelp beds, including data collected by the Washington Department of Natural Resources (WADNR; Dataset 23 in Appendix 4). Two additional years of WADNR floating kelp data (2015–2016) were included (Dataset 18 in Appendix 4). The BOEM and WADNR kelp datasets included canopy-forming kelp habitat extent data for the Strait of Juan de Fuca subregion of the Salish Sea. Another WADNR canopy-forming kelp dataset was included for areas focused on the San Juan Archipelago (Dataset 4 in Appendix 4), and regional kayak-based surveys of Bull Kelp were collected using GPS throughout Puget Sound by members of county Marine Resources Committees (Dataset 2 in Appendix 4). The final canopy-forming kelp dataset was collected by WADNR throughout Puget Sound in 1912 as part of an inventory of fertilizer resources (Dataset 1 in Appendix 4).

The intertidal habitat inventories used in the substrate compilation also classified biotic habitats. And a third intertidal habitat inventory included biotic features for Whatcom County, Washington (Datasets 5, 6, & 7 in Appendix 4). These habitat inventories classified 12 different biotic habitat types in the region. The PMEP West Coast Maximum Observed Extent of Eelgrass dataset was a compilation of multiple data sources for eelgrass, including data from the WADNR submerged vegetation monitoring program in the Salish Sea (Dataset 20 in Appendix 4). The data on the extent of faunal beds (habitats dominated by oysters, urchins, clam, scallop, etc.) were estimated from the Puget Sound Environmental Atlas from WADNR. This dataset was considered low quality since the data were based on expert opinion rather than habitat surveys (Dataset 10 in Appendix 4). However, it provided the best available information on faunal beds in the region. In the Salish Sea, approximately 60% of the Core Zone and 89% of the Seaward Zone are unclassified for biotic habitats.

Core Zone

The great majority of the classified substrate in U.S. Core Zone waters of the Salish Sea is composed of fine unconsolidated sediment. Among these sediments, sand (27.4%) and mud (15.2%) are most prominent, with mixtures of grain sizes ranging from clay to slightly gravelly sand contributing the remaining portion (Table 4). Fine unconsolidated substrates are abundant throughout the Strait of Juan de Fuca, Whidbey Basin, South Central Puget Sound Basin, Hood Canal, and South Puget

Sound Basin (Fig. 5, Inset 1). Nearly twice as much coarse unconsolidated substrate (14.0%) was mapped compared to rock substrate (7.6%). Among classified components of these categories, gravelly sand (3.7%) and bedrock (4.6%), respectively, were observed most. In the San Juan Archipelago and Georgia Strait Basin and in the North Central Puget Sound Basin, coarse unconsolidated substrates are the predominant habitats. Rock substrate is scattered throughout the Core Zone of the Salish Sea but has mostly been documented in the southern part of the Strait of Juan de Fuca and in the San Juan Archipelago region (Fig. 5, Insets 2 & 3). Trivial amounts of biogenic and anthropogenic substrates were mapped (Fig. 5, Inset 4), and all the documented unconsolidated mineral substrate was unclassified (Table 4).

Overall, benthic and attached biota were documented throughout 41% of the Core Zone of the Salish Sea (Table 5). Seagrass, such as eelgrass, and faunal beds (which include attached oysters, sea urchins, clam beds, and scallop beds) were documented throughout all regions of the U.S. waters of the Salish Sea and represented 11% and 21% of the Core Zone area, respectively. Tidal wetlands were found in less than 2% of the Core Zone, commonly in estuary overlap areas of the zone (Fig. 6, Inset 1).

Table 4. Total area and relative percentage of CMECS substrate types in the Core and Seaward Zones of the Salish Sea.

CMECS Substrate Category	Substrate Details	Core Zone Area (ha)	Core Zone Area (%)	Seaward Zone Area (ha)	Seaward Zone Area (%)
Rock substrate	Bedrock	11,031	4.57	5,505	2.32
	Unclassified	7,325	3.03	2,798	1.18
	Subtotal	**18,356**	**7.60**	**8,302**	**3.51**
Unconsolidated mineral substrate	Unclassified	**27,395**	**11.34**	**5,659**	**2.39**
Coarse unconsolidated substrate	Boulder	766	0.32	1,231	0.52
	Cobble	1,180	0.49	8,233	3.48
	Pebble	198	0.08	0	0.00
	Gravel	5,520	2.29	3,687	1.56
	Granule	1,809	0.75	18,863	7.97
	Cobbley sand	177	0.07	0	0.00
	Sandy cobble	53	0.02	434	0.18
	Sandy muddy cobble	0	0.00	80	0.03
	Cobble mix	213	0.09	779	0.33
	Gravel mixes	372	0.15	323	0.14
	Sandy gravel	7,367	3.05	24,974	10.55
	Muddy sandy gravel	261	0.11	524	0.22
	Muddy gravel	614	0.25	622	0.26
	Gravelly	4,017	1.66	825	0.35
	Gravelly sand	8,927	3.70	4,160	1.76
	Gravelly muddy sand	4	0.00	5	0.00
	Gravelly mud	915	0.38	5,603	2.37

Table 4. Continued.

CMECS Substrate Category	Substrate Details	Core Zone Area (ha)	Core Zone Area (%)	Seaward Zone Area (ha)	Seaward Zone Area (%)
	Cobbley sand	135	0.06	616	0.26
	Cobbley sandy mud	0	0.00	14	0.01
	Cobbley	0	0.00	9	0.00
	Unclassified	1,209	0.50	1,985	0.84
	Subtotal	**33,736**	**13.97**	**72,968**	**30.82**
Fine unconsolidated substrate	Slightly gravelly sand	1,232	0.51	415	0.18
	Slightly gravelly muddy sand	6,821	2.82	84	0.04
	Slightly gravelly mud	0	0.00	5	0.00
	Slightly cobbley sand	42	0.02	103	0.04
	Sand	66,206	27.41	58,721	24.80
	Muddy sand	22,906	9.48	39,844	16.83
	Sandy mud	17,802	7.37	21,292	8.99
	Sandy silt	0	0.00	154	0.07
	Mud	36,751	15.22	19,782	8.35
	Silt	104	0.04	107	0.05
	Silt-clay	907	0.38	1,253	0.53
	Clay	42	0.02	76	0.03
	Unclassified	7,586	3.14	7,395	3.12
	Subtotal	**160,398**	**66.41**	**149,231**	**63.02**
Biogenic substrate	Shell hash	187	0.08	539	0.23
	Organic substrate	128	0.05	0	0.00
	Woody debris	4	0.00	0	0.00
	Subtotal	**319**	**0.13**	**539**	**0.23**
Anthropogenic substrate	Anthropogenic rock	2	0.00	0	0.00
	Anthropogenic rock rubble	7	0.00	2	0.00
	Metal reef	0	0.00	1	0.00
	Unclassified	96	0.04	0	0.00
	Subtotal	**105**	**0.04**	**3**	**0.00**
Unclassified	Unclassified	**1,217**	**0.50**	**89**	**0.00**
	Total	241,527	100.00	236,791	100.00

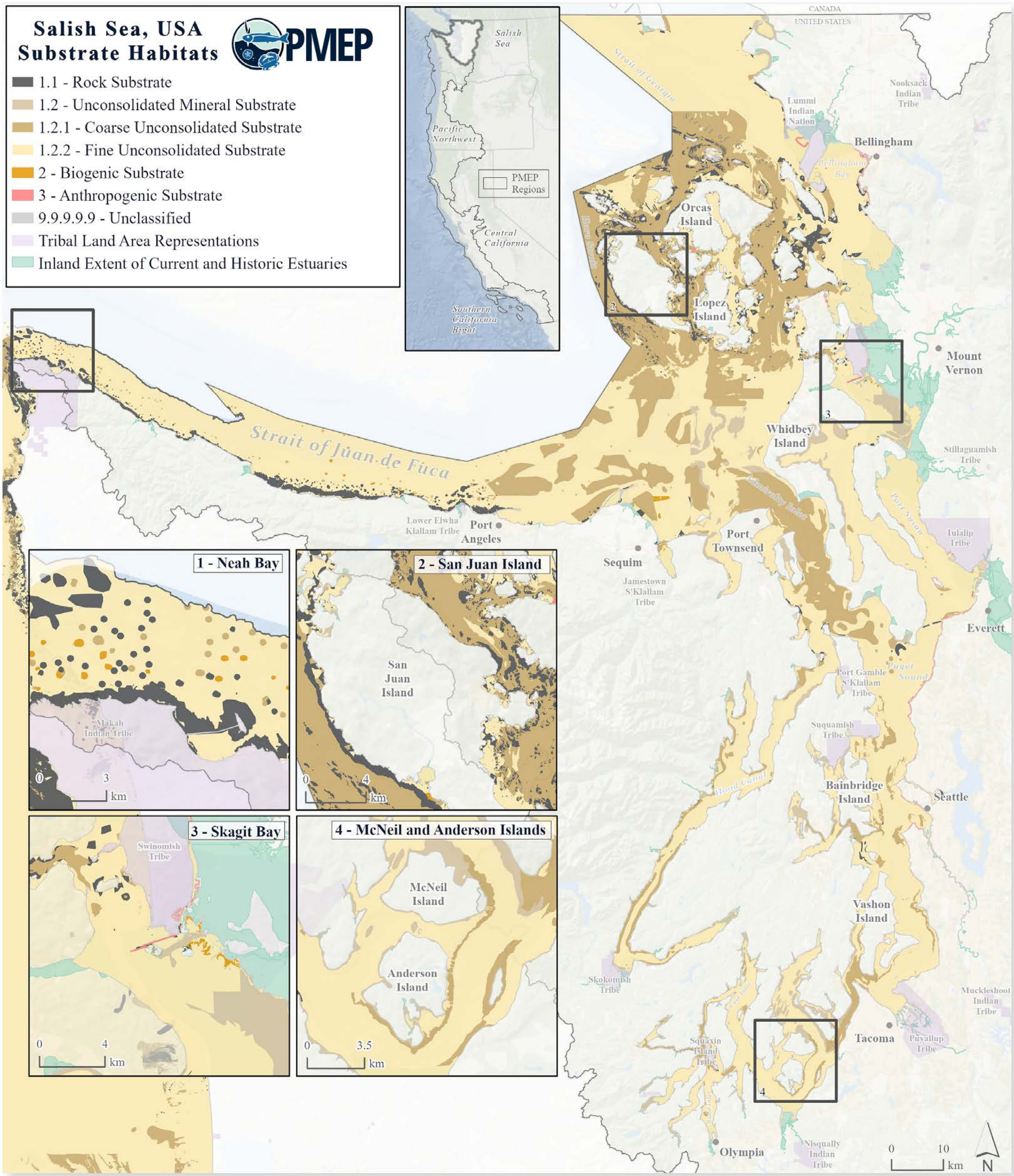


Figure 5. Distribution of CMECS substrate habitats in the Salish Sea Ecoregion.

Table 5. Total estimated mapped area based on the maximum observed extent of a habitat type, relative percentage of total zone area, and data completeness status for each CMECS biotic category in U.S. waters of the Salish Sea.

Biotic Category	CMECS Habitat Details (Group)	Core Zone		Seaward Zone		Spatial Data Completeness
		Area (ha)	Area (%)	Area (ha)	Area (%)	
Benthic / Attached Biota		98,877	40.9%	24,911	10.5%	Limited or incomplete mapping
Faunal Bed		54,001	22.4%	24,339	10.3%	Limited or incomplete mapping
Aquatic Vegetation Bed		51,501	21.3%	1,271	0.5%	Limited or incomplete mapping
Benthic Macroalgae	Canopy-Forming Algal Bed (Kelp)	12,763	5.3%	1,270	0.5%	Local or subregion-level mapping
	Other (Unclassified)	1,656	0.7%	1	0.0%	Limited or incomplete mapping
Aquatic Vascular Vegetation	Seagrass Bed	27,481	11.4%	0	0.0%	Region-wide mapping
Emergent Wetland	Unclassified	3,817	1.6%	NA	NA	Local or subregion-level mapping
Scrub-Shrub Wetland	Unclassified	84	0.0%	NA	NA	Local or subregion-level mapping
Forested Wetland	Unclassified	156	0.1%	NA	NA	Local or subregion-level mapping
	Total Zone Area	**241,527**		**236,791**		

Note. Because they are more specific, subcategories may have a greater amount of mapped area than more generalized categories in which they are contained. The biotic area estimates are limited by data availability; certain biotic datasets have more extensive and complete habitat mapping than others and are ranked for data completeness using the following categories:

- **No data**: No spatial-extent data were available
- **Limited or incomplete mapping**: Mapping of habitat is limited in scope and is known to be an insufficient estimate of area
- **Local or subregion-level mapping**: Mapping efforts exist at the local/subregion scale, and the regional area calculation is likely an underestimate
- **Region-wide mapping**: Mapping efforts exist across the region and provide a coarse estimate of area

Striped Surfperch (*Embiotoca lateralis*). (J. Tomelleri)

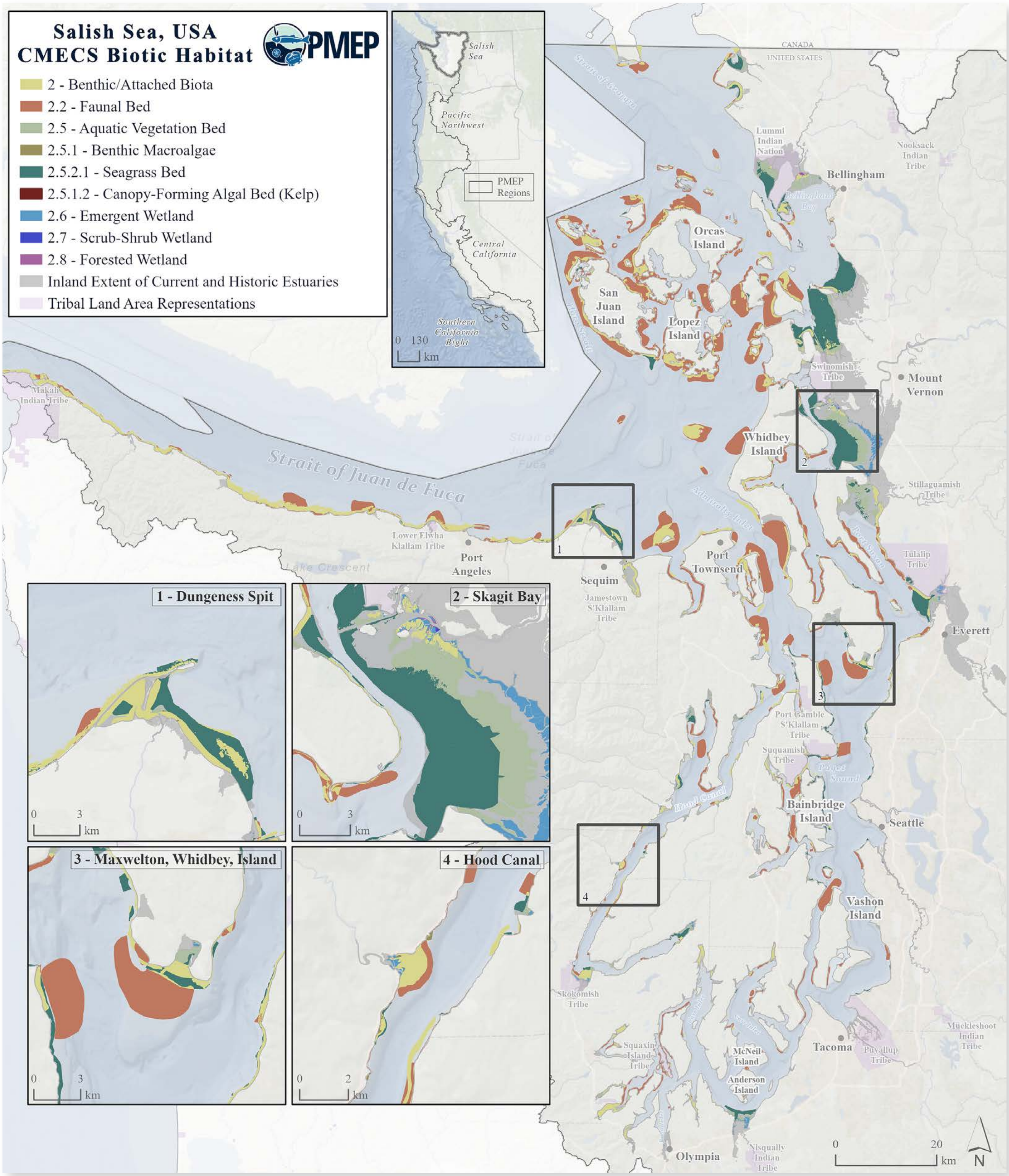


Figure 6. Distribution of CMECS biotic habitats in the Salish Sea Ecoregion.

Mapping efforts for seagrass exist across the region and are extensive in the eastern subregions of San Juan Archipelago and Georgia Strait Basin and of Whidbey Basin (Fig. 6), particularly in Possession Sound and Lummi, Samish, Padilla, and Skagit Bays (Fig. 6, Inset 1). In the Salish Sea's U.S. waters, WADNR provided probabilistic estimates of aerial coverage of eelgrass (predominantly *Zostera marina*), the most common seagrass found in the Salish Sea and in estuaries along the outer West Coast. The PMEP Nearshore dataset summarized approximately 27,000 ha of seagrass habitat in the Salish Sea, which included eelgrasses (*Zostera* spp.) and other mapped seagrass species, such as surfgrasses (*Phyllospadix* spp.). WADNR reported a rolling average from 2017 to 2019 of approximately 22,662 ha of eelgrass, with a range of 21,000–25,000 ha since 2008 (WADNR 2020).

Faunal beds, which include but are not limited to attached oysters and sea urchins as well as clam and scallop beds, were generally mapped in association with the San Juan Archipelago and in North Central Puget Sound Basin (Fig. 6, Inset 3). Faunal beds are known to be extensive in the nearshore of the Salish Sea's U.S. waters, with over 100,000 ha of commercially harvested shellfish beds in the region. This estimate is almost twice the amount of area coverage than is documented in the CMECS biotic habitat dataset (Table 5), indicating that there is limited or incomplete mapping of the region's faunal beds.

The extent of canopy-forming macroalgae (kelp) was mapped at the local or subregional level, mainly throughout the Strait of Juan de Fuca Basin and the San Juan Archipelago and Georgia Strait Basin. Spatial data showing the extent of canopy-forming kelp was not as prevalent throughout North Central, South Central, and South Puget Sound (see the Data Gaps and Considerations section). Spatial-extent data for canopy-forming algal beds (kelp) was limited to the Strait of Juan de Fuca and the San Juan Archipelago. Additional monitoring efforts by WADNR for kelp exist throughout other parts of the U.S. waters of the Salish Sea, including Central and Southern Puget Sound; however, the goal of these monitoring efforts is to document areal variation over time to better understand kelp loss, not specifically to map the spatial extent of the kelp beds. Nonetheless, these recent efforts identified bull kelp across 21% and 20% of the Core Zone of Central Puget Sound and South Puget Sound, respectively, indicating more coverage of this biotic habitat in the region than is mapped (Berry et al. 2020). The aerial coverage of canopy-forming algal beds is, therefore, underestimated herein due to a lack of region-wide data availability.

Other macroalgae (non-canopy-forming kelps) had limited or incomplete mapping for the Salish Sea. Washington ShoreZone mapped the distribution of non-floating kelps along the shoreline for all of Washington State and found them present along 31% of the state shoreline, as opposed to floating kelps, which were observed along 11% of the state shoreline (Berry et al. 2020). It was recently determined that green algae are the predominant vegetation type in Central Puget Sound, with over 3,600 ha (Christiaen et al. 2020). This estimate is twice the area of other macroalgae mapped in the PMEP Nearshore dataset, indicating a significant data gap for other macroalgae. The Washington Department of Fish and Wildlife (WDFW) has also conducted systematic surveys of herring spawning grounds at select locations through U.S. waters of the Salish Sea since the 1970s (Stick and Lindquist 2009; Stick et al. 2014; Sandell et al. 2019). These surveys have utilized hand-thrown vegetation rakes to collect spawning substrate and have documented a diverse assemblage of macroalgae in several locations where vegetation beds were not detected using the approach employed here. The limited areal coverage of herring surveys prohibited the use of this dataset, but it further substantiates that estimates of understory vegetation coverage provided herein are incomplete.

Seaward Zone

Similar to the Core Zone, the great majority (63.0%) of the classified substrate in U.S. Seaward Zone waters of the Salish Sea is composed of fine unconsolidated sediment. Sand (24.8%) and muddy sand (16.8%) were most documented within this category, with similar proportions of sand and a greater proportion of muddy sand reported relative to the Core Zone (Table 4). Coarse unconsolidated substrate, especially gravel mixtures and granules, was much more commonly reported in the Seaward Zone as compared to the Core Zone (Table 4). These sediments were well documented in association with the San Juan Archipelago and in North Central Puget Sound Basin (Fig. 5, Inset 3). To a lesser extent, these sediments were documented throughout other areas of Puget Sound, especially in Hood Canal. Rock sediment was relatively rare (3.5%) in the Seaward Zone and mainly found in the San Juan Archipelago and Georgia Strait Basin subregion (Fig. 5, Inset 3). Minor amounts of organic and anthropogenic substrates were reported (Table 4). Unconsolidated mineral substrate was limited (2.4%) and unclassified.

Faunal beds were the main biotic habitat documented in the Seaward Zone of Salish Sea's U.S. waters (Table 5). The data for these habitats mostly consisted of scallop beds and were largely distributed from the San Juan Archipelago to North Central Puget Sound Basin, where they extended into the Core Zone (Fig. 6, Inset 3). In contrast, the mapping of faunal beds in the Strait of Juan de Fuca was mainly restricted to the Core Zone (Fig. 6). The only other biotic habitats that were documented in the Seaward Zone of the Salish Sea were canopy-forming algal beds (kelp). The limit of the photic zone in the Salish Sea is approximately 30 m (EnviroVision, Herrera Environmental, and Aquatic Habitat Guidelines Working Group 2007); therefore, the general absence of photosynthetic flora in the Seaward Zone is expected.

Landward Zone

The Landward Zone of the Salish Sea Ecoregion comprises variable amounts of beaches, flats, and bluffs consisting of mostly mud, sand, and gravel substrates; rock outcrops; marine riparian vegetation; and armored shorelines. Unconsolidated and rock substrate types and marine riparian vegetation may extend both seaward and landward, whereas anthropogenic modifications are mainly limited to the shoreline. In regions heavily influenced by oceanic and riverine inputs, the extent and composition of the Landward Zone are dynamic on seasonal and yearly cycles. The underlying geology of the Olympic and Kitsap Peninsulas and numerous large islands also affects the shape and character of the shoreline through erosion, landslides, sediment movement, and beach formation. Specific functions of marine riparian vegetation include water quality protection, pollution abatement, biological habitat, terrain stabilization and sediment control, and regulation of nutrient, temperature, and energy flux (Levings and Jamieson 2001, Lemieux et al. 2004). For example, organisms associated with shoreline vegetation provide an important food source for salmonids and juveniles of a broad array of vertebrate and invertebrate species.

The anthropogenic modification of shorelines for erosion abatement (i.e., shoreline armoring) is estimated to cover 29% of the linear extent of the shoreline in the Landward Zone in Puget Sound (Puget Sound Vital Signs 2021). The degree of armoring varies spatially in the Salish Sea, covering more than 90% of the urban region between Tacoma and Everett, Washington, but only 5% around the San Juan Archipelago (Encyclopedia of Puget Sound 2012). However, datasets concerning the linear extent of shoreline armoring were not consolidated for this zone.

Spotted Snailfish (*Liparis callyodon*). (J. Tomelleri)

LARVAL DUNGENESS CRAB MONITORING IN THE SALISH SEA: THE PACIFIC NORTHWEST CRAB RESEARCH GROUP

by Allison Brownlee, Emily Buckner, Claire Cook,
Ryan Crim, Sarah Grossman, and Margaret Homerding

Pacific Northwest Crab Research Group

Along the California Current System off the Pacific coast of North America, Dungeness Crab (*Metacarcinus magister*) appear to be a single open metapopulation with very little genetic differentiation from Central California to Washington (Jackson et al. 2017). However, within the waters of the Salish Sea, Dungeness Crab populations have been shown to exhibit differences in terms of size and life-history schedules by region. Still, it is currently unknown if the observed phenotypic differences are attributed to gradients of rearing conditions or genetic traits. In contrast to outer coast Dungeness Crab, there is some evidence for significant population genetic structure among adult Dungeness Crab in Washington waters (Jackson and O'Malley 2017; O'Malley et al. 2017) and the existence of multiple distinct recruitment cohorts, each settling at different times and potentially growing at different rates, has long been proposed (Orensanz and Gallucci 1988; Dinnel et al. 1993). These genetic and phenotypic data suggest that the Salish Sea may represent a mixed-stock Dungeness Crab fishery, in which fishery yields vary according to the relative supply, survival, and growth of genetically distinct cohorts.

Dungeness Crab megalopa. (Claire Cook, Swinomish Tribal Community Fisheries Department)

In 2019, the Pacific Northwest Crab Research Group (PCRG) initiated a larval Dungeness Crab monitoring network to examine the temporal and spatial population dynamics of postlarvae (megalopae) across the Salish Sea. This collective monitoring aims to fill data gaps relating to Dungeness Crab population connectivity between and within Puget Sound sub-basins. The long-term goal is to develop models correlating larval supply with subsequent fisheries landings. PCRG realizes that population sources/sinks and larval delivery are based upon biological and physical factors operating at a scale beyond the boundaries of individual basins or the Salish Sea as a whole. A high priority for PCRG is gaining a better understanding of which Puget Sound populations are more vulnerable to collapse versus which are more resilient and comprised of multiple source populations, especially given the recent population declines in Southern Puget Sound and the southern portion of Hood Canal.

Early PCRG results suggest that the total annual larval supply varies significantly across Washington's inland waters, and generally, abundances decrease further from the Strait of Juan de Fuca complex. Except for Hood

Canal, the spatial trend can partially be explained by the protracted larval delivery season at northern sites (April to September). We hypothesize that the early-season conveyance (April/May) of Dungeness Crab larvae originates from outer coast populations and provides a subsidy to Salish Sea populations. This potential influx of coastal Dungeness Crab represents a connective pathway between Pacific coast and Salish Sea populations. As the PCRG network continues to examine the annual patterns of larval inputs across the Salish Sea, the group is filling essential data gaps relating to the development of region-specific population models that incorporate the relative annual contributions of these larval cohorts. In addition, PCRG is working to better understand the physical and oceanographic drivers (i.e., circulation and water temperature) that influence larval crab delivery and growth trajectories across the Salish Sea.

Fish Fauna, Fish Assemblages, and Selected Invertebrates: Summary Points

The primary nearshore ichthyofauna of the Salish Sea consists of 173 species distributed among 19 orders (Scorpaeniformes, or scorpionfishes = 81 species) and 50 families (Psychrolutidae, or marine sculpins = 22 species; Scorpaenidae, rockfishes, and thornyheads = 21 species).

Species richness is highly variable among subregions (San Juan Archipelago and Georgia Strait Basin = 166, South Puget Sound = 117) but more similar between depth zones (Core Zone = 165 total, 64 common or abundant; Seaward Zone = 156 total, 48 common or abundant).

The number of common and abundant fishes among Salish Sea assemblages increases with depth (Core Zone: Intertidal = 64, Core Zone: Subtidal = 94, Seaward Zone = 98).

There is a strong similarity between Core and Seaward Zones for soft bottom, hard bottom, and pelagic assemblages of the Core and Seaward Zones. The assemblage structure of habitat generalists is somewhat reduced in the Seaward Zone because of the loss of some small benthic species.

The selected invertebrate species of the Salish Sea consist of several ecologically important intertidal and subtidal species (e.g., Mud Shrimp, Purple Sea Urchin) and support recreational and commercial fisheries (e.g., Geoduck, Dungeness Crab).

Several selected invertebrate species reach their range-wide maximum documented sizes in the Salish Sea and associated outer coast.

The great majority of invertebrates selected for this report were primarily distributed in intertidal or subtidal waters of the Core Zone; fewer were selected in the Seaward Zone.

Most of the selected invertebrates are commonly encountered in the Salish Sea, but the Pinto Abalone is endangered in Washington, and the Olympia Oyster is a candidate for state listing. Since 2013, the frequency of occurrence has decreased substantially for both the Ochre Star and the Sunflower Sea Star as a consequence of Sea Star Wasting Disease.

Salish Sea Ichthyofaunal Characteristics and Fish Assemblages

Salish Sea Ichthyofauna

Although 261 fish species have been documented in the Salish Sea, many are represented by one or a few scattered records (Pietsch and Orr 2019). When these errant species and those strictly occurring at depths greater than 100 m were removed, 173 species remained to form the primary nearshore ecoregional ichthyofauna (Appendix 5). These species are distributed among 19 orders and 50 families, with the most species-rich taxon being Scorpaeniformes (scorpionfishes, 81 species). The most species-rich families within Scorpaeniformes include Psychrolutidae (marine sculpins, 22 species) and Scorpaenidae (rockfishes and thornyheads, 21 species). The great majority of established nearshore fishes in the Salish Sea's U.S. waters have solely marine or estuarine distributions (85.6%), but 18 are anadromous (10.4%), including 10 salmonids. Also, seven occur in freshwater (4.0%; e.g., Coastrange Sculpin, Starry Flounder; Appendix 6). Most of the nearshore ichthyofauna is exclusively or primarily benthic or demersal (82.7%), whereas 11.0% are pelagic, and 6.4% are distributed throughout the water column (Appendix 6). Fish distributions are driven by ecological and habitat associations of individual species, and the variety of seafloor types may contribute to high localized fish diversity, especially for benthic and demersal species in the Salish Sea (Pietsch and Orr 2019).

Starry Flounder (*Platichthys stellatus*). (J. Tomelleri)

Historically, the marine fauna of the Salish Sea was seeded by the immigration of outer coast populations or by their eggs and larvae. Of the 450 fish species distributed off the Washington and British Columbia coasts, approximately 58% occur in the Salish Sea (Pietsch and Orr 2019). Whereas the great majority (~80%) of outer coast fishes are of southern origin, more than half of the fishes in the Salish Sea are of northern origin. Cooler historical temperatures, in association with deglaciation, probably seeded much of the fish fauna, which was effectively trapped when oceanic waters began to warm (Pietsch and Orr 2019). Given its rather recent geological origin, there is a distinct lack of endemics in the Salish Sea, although genetically unique subspecies, stocks, or Distinct Population Segments (DPSs) have been identified. Only one such endemic species (Blackfin Fathead) has been reported (Pietsch and Orr 2019), and its geographic distribution remains somewhat ambiguous (Stevenson 2015).

Some notable changes in the Salish Sea ichthyofauna have occurred since the late 20th century. Basking Sharks occasionally were encountered prior to 1970 but have been functionally extirpated (Wallace and Gisborne 2006), largely because of directed efforts to reduce their interaction with salmon fisheries. Only a handful of reports of this species in the Salish Sea have been verified by the WDFW, NOAA Fisheries, and Fisheries and Oceans Canada in the last 10 years (D. Lowry, NOAA Fisheries, pers. comm.). The Pacific Lamprey population has notably declined in the Salish Sea and throughout its range during the last 30 years (Close et al. 2002), and seven marine and anadromous fishes are ESA-listed (Eulachon, Yelloweye Rockfish, Bocaccio, Bull Trout, Steelhead, and distinct runs of Chum and Chinook Salmon). Additionally, 37 marine, estuarine, and freshwater fishes, including 13 rockfishes and five salmonids comprising 13 unique stocks, are candidates for state listing (WDFW 2020). Five non-native fishes have been introduced to the Salish Sea, including a massive accidental release of farmed Atlantic Salmon in 2017 after years of periodic escapement (Alverson and Ruggerone 1998; Pietsch and Orr 2019). Among these introduced species, only the American Shad is currently established (Appendix 5).

The distributions of marine fishes are not static but expand and recede on spatiotemporal scales related to environmental variability and ecological interactions among sympatric species. In the Salish Sea, estuarine inputs and tidal forcing influence marine fish distributions through physical transport and behavioral responses to physiological tolerances. These hydrological factors especially affect the distributions of pelagic, anadromous, and estuarine species. The relative input of marine water and freshwater (9:1 on average; Pietsch and Orr 2019) regulates the overall salinity of the Salish Sea and the heterogeneity of salinity gradients within the system. On a larger scale, changes in ocean temperature and current patterns, such as those associated with El Niño and La Niña conditions or marine heatwaves, can result in the punctuated occurrence of itinerant fishes (especially pelagic species) that are typically absent from the region.

One reason for the high local fish diversity is the great variety of seafloor habitats. Sixty-eight distinct marine habitats have been documented in the Salish Sea (Dethier 1990), including nearly all of those found on the outer coast (Pietsch and Orr 2019). Species richness is greatest in the center of the region, extending from adjacent waterways through the San Juan Archipelago, where dynamic hydrology and variable depths and substrate types provide myriad habitat niches to support a great diversity of fishes. Benthic habitat dynamics, which can be driven by the seasonal redistribution of unconsolidated substrate and variability in the distribution and

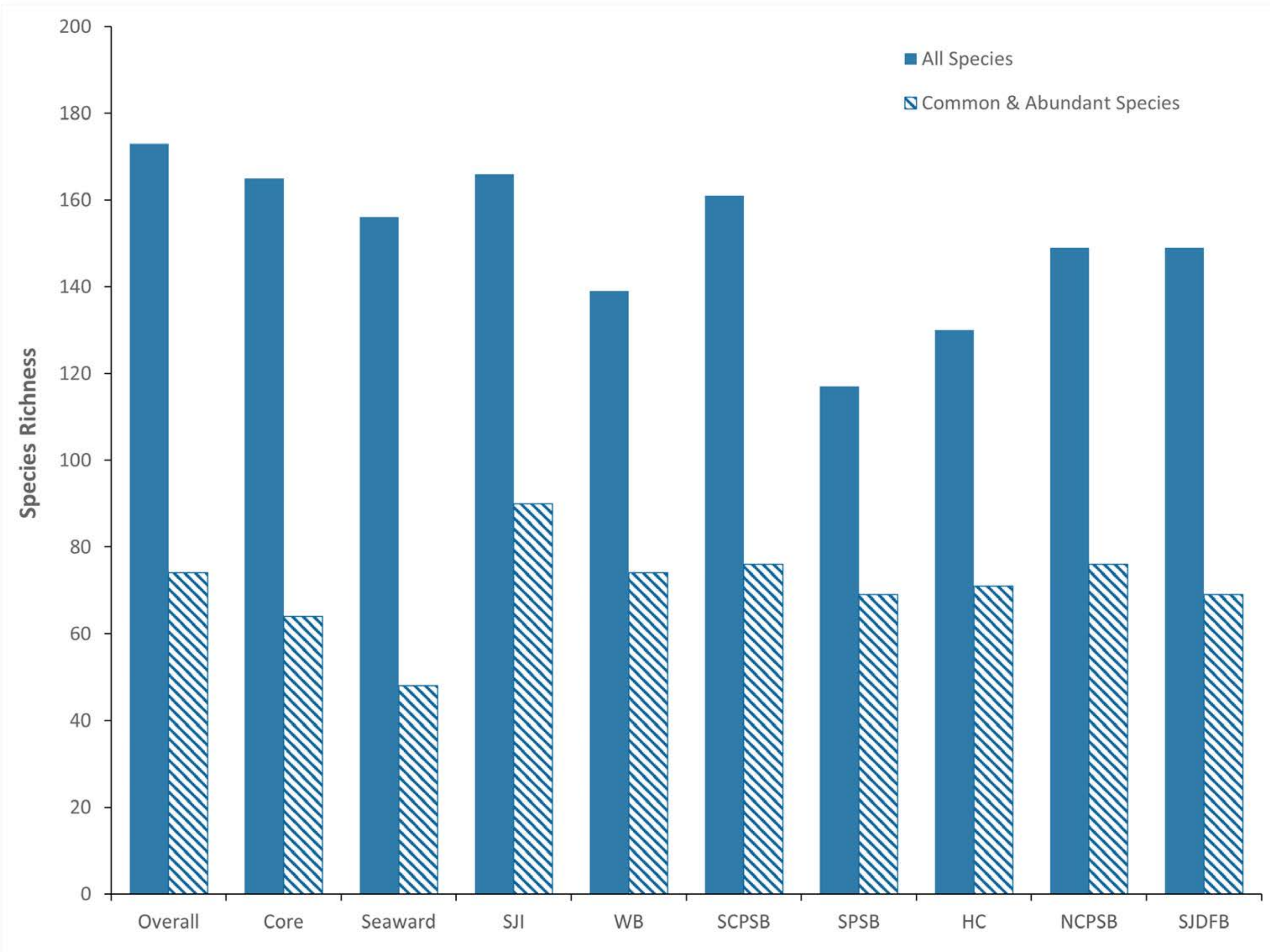


Figure 7. Number of established (All Species) and common or abundant (Common and Abundant Species) fish species in U.S. waters of the Salish Sea (Overall), in the Core and Seaward Zones, and among subregions.

Note. SJI = San Juan Islands Archipelago, WB = Whidbey Basin, SCPSB = South Central Puget Sound Basin, SPSB = South Puget Sound Basin, HC = Hood Canal, NCPSB = North Central Puget Sound Basin, SJDFB = Strait of Juan de Fuca Basin.

abundance of biotic habitats, can further modify the occurrence patterns of benthic and demersal fishes.

Regional and Subregional Characteristics of Salish Sea Ichthyofauna

The number of total established fish species (abundant, common, and rare combined) varies among Salish Sea subregions, but the number of common species is relatively more similar (Fig. 7). *Species richness* (the number of species documented) is greatest in the San Juan Archipelago and Georgia Strait Basin (n = 166) and in South Central Puget Sound (n = 161), whereas South Puget Sound has the fewest fishes (n = 117). Species richness is intermediate among the other regions, varying from 130 species reported in Hood Canal to 149 species in North Central Puget Sound and Strait of Juan de Fuca Basins (Fig. 7). The San Juan Archipelago Basin has the most commonly reported species (n = 90 out of 166), whereas totals are comparable among the other basins (Fig. 7). Forty-three percent of established nearshore fish species are reported as common throughout the ecoregion (n = 74).

In U.S. waters of the Salish Sea, slightly more fishes occur in the Core Zone (165 total, 64 common) than in the Seaward Zone (156 total, 48 common; Fig. 7). Species richness is similar within Core and Seaward Zones across subregions except in the Strait of Juan de Fuca, which has fewer species in both zones (Fig. 8). Ichthyofaunal differences among subregions are largely driven by differences in benthic habitat types and salinity gradients. Therefore, it is likely that comparably fewer fishes are found in the

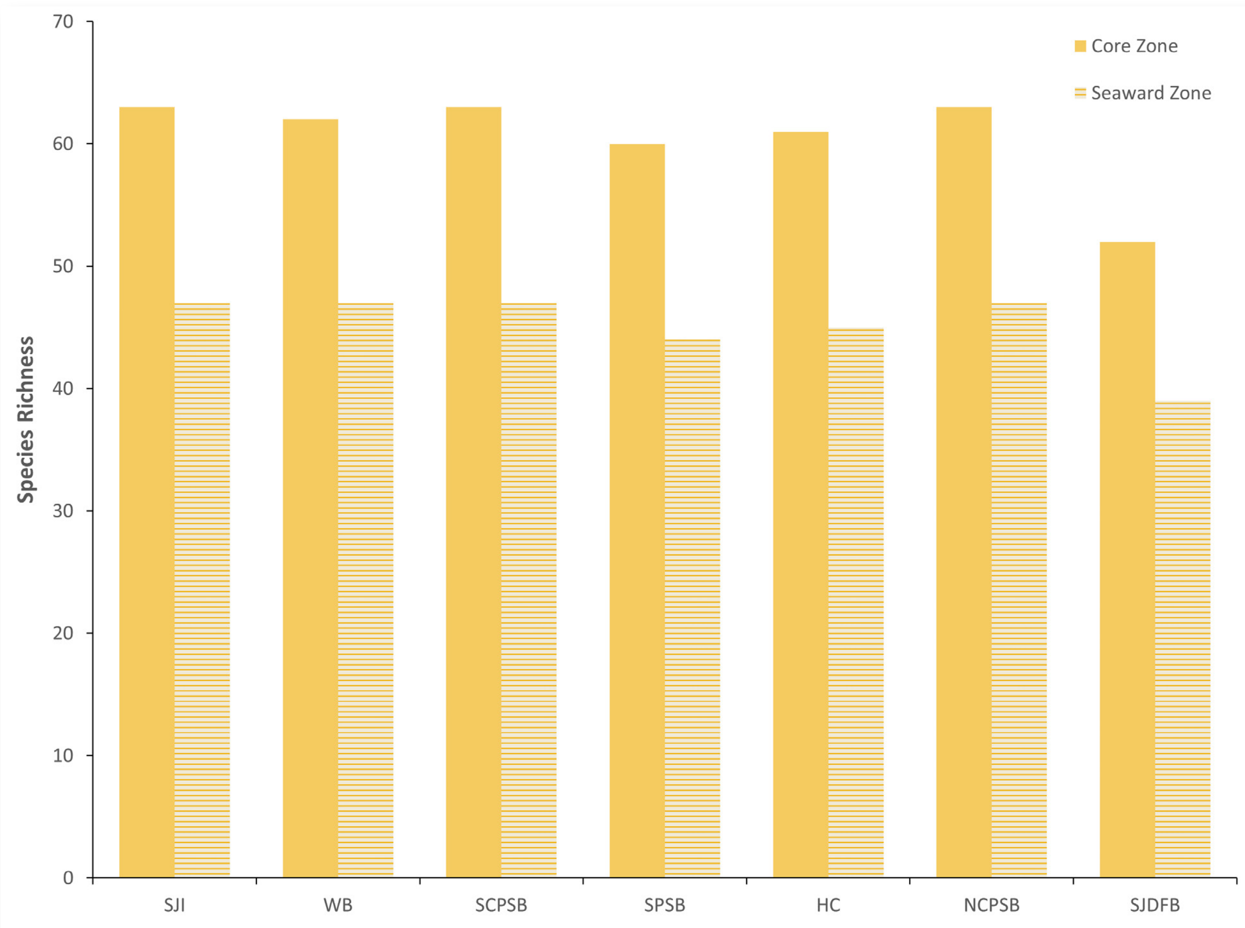


Figure 8. Number of common and abundant fish species in the Core and Seaward Zones of each subregion in the Salish Sea Ecoregion.

Note. SJI = San Juan Islands Archipelago, WB = Whidbey Basin, SCPSB = South Central Puget Sound Basin, SPSB = South Puget Sound Basin, HC = Hood Canal, NCPSB = North Central Puget Sound Basin, SJDFB = Strait of Juan de Fuca Basin.

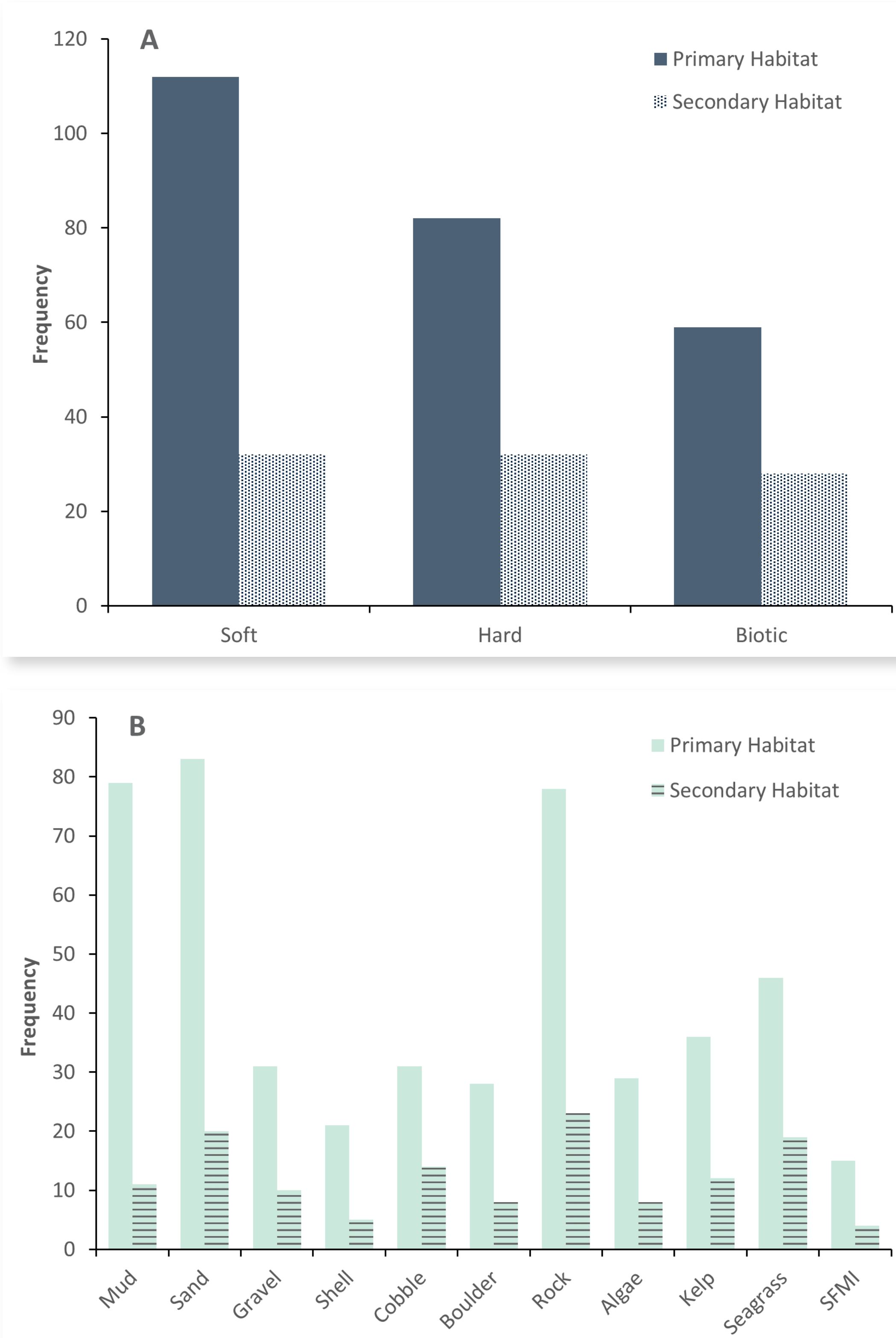


Figure 9. General (A) and specific (B) benthic habitats use by established fishes in U.S. waters of the Salish Sea.

Note. Fishes can have multiple primary and secondary habitats (e.g., mud, sand, and gravel). Soft = Mud, Sand, and Gravel. Hard = Cobble, Boulder, and Rock. Biotic = Algae, Kelp, Seagrass, and SFMI. Gravel = gravel and pebbles. Algae = attached and drift algae other than kelp. Seagrass = eelgrass and surfgrass. SFMI = structure-forming marine invertebrates.

Strait of Juan de Fuca because environmental conditions are less heterogeneous than those of other subregions.

Salish Sea fishes occur in association with a wide variety of benthic habitats. Most fishes primarily use soft sediment seafloors, which are by far the most prevalent, followed by hard seafloors and biotic habitats (Fig. 9A). In addition, 47 species use two different primary habitat types, and 27 habitat generalists use all three primary habitat types (Appendix 6). Secondary habitat use is more evenly divided among soft, hard, and biotic habitats (Fig. 9A). Among soft seafloor habitats, sand and mud are utilized by similar numbers of fishes; in this report's analysis, they were much more often documented than gravel (or pebble) and shell habitats (Fig. 9B). Most fishes associated with hard seafloor habitats use rock outcrops, pavements, and reefs of various rugosity (Fig. 9B). Among biotic habitats, algae and vascular plants (seagrasses) are utilized to a much greater degree than faunal beds, or structure-forming marine invertebrates (SFMI; Fig. 9B). This final conclusion should be interpreted cautiously, however, given the evidence of under-documentation of these habitat types demonstrated above.

Salish Sea Fish Assemblages: Depth Zonation

Core Zone: Intertidal

In this report's underlying assessment, at least 64 fishes common or abundant in the Core Zone of the Salish Sea's U.S. waters were documented from the intertidal zone, including 36 species that regularly utilize this dynamic environment (Love 2011; Pietsch and Orr 2019). This ichthyofauna represents a combination of species that are resident across their life history, in the early life stages of generally deeper-dwelling species, spawning adults, and roaming predators. Fishes that occupy intertidal habitats throughout their life history include mostly small benthic species, such as sculpins (e.g., Pacific Staghorn Sculpin, Red Irish Lord), snailfishes (e.g., Spotted Snailfish, Tidepool Snailfish), and pricklebacks (e.g., Black Prickleback, Rock Prickleback). Although these habitats are limited, early juveniles of some species (e.g., Black Rockfish) utilize tidepools, whereas other fishes typically are associated with shorelines (e.g., Pacific Sand Lance, English Sole). Several of these species can survive for limited periods relatively out of water during low tide, including sculpins (e.g., Smoothhead Sculpin, Sharpnose Sculpin), gunnels (e.g., Penpoint Gunnel, Crescent Gunnel), and pricklebacks (e.g., Black Prickleback, Rock Prickleback), which are capable of respiring through their skin and can endure prolonged exposure in a wet environment (Glover et al. 2013).

The intertidal zone is a productive region with relatively low predation pressure for mobile fauna; therefore, it is commonly used as nursery grounds for myriad marine and estuarine fishes (e.g., salmonids, gadids, rockfishes, flatfishes). Whereas larvae or early juveniles of these taxa are advected or swim intentionally to intertidal waters, there are others that are deposited directly into these habitats through adhesive eggs (e.g., Surf Smelt, Pacific Herring) or by live birth (e.g., Shiner Perch, Pile Perch). Some predators utilize intertidal areas for foraging habitat. This behavior is well documented among ancestral species (e.g., Spotted Ratfish, Pacific Spiny Dogfish, White Sturgeon) that typically forage during nocturnal high tides using a combination of nonvisual cues, such as chemoreception, mechanoreception, and electroreception (Dumbauld et al. 2008; Love 2011).

Core Zone: Subtidal

An estimated 94 species frequent the subtidal waters of the Core Zone in U.S. waters of the Salish Sea (Appendix 5), including all the species occurring in the intertidal zone. Juveniles and adults of some species, such as Sharpnose Sculpin and Starry Flounder, are more common in intertidal than subtidal waters, as are eggs (e.g., sculpins, pricklebacks, gunnels) and YOY of other species (e.g., Blackeye Goby, Kelp Greenling; Love 2011). However, several species' primary depth ranges are centered in the subtidal (e.g., Silverspotted Sea Raven, Tubesnout, C-O Sole; Pietsch and Orr 2019). Additionally, eight species common in benthic, subtidal waters (e.g., Bay Pipefish, Penpoint Gunnel, Sharpnose Sculpin) have depth ranges that do not extend into the Seaward Zone (Appendix 6).

Utilization patterns of the shallow subtidal are like those of the intertidal. Subtidal fishes include residents, the early life stages of deeper-dwelling species, spawning adults, and roaming predators; however, species generally reach larger sizes and include a greater proportion of older life stages in deeper subtidal waters. For instance, the adult Lingcod is common in subtidal regions of the Salish Sea, and Bluntnose Sixgill Sharks commonly forage in these regions at night (Hueckel and Buckley

1989; Williams et al. 2010). The subtidal zone also is an important nursery region for salmonid species (e.g., Chinook Salmon, Chum Salmon, Pink Salmon). Several rockfish and flatfish species commonly occur more frequently in the subtidal than the intertidal, but distributions of other abundant intertidal groups, like sculpins, snailfishes, and pricklebacks, extend throughout the subtidal (Appendix 5).

Seaward Zone

At least 98 fishes are common or abundant in the Seaward Zone of U.S. Salish Sea waters, including 82 species that also regularly inhabit the shallower depths of the Core Zone (Appendix 5). Nine relatively abundant, mostly tidepool-associated fishes from the Core Zone are absent in the Seaward Zone (e.g., Sharpnose Sculpin, Tidepool Snailfish, Black Prickleback; Appendix 5). The inner shelf waters of the Seaward Zone (30–100 m) contain one species (Whitebarred Prickleback) that does not venture into the subtidal waters of the Core Zone, and 15 species (e.g., Longnose Skate, Yelloweye Rockfish, Dover Sole) are more common in deeper waters (Appendix 6). Early juveniles of these species and others, such as Greenstriped Rockfish, Sablefish, and Rex Sole, commonly occur in the Seaward Zone and move deeper as they age and grow (Demory 1971; Heifetz and Fujioka 1991; Bizzarro et al. 2014; Blaine et al. 2020; Love et al. 2021). Unlike fish associations in the Core Zone's intertidal or subtidal regions, most biotic habitat in the Seaward Zone consists of drift algae or faunal beds. The general trend of increasing size with depth extends into the Seaward Zone, with larger pelagic fauna from deeper or more offshore waters more common in these deeper waters (e.g., Pacific Hake, Salmon Shark).

Blackbelly Eelpout (*Lycodes pacificus*). (J. Tomelleri)

Salish Sea Fish Assemblages: Habitat Associations

Many fishes in the Salish Sea are associated with ubiquitous soft bottom habitats, including habitats with attached biota (Table 6). The soft bottom intertidal assemblage includes the Threespine Stickleback, Plainfin Midshipman, Pacific Sand Lance, and Showy Snailfish. Sand and mud are the principal habitats of all these species except the Pacific Sand Lance, which burrows into sediments ranging from medium sand to fine gravel (Bizzarro et al. 2016). All life stages of these species occur in intertidal waters associated with shorelines, and Pacific Sand Lance and Plainfin Midshipman additionally spawn in these waters. YOY of some deeper-dwelling gadids (e.g., Walleye Pollock, Pacific Tomcod) and flatfishes (e.g., Pacific Sanddab, Speckled Sanddab) often occur in soft bottom intertidal regions, as do juveniles and adults of fishes with similar habitat associations but slightly deeper distributions (e.g., Roughback Sculpin, Sand Sole; e.g., Wingert and Miller 1979; Frierson et al. 2017).

Blacktip Poacher (*Xeneretmus latifrons*). (J Tomelleri)

The species that constitute the soft bottom biotic intertidal assemblage associate with eelgrass, kelp, and other algae (e.g., Surf Smelt, Bay Pipefish) or seagrasses (e.g., English Sole, Starry Flounder, Pacific Staghorn Sculpin; Appendix 6). The five species in the intertidal soft bottom assemblage are also included in the designated subtidal assemblage, with 19 additional species, including eight flatfishes (Table 6). Most of the members of this assemblage primarily utilize sand and mud habitats, but Pacific Sand Lance and Southern Rock Sole are mainly found in sand and gravel (Love 2011; Bizzarro et al. 2016), and the Pacific Sanddab is primarily associated with mud, sand, and gravel (Limbaugh 1955). Pacific Tomcod, Plainfin Midshipman, and Sand Sole occupy vegetated habitats as early juveniles, whereas most other subtidal soft bottom fishes occur on soft bottom habitats throughout their life history, with some moving to slightly larger grain sizes (e.g., Pacific Sand Lance, Northern Rock Sole). The soft bottom biotic subtidal assemblage includes all species in the corresponding intertidal and five additional species (Table 6). Each of these species uses sand and eelgrass habitats, with some additionally incorporating mud (e.g., Bay Goby, English Sole) or kelp (Surf Smelt, Pile Perch; Appendix 6).

Table 6. Salish Sea soft bottom and soft bottom biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Big Skate	*Beringraja binoculata*	A		X	A
Soft Bottom	Threespine Stickleback	*Gasterosteus aculeatus*	A	X	X	
Soft Bottom	Blacktip Poacher	*Xeneretmus latifrons*	A		X	A
Soft Bottom	Plainfin Midshipman	*Porichthys notatus*	A	X	X	A
Soft Bottom	Pacific Sanddab	*Citharichthys sordidus*	A		X	A
Soft Bottom	Speckled Sanddab	*Citharichthys stigmaeus*	A		X	A
Soft Bottom	Sand Sole	*Psettichthys melanostictus*	A		X	A
Soft Bottom	Pacific Tomcod	*Microgadus proximus*	C		X	C
Soft Bottom	Pacific Sand Lance	*Ammodytes personatus*	C	X	X	C
Soft Bottom	Slim Sculpin	*Radulinus asprellus*	C		X	C
Soft Bottom	Northern Spearnose Poacher	*Agnopsis vulsa*	C		X	C
Soft Bottom	Showy Snailfish	*Liparis pulchellus*	C	X	X	C
Soft Bottom	Blackbelly Eelpout	*Lycodes pacificus*	C		X	A
Soft Bottom	Butter Sole	*Iopsetta isolepis*	C		X	C
Soft Bottom	Southern Rock Sole	*Lepidopsetta bilineata*	C		X	C
Soft Bottom	Northern Rock Sole	*Lepidopsetta polyxystra*	C		X	C
Soft Bottom	Slender Sole	*Lyopsetta exilis*	C		X	A
Soft Bottom	Dover Sole	*Microstomus pacificus*	C		X	C
Soft Bottom	Eulachon	*Thaleicthys pacificus*	C		X	C
Soft Bottom	Walleye Pollock	*Gadus chalcogrammus*	C		X	C
Soft Bottom	Roughback Sculpin	*Chitonotus pugetensis*	C		X	C
Soft Bottom	Pygmy Poacher	*Odontopyxis trispinosa*	C		X	C
Soft Bottom	Dwarf Wrymouth	*Cryptacanthodes aleutensis*	C		X	C
Soft Bottom	Longnose Skate	*Beringraja rhina*	R			C
Soft Bottom	Sablefish	*Anoplopoma fimbria*	R			C
Soft Bottom	Bluespotted Poacher	*Xeneretmus triacanthus*	R			C
Soft Bottom	Spiny Fathead	*Dasycottus setiger*	R			C
Soft Bottom	Shortfin Eelpout	*Lycodes brevipes*	R			C
Soft Bottom	Arrowtooth Flounder	*Atherestes stomias*	R			C

Table 6. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Rex Sole	*Glyptocephalus zachirus*	R			C
Soft Bottom	Flathead Sole	*Hippoglossoides elassodon*	R			C
Soft Bottom Biotic	Shiner Perch	*Cymatogaster aggregata*	A		X	C
Soft Bottom Biotic	Pile Perch	*Rhacochilus vacca*	A		X	A
Soft Bottom Biotic	Pacific Staghorn Sculpin	*Leptocottus armatus*	A	X	X	C
Soft Bottom Biotic	English Sole	*Parophrys vetulus*	A	X	X	C
Soft Bottom Biotic	Surf Smelt	*Hypomesus pretiosus*	C	X	X	C
Soft Bottom Biotic	Bay Pipefish	*Syngnathus leptorhynchus*	C	X	X	
Soft Bottom Biotic	Bay Goby	*Lepidogobius lepidus*	C		X	C
Soft Bottom Biotic	Sturgeon Poacher	*Podothecus accipenserinus*	C		X	C
Soft Bottom Biotic	Starry Flounder	*Platichthys stellatus*	C	X	X	C
Soft Bottom Biotic	Pacific Spiny Lumpsucker	*Eumicrotremus orbis*	C		X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Also, there is a strong similarity between the subtidal Core and Seaward soft bottom fish assemblages, with all but one of 23 designated subtidal Core Zone species (Threespine Stickleback) regularly inhabiting the deeper waters of the inner shelf. Eight additional species with mostly deepwater distributions (e.g., Longnose Skate, Arrowtooth Flounder) complete a unique fish species assemblage (Tolimieri and Levin 2006; Blaine et al. 2020). These fishes primarily occur on a combination of mud and sand habitats, with adult Longnose Skates and Arrowtooth Flounder also utilizing gravel and rock seafloors (Bizzarro et al. 2014; Pirtle et al. 2019). The species composition of the soft bottom biotic fish assemblage for the Seaward Zone is identical to that of the subtidal region except for the Bay Pipefish, which is restricted to depths less than or equal to 18 m (Love et al. 1986).

The number of species that constitute the hard bottom nearshore fish assemblages of the Salish Sea is substantially lower than that of corresponding soft bottom assemblages, probably because of more limited habitat availability. However, a greater proportion of early life stages are represented in hard bottom assemblages, especially in the Core Zone (Table 7). Scorpaeniformes (e.g., rockfishes, sculpins) dominate these assemblages at all nearshore depths. The hard bottom intertidal fish assemblage includes all life stages of seven species (excluding rockfishes; Table 7) primarily associated with rock outcrops or pavement and secondarily with a variety of soft bottom or biotic habitats (Appendix 6). The hard bottom biotic intertidal assemblage contains species that mainly inhabit rocky intertidal shorelines with algae and seagrasses (Table 7); however, Scalyhead Sculpin and Longfin Sculpin are also commonly associated with SFMI, such as sea anemones and barnacle beds (Appendix 6).

The designated hard bottom subtidal fish assemblages contain all members of the corresponding intertidal assemblages and three additional species, Copper Rock-

Table 7. Salish Sea hard bottom and hard bottom biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

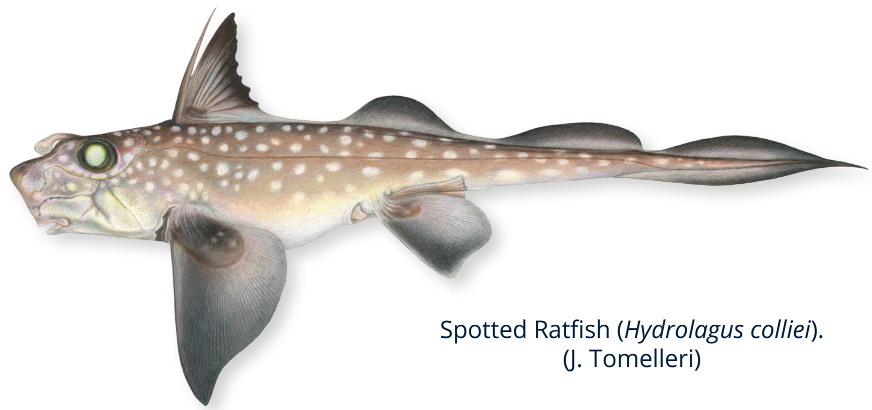
Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom	Copper Rockfish	*Sebastes caurinus*	A		X	A
Hard Bottom	Brown Rockfish	*Sebastes auriculatus*	C		X	C
Hard Bottom	Padded Sculpin	*Artedius fenestralis*	C	X	X	R
Hard Bottom	Cabezon	*Scorpaenichthys marmoratus*	C	X	X	C
Hard Bottom	Canary Rockfish	*Sebastes pinniger*	C		X	C
Hard Bottom	Northern Clingfish	*Gobiesox maendricus*	C	X	X	R
Hard Bottom	Grunt Sculpin	*Rhamphocottus richardsonii*	C	X	X	R
Hard Bottom	Yelloweye Rockfish	*Sebastes ruberrimus*	R			C
Hard Bottom Biotic	Quillback Rockfish	*Sebastes maliger*	A		X	A
Hard Bottom Biotic	Striped Surfperch	*Embiotoca lateralis*	A	X	X	A
Hard Bottom Biotic	Puget Sound Rockfish	*Sebastes emphaeus*	C		X	C
Hard Bottom Biotic	Black Rockfish	*Sebastes melanops*	C	X	X	C
Hard Bottom Biotic	Scalyhead Sculpin	*Artedius harringtoni*	C	X	X	R
Hard Bottom Biotic	Silverspotted Sea Raven	*Blepsias cirrhosus*	C	X	X	R
Hard Bottom Biotic	Sailfin Sea Raven	*Nautichthys oculofasciatus*	C	X	X	R
Hard Bottom Biotic	Crescent Gunnel	*Pholis laeta*	C	X	X	C
Hard Bottom Biotic	Kelp Greenling	*Hexagrammos decagramus*	C	X	X	C
Hard Bottom Biotic	Longfin Sculpin	*Jordania zonope*	C	X	X	C
Hard Bottom Biotic	Rock Prickleback	*Xiphister mucosus*	C	X	X	

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Inner Shelf regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R= rare, and blank = absent.

Yelloweye Rockfish (*Sebastes ruberrimus*). (J. Tomelleri) fish, Brown Rockfish, and Canary Rockfish, which are rare or absent in intertidal waters (Love et al. 2002). Quillback Rockfish and Puget Sound Rockfish, which are absent in intertidal waters, are included in the hard bottom biotic subtidal assemblage (Pacunski et al. 2020; Pietsch and Orr 2019; Lowry et al. 2022). Quillback Rockfish juveniles commonly occupy cloud sponge beds in deeper water than adults, which typically inhabit complex rock habitats with algae, kelps, or seagrasses (Gascon and Miller 1981; Richards 1987; Love 2011; Pacunski et al. 2020), but the Quillback Rockfish adults are also often encountered on deepwater soft bottom habitats in association with isolated boulders, cobble, and other patchy structures with or without biogenic habitat components (Lowry et al. 2022). Puget Sound Rockfishes are found in high-current areas consisting of rocky reefs, boulders, and kelp (Palsson et al. 2009).

The similarity is strong between Core and Seaward Zone hard bottom assemblages, but Seaward Zone assemblages have lower species richness. The Yelloweye Rockfish is strongly associated with high-relief rock seafloors, including boulders (O'Connell and Carlisle 1993; Love 2011; Pacunski et al. 2020) and is included in the hard bottom Seaward assemblage, whereas three species from the corresponding subtidal Core Zone assemblage are omitted (Table 7). The hard bottom biotic Seaward assemblage includes seven of the 11 species that constitute the corresponding subtidal assemblage (Table 7).

Salish Sea assemblages of fishes associated with soft-hard bottoms and habitat generalists exhibit differences among depth zones. All of the common or abundant species in the intertidal zone that utilize soft-hard-bottom seafloor habitats also utilize biotic habitats; therefore, there is no separate soft and hard bottom category for



Spotted Ratfish (*Hydrolagus colliei*).
(J. Tomelleri)

Table 8. Salish Sea soft-hard bottom fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

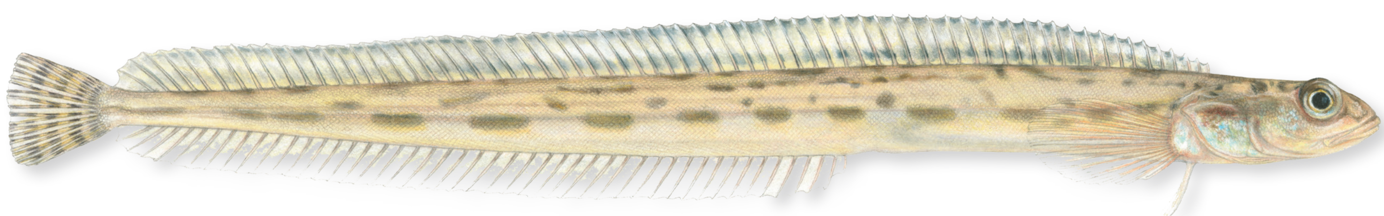
Common Name	Taxon	Core	Intertidal	Subtidal	Seaward
Spotted Ratfish	*Hydrolagus colliei*	C		X	A
Northern Ronquil	*Ronquilis jordani*	C		X	C
Bluntnose Sixgill Shark	*Hexanchus griseus*	C		X	C
White Sturgeon	*Acipenser transmontanus*	C		X	C
Blackeye Goby	*Rhinogobiops nicholsii*	C		X	C
Smooth Alligatorfish	*Anoplagonus inermis*	C		X	C
Marbled Snailfish	*Liparis dennyi*	C		X	C
Slipskin Snailfish	*Liparis fucensis*	C		X	C
Pacific Halibut	*Hippoglossus stenolepis*	C		X	C
Greenstriped Rockfish	*Sebastes elongatus*	R			C
Redstripe Rockfish	*Sebastes proriger*	R			C
Whitebarred Prickleback	*Poroclinus rothrocki*				C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Table 9. Salish Sea habitat generalist fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Taxon	Core	Intertidal	Subtidal	Seaward
Lingcod	*Ophiodon elongatus*	A	X	X	A
Great Sculpin	*Myoxocephalus polyacanthocephalus*	A	X	X	A
Tidepool Sculpin	*Oligocottus maculosus*	A	X	X	
Snake Prickleback	*Lumpenus sagitta*	A		X	A
Spotted Spiny Dogfish	*Squalus suckleyi*	C		X	A
Tubesnout	*Aulorhynchus flavidus*	C		X	C
Whitespotted Greenling	*Hexagrammos stelleri*	C		X	C
Smoothhead Sculpin	*Artedius lateralis*	C	X	X	C
Buffalo Sculpin	*Enophrys bison*	C		X	C
Red Irish Lord	*Hemilepidotus hemilepidotus*	C	X	X	C
Northern Sculpin	*Icelinus borealis*	C		X	C
Penpoint Gunnel	*Apodichthys flavidus*	C	X	X	
Saddleback Gunnel	*Pholis ornata*	C	X	X	C
C-O Sole	*Pleuronichthys coenosus*	C		X	C
Sharpnose Sculpin	*Clinocottus acuticeps*	C	X	X	
Fourhorn Poacher	*Hypsagonus quadricornis*	C		X	C
Tadpole Fathead	*Psychrolutes paradoxus*	C		X	C
Spotted Snailfish	*Liparis callyodon*	C	X	X	C
Ribbon Snailfish	*Liparis cyclopus*	C	X	X	C
Tidepool Snailfish	*Liparis florae*	C	X	X	
High Cockscomb	*Anoplarchus purpurescens*	C	X	X	R
Black Prickleback	*Xiphister atropurpureus*	C	X	X	
Pacific Cod	*Gadus macrocephalus*	R			C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent. Generalist = similar use of soft, hard, and biotic habitats.



Snake Prickleback (*Lumpenus sagitta*). (J. Tomelleri) the intertidal assemblage (Table 8). In subtidal waters, nine common or abundant species primarily utilize a combination of soft and hard habitats (Table 8). They include roaming predators (Spotted Ratfish, Bluntnose Sixgill Shark, White Sturgeon, Pacific Halibut) that forage among different habitat types (McCabe et al. 1983; Ebert 2003; Hurst et al. 2007) and small-bodied, benthic species (e.g., Blackeye Goby, Smooth Alligatorfish, Marbled Snailfish; Table 8). Most of these larger, predatory species utilize a suite of soft and hard bottom habitats, whereas Pacific Halibut primarily inhabit soft sediments and cobble seafloors (Appendix 6; Nielson et al. 2014).

By contrast, the smaller benthic species primarily occupy a variety of soft sediment habitats and rock pavement seafloors (Love 2011; Pietsch and Orr 2019). Three species (Greenstriped Rockfish, Redstripe Rockfish, Whitebarred Prickleback) that are uncommon or absent at subtidal Core Zone depths are included in the soft-hard-bottom Seaward assemblage. Greenstriped Rockfish use a suite of non-biotic seafloor types evenly, whereas the Redstripe Rockfish is primarily associated with gravel, cobble, boulder, and rocky reef environments (Love et al. 2002; Palsson et al. 2009; Blaine et al. 2020). The Whitebarred Prickleback primarily inhabits rock seafloors or shell hash (Love 2011; Pietsch and Orr 2019). In addition, the Spotted Ratfish, which is a member of this assemblage, is the most abundant fish by biomass in the Salish Sea and is extremely common in the Seaward Zone (Reum and Essington 2011; Blaine et al. 2020).

Slender Sole (*Lyopsetta exilis*). (J. Tomelleri)

Habitat generalists are the most common of the designated intertidal fish assemblages in the Salish Sea and are mainly represented by scorpionfishes (e.g., sculpin, snailfishes; Table 9). The habitat generalist assemblage in subtidal waters contains 22 species, including all those in the intertidal assemblage (Table 9). All these species primarily use sand, rock, and eelgrass habitats with the exception of the Snake Prickleback, which commonly uses cobble but has not been associated with other rock types, and the Fourhorn Poacher, which is found with sponges, hydroids, and other SFMI (Love 2011; Pietsch and Orr 2019). The assemblage structure of habitat generalists in the Seaward Zone differs somewhat from those in the subtidal portion of the Core Zone. Five small benthic species that are at least relatively common in intertidal and subtidal waters of the Core Zone are absent in the deeper waters of the inner shelf (Table 9). Pacific Cod is the only novel habitat generalist in the Seaward assemblage. It uses primarily mud, sand, and cobble habitats, as well as both vegetated bottoms and SFMI (Love 2011; Ottmar and Hurst 2012; Blaine et al. 2020; Appendix 6).

Pelagic fish assemblages exhibit strong similarity across depth zones. The intertidal assemblage is mainly represented by the early juvenile life stages of out-migrating or resident salmon (e.g., Chinook Salmon, Coho Salmon); euryhaline trouts (e.g., Cutthroat Trout, Dolly Varden; Olson et al. 2008; Shaffer et al. 2009); and a diversity of forage fishes (Table 10). Juvenile salmonids can be quite common in intertidal waters of the Salish Sea, especially during summer months in Puget Sound (Toft et al. 2007), with species composition reflecting a combination of local abundance and the seasonality of juvenile migrations from both natural and hatchery sources (Olson et al. 2008). Adult Pacific Herring spawn on marine vegetation and rocks from the intertidal to approximately 20 m (Stick and Lindquist 2009; Stick et al. 2014; Sandell et al. 2019). YOY are sometimes retained in intertidal waters (Scattergood 1959; Love 2011). Surf Smelt and Shiner Perch utilize intertidal areas for spawning on a seasonal basis but are also found here in reduced numbers throughout the year. Additionally, although Longfin Smelt spawn in freshwater, juveniles and adults commonly occupy the surf zone (Matarese et al. 1989). One additional species (Northern Anchovy) that rarely ventures into intertidal waters is included with that assemblage to form the subtidal pelagic assemblage. The occurrence of anchovy, a

Table 10. Salish Sea pelagic fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Taxon	Core	Intertidal	Subtidal	Seaward
Pacific Herring	*Clupea pallasii*	A	X	X	A
Cutthroat Trout	*Oncorhynchus clarkii*	C	X	X	C
Pink Salmon	*Oncorhynchus gorbuscha*	C	X	X	C
Chum Salmon	*Oncorhynchus keta*	C	X	X	C
Coho Salmon	*Oncorhynchus kisuch*	C	X	X	C
Steelhead	*Oncorhynchus mykiss*	C	X	X	C
Sockeye Salmon	*Oncorhynchus nerka*	C	X	X	C
Chinook Salmon	*Oncorhynchus tshawytscha*	C	X	X	C
Dolly Varden	*Salvelinus malma*	C	X	X	C
Northern Anchovy	*Engaulis mordax*	C	X	X	C
Longfin Smelt	*Spirinchus thaleichthys*	C	X	X	C
Bull Trout	*Salvelinus confluentus*	C	X	X	C
Pacific Lamprey	*Entosphenus tridentatus*	R		X	C
Salmon Shark	*Lamna ditropis*	R		X	C
Pacific Hake	*Merluccius productus*	R		X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Inner Shelf regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R= rare, and blank = absent.

primarily southern distributed species, is temporally variable; however, it has a high local abundance associated with warm water years and a persistent presence in some subregions (especially South Puget Sound; Duguid et al. 2019).

Each species in this assemblage is more abundant in the deeper subtidal zone, where the waters are less turbulent, and the pelagic zone is spatially distinct from the benthos (Love 2011). Pacific Herring populations in subtidal and inner continental shelf waters of Puget Sound have declined during the last 40 years, likely because of coastal development and overharvesting (Stick and Lindquist 2009; Stick et al. 2014; Greene et al. 2015; SSPHAMST, 2018; Sandell et al. 2019). The pelagic assemblage in Seaward waters represents a further expansion of the subtidal pelagic assemblage to include three species with deeper distributions (Table 10). Pacific Lamprey can be found to bottom depths greater than 1,500 m and occur throughout the water column (Hoff and Britt 2003). Its abundance has declined substantially throughout its range, including its distribution in the Salish Sea (Pietsch and Orr 2019), possibly because of declining host availability and increasing host contamination (Clemens et al. 2019). Salmon Sharks are relatively uncommon beyond the oceanic waters of the Strait of Juan de Fuca and the Strait of Georgia, but they are abundant in these regions, where they often inhabit nearshore waters (Pietsch and Orr 2019). The Pacific Hake once was extremely abundant in the waters of the Salish Sea but has declined precipitously in recent years, even after a nearly 30-year fishery closure, and is currently listed as a federal species of con-

Pacific Lamprey (*Entosphenus tridentatus*). (J. Tomelleri) cern in Puget Sound (Chittaro et al. 2013; Pietsch and Orr 2019). The local population appears to be mainly self-seeded, and net losses through emigration may be confounding recovery (Chittaro et al. 2013).

Selected Marine Invertebrates

In contrast to the ichthyofauna, the marine macroinvertebrates of the Salish Sea are poorly documented. The total number of macroinvertebrate species has been conservatively estimated at 3,000, but no local species list exists (Harbo 2014; Pietsch and Orr 2019). However, most of the selected invertebrates (Table 2) are well studied in the Salish Sea.

The selected invertebrate species of the Salish Sea consist of several ecologically important intertidal and subtidal species and support a variety of recreational and commercial fisheries. Sea urchins, burrowing shrimps, predatory sea stars, and octopuses are important ecosystem species because they influence community structure through habitat alteration and top-down effects (see Table 11 for species list). Geoduck, California Market Squid, Dungeness Crab, Spot Prawn, California Sea Cucumber, Green Sea Urchin, and Red Sea Urchin are commercially harvested in Salish Sea waters. Because of its high productivity and a general tendency of marine organisms to reach larger sizes at high latitudes, several of the selected invertebrate species reach their range-wide maximum sizes in the Salish Sea and associated outer coast (e.g., Olympia Oyster, Sunflower Sea Star, Red Sea Urchin). The great majority of the selected invertebrates are primarily distributed in intertidal or subtidal waters of the Core Zone (Table 11); however, the California Market Squid mainly occurs in the Seaward Zone, and the Spot Prawn is most abundant in deeper regions (> 100 m). Although most of the selected invertebrate species are commonly encountered, the Pinto Abalone is endangered in Washington; the Olympia Oyster is a candidate for state listing as endangered, threatened, or sensitive (WDFW 2020); and the Sunflower Sea Star has experienced substantial regional declines in recent years. In 2020, it was placed on the Red List of the International Union for Conservation of Nature (IUCN) as critically endangered (Gravem et al. 2021) and was proposed for federal listing in 2021, with a decision on listing status scheduled for 2022 (86 FR 73230).

Specific biological and fisheries information was available for several of the selected invertebrate species in the Salish Sea Ecoregion. The Geoduck is one of the most abundant species in the Salish Sea in terms of biomass (Harvey et al. 2010), with an average of 1.66 (wild) clams/m^2 reported within their ideal depth range and habitats in Puget Sound (Goodwin and Pease 1991). Geoduck aquaculture was developed in the early 1990s to augment productive commercial harvests in subtidal areas and has since increased dramatically (Reum et al. 2015). Geoducks are now farmed throughout the Salish Sea, especially in southern Puget Sound, because of its expansive soft-sediment beaches (Brown and Thuesen 2011). Around 11 million pounds (4.99 million kg; 85%–90% of harvest) of farmed and wild Geoduck are exported annually from Washington State.

The Olympia Oyster commonly reaches its maximum size (> 5 cm shell length) in the Salish Sea. The species once covered an estimated 130,265 ha of intertidal area in the ecoregion. Currently, its population is less than 4% of historic numbers. Declines in Salish Sea populations are generally attributed to habitat loss, overharvesting, and water pollution (Toft and Peabody 2021). Currently, there are efforts to recover the species, including seed production, outplanting, and habitat improvement (Blake and Bradbury 2012; Grossman et al. 2020; Toft and Peabody 2021), as well as research into larval transport and other factors affecting restoration success (Becker et al. 2020; Grossman et al. 2020).

Despite a fishery closure in 1994, Pinto Abalone populations declined by 97% in the San Juan Archipelago between 1992 and 2017 (Carson et al. 2019), in large part from illegal poaching. Furthermore, a lack of recent recruitment in the Salish Sea appears to indicate reproductive failure due to low population densities (Rothaus et al. 2008; Carson et al. 2019). Current populations in the Salish Sea appear to be below the density necessary for successful spawning. Still, efforts to restore Pinto Abalone in the Salish Sea include captive breeding and the outplanting of juveniles (Carson et al. 2019).

The California Market Squid is the most common squid species in the Salish Sea and supports a popular recreational fishery. Adults can be found throughout the region for the duration of their four- to nine-month lifespan, typically from May to February. Its movement patterns within the Salish Sea are not well understood.

Like many other loliginid squids, the California Market Squid deposits egg cases on the seafloor. The Giant Pacific Octopus occupies shallower waters at the northern end of its range and is common to at least 45 m depth in Puget Sound (Heery et al. 2018; Blaine et al. 2020). The Ghost Shrimp is of particular importance in the Salish Sea to a small population of Gray Whales, commonly referred to as the "Sounders." These dozen or so whales enter the Salish Sea in the spring and feed on Ghost Shrimp in relatively shallow areas (Calambokidis et al. 2016).

Table 11. Occurrence of selected invertebrates in the Salish Sea Ecoregion among nearshore zones and established coastal regions.

	Core		Seaward
Higher Taxon/Species	**Intertidal**	**Subtidal**	**Inner Shelf**
MOLLUSCA			
Geoduck (*Panopea generosa*)	Secondary	Primary	Tertiary
Olympia Oyster (*Ostrea lurida*)	Primary	Secondary	Tertiary
Pinto Abalone (*Haliotis kamtschatkana*)	Primary	Primary	Absent
California Market Squid (*Doryteuthis opalescens*)	Absent	Secondary	Primary
Giant Pacific Octopus (*Enteroctopus dofleini*)	Secondary	Primary	Secondary
Red Octopus (*Octopus rubescens*)	Primary	Secondary	Tertiary
CRUSTACEA			
Spot Prawn (*Pandalus platyceros*)	Absent	Tertiary	Secondary
Ghost Shrimp (*Neotrypaea californiensis*)	Primary	Secondary	Absent
Mud Shrimp (*Upogebia pugettensis*)	Primary	Secondary	Absent
Dungeness Crab (*Metacarcinus magister*)	Primary	Primary	Primary
Red Rock Crab (*Cancer productus*)	Primary	Primary	Primary
ECHINODERMATA			
Ochre Sea Star (*Pisaster ochraceus*)	Primary	Primary	Absent
Sunflower Sea Star (*Pycnopodia helianthoides*)	Secondary	Primary	Secondary
California Sea Cucumber (*Parastichopus californicus*)	Secondary	Primary	Primary
Green Sea Urchin (*Strongylocentrotus droebachiensis*)	Secondary	Primary	Secondary
Purple Sea Urchin (*Strongylocentrotus purpuratus*)	Primary	Primary	Secondary
Red Sea Urchin (*Mesocentrotus franciscanus*)	Tertiary	Primary	Secondary

Note. When possible, regional depth distributions were used. The primary depth distribution of the Spot Prawn is > 100 m. Intertidal = Splash Zone to MLLW, Subtidal = MLLW to 30 m, and Inner Shelf = 30–100 m. Black = primary depth range, dark gray with vertical hatch marks = secondary depth range, light gray with diagonal hatch marks = tertiary depth range, and white = absent. All utilized citations are provided in the text.

Low tide, Cascade Head Marine Reserve, Oregon, 07/02/2019. (ODFW)

PACIFIC NORTHWEST MARINE ECOREGION

Distribution and Abundance of CMECS Habitat Types Among Nearshore Zones

The Pacific Northwest Marine Ecoregion extends from Cape Flattery at the mouth of the Strait of Juan de Fuca in Washington to Cape Mendocino in Northern California, including all of the outer coast of Washington and Oregon (Fig. 2). The total area of the ecoregion within PMEP's Scope Boundary is approximately 3.1 million ha. The Seaward Zone and Outer Shelf are approximately equal in size, and the Core Zone is much smaller (Table 12). The Core Zone off Washington, Oregon, and Northern California largely parallels the coast in a strip that extends less than 13 km offshore (Fig. 10). The great majority of the Core Zone (92%) is in state waters; however, only 20% of the Seaward Zone and less than 1% of the Outer Shelf Zone occur in state waters. Seaward Zone waters reach far offshore (to ~38 km) off Washington and Northern California but are more variable off Oregon. The latter waters are located more than 50 km offshore of the central coast in association with Hecate Bank but less than 3 km offshore in parts of southern Oregon (Fig. 10).

Habitat Data Source Summary

For the Pacific Northwest, we compiled existing seafloor substrate and sediment data from five sources (Appendix 4, region PNW). The majority of this region's substrate data, particularly for Washington and Oregon, was incorporated from the Essential Fish Habitat Surficial Geologic Habitat (EFH SGH) dataset. EFH SGH is a composite of datasets delineating geological seafloor characteristics of the continental margin of the U.S. West Coast adjacent to Washington, Oregon, and California (Dataset 3 in Appendix 4). The Pacific Northwest portion of the dataset (north of Fort Bragg) depicts seafloor substrate types as interpreted from a multitude of seafloor mapping surveys, including multibeam sonar, side-scan sonar, sediment grab samples, cores samples, seismic reflection profiles, and still or video images. It is of moderate quality since the source data quality varies. These data were further examined and interpreted by a geologist, and source habitat types were crosswalked into CMECS.

In the northern portion of Washington, the Olympic Coast Sanctuary Seafloor Mapping data were used in place of the EFH SGH data, as they provided more recent and additional details to the area (Dataset 25 in Appendix 4). These data were developed in 2016 as part of the Olympic Coast Intergovernmental Policy Council Habitat Framework for ecosystem-based management planning (Goodwin et al. 2016). Another dataset incorporated along the Oregon coast is a modeled substrate dataset, which was developed using ShoreZone and aerial imagery for the Oregon Coastal Management (Dataset 11 in Appendix 4). These data exist within the intertidal zone, so they filled a gap in the EFH SGH dataset. For California's state waters, benthic substrate data developed by the Institute of Marine Sciences, University of Cal-

Table 12. Total area and relative percentage of CMECS Aquatic Setting types in PMEP Scope Boundary within the nearshore zones of the Pacific Northwest.

Nearshore Zone		CMECS Aquatic Setting	Area (ha)	Area (%)
Core Zone		3.1 Marine Nearshore	386,568	12.5%
	Subtotal		**386,568**	**12.5%**
Seaward Zone		3.2 Marine Offshore	1,354,155	44.0%
	Subtotal		**1,354,155**	**44.0%**
Outer Shelf		3.3 Oceanic	1,390,503	45.1%
	Subtotal		**1,390,503**	**45.1%**
	Total		**3,131,226**	**100.0%**

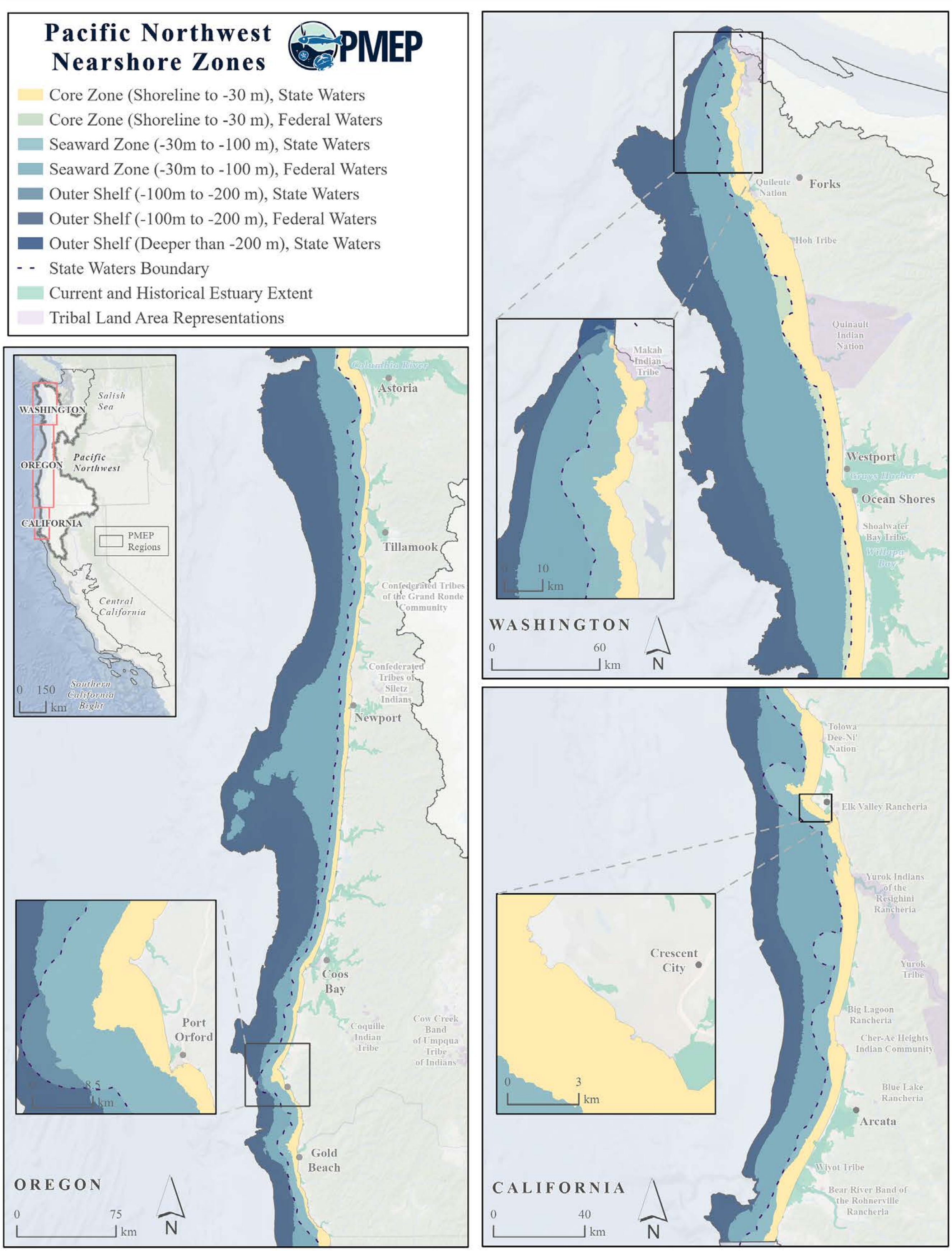
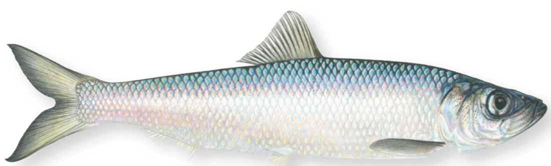


Figure 10. Distribution of nearshore zones and adjacent offshore and inshore regions in the Pacific Northwest Ecoregion.

ifornia, Santa Cruz (UCSC) for the California Coastal and Seafloor Mapping project were used (Dataset 12 in Appendix 4). The benthic substrate classifications provided by this dataset were not derived through traditional geologic interpretations. Instead, they were algorithmically defined using seafloor roughness (rugosity analysis) as a proxy for determining areas likely to consist of rocky reefs with significant relief and sandy bottoms with lower relief. This dataset is of high quality since it comes from high-resolution data and classifies substrate habitat into two categories: rock and sediment. The fourth dataset from the same source is based on a modeled *white zone* (areas generally shallower than 10 m that are dominated by wave action), which includes a predicted portion of rock that occurs within the shallow nearshore areas that could not be surveyed using boat-based methods. The models are based on NOAA's Environmental Sensitivity Index shoreline (Dataset 13 in Appendix 4).



Pacific Herring (*Clupea pallasii*). (J. Tomelleri)

We compiled biotic habitat datasets from six sources. The majority of biotic habitat data along the coast were for kelp and came from BOEM, California Department of Fish and Wildlife (CDFW), and WADNR (Datasets 18, 19, & 23 in Appendix 4). Additional kelp observations from 2015–2016 from CDFW and WADNR were available and incorporated into the CMECS biotic dataset. The 1912 historical kelp dataset was also used (Dataset 1 in Appendix 4). Faunal bed extent data came from the WDFW Puget Sound Environmental Atlas (Dataset 10 in Appendix 4), and NWI documented macroalgae beds along the coast (Dataset 4 in Appendix 4).

Core Zone

Most of the classified substrate in Core Zone waters off the Pacific Northwest is composed of fine unconsolidated sediment. Among these sediments, sand is dominant (60.9%), with fine sand contributing 9.0% of the total and other fine unconsolidated substrates mapped in minor proportions (Table 13). Fine unconsolidated substrate is extensively mapped throughout the Pacific Northwest. However, Northern California's state waters contain most of the mapped unconsolidated mineral substrate designated in the ecoregion, which was not classified into more specific categories (either fine or coarse categories) by the data source (Fig. 11, see the Data Gaps and Considerations section). Rock substrate is relatively uncommon (8.0%), is mainly associated with the northern coast of Washington, and is found sporadically throughout the Oregon Core Zone (Fig. 11). Only trivial amounts of coarse unconsolidated, organic, and anthropogenic substrates were designated in Core Zone waters of the Pacific Northwest Ecoregion.

Bat Ray (*Myliobatis californica*) in soft bottom habitat. (A. Obaza, Paua Marine Research Group)

Table 13. Total area and relative percentage of CMECS substrate types in the Core and Seaward Zones of the Pacific Northwest.

CMECS Substrate Category	Substrate Details	Core Zone Area (ha)	Core Zone Area (%)	Seaward Zone Area (ha)	Seaward Zone Area (%)
Rock substrate	Bedrock	25,617	6.63	76,505	5.65
	Unclassified	5,358	1.39	2,176	0.16
	Subtotal	**30,976**	**8.01**	**78,680**	**5.81**
Unconsolidated mineral substrate	Unclassified	**69,812**	**18.06**	**57,090**	**4.22**
Coarse unconsolidated substrate	Boulder	255	0.07	37	0.00
	Cobble	2,385	0.62	3,576	0.26
	Gravel	1,460	0.38	6,566	0.48
	Gravel mixes	975	0.25	22,631	1.67
	Sandy gravel	0	0.00	0	0.00
	Muddy Sandy Gravel	150	0.04	1,249	0.09
	Gravelly Sand	0	0.00	0	0.00
	Unclassified	27	0.01	0	0.00
	Subtotal	**5,251**	**1.36**	**34,058**	**2.52**
Fine unconsolidated substrate	Slightly Gravelly Sand	0	0.00	293	0.02
	Slightly gravelly muddy sand	336	0.09	896	0.07
	Slightly Gravelly Mud	0	0.00	109	0.01
	Sand	235,361	60.88	662,155	48.90
	Coarse Sand	76	0.02	4,514	0.33
	Medium Sand	2,070	0.54	69,126	5.10
	Fine Sand	34,965	9.04	44,773	3.31
	Muddy sand	1,226	0.32	140,913	10.41
	Sandy mud	151	0.04	5,503	0.41
	Mud	375	0.10	255,944	18.90
	Unclassified	5,216	1.35	0	0.00
	Subtotal	**279,775**	**72.37**	**1,184,226**	**87.45**
Biogenic substrate	Shell Hash	268	0.07	105	0.01
	Very Coarse Woody Debris	0	0.00	0	0.00
	Subtotal	**269**	**0.07**	**105**	**0.01**
Anthropogenic substrate	Anthropogenic rock rubble	10	0.00	0	0.00
	Subtotal	**10**	**0.00**	**0**	**0.00**
Unclassified	Unclassified	**474**	**0.12**	**1**	**0.00**
	Total	**386,568**	**100.00**	**1,354,160**	**100.00**

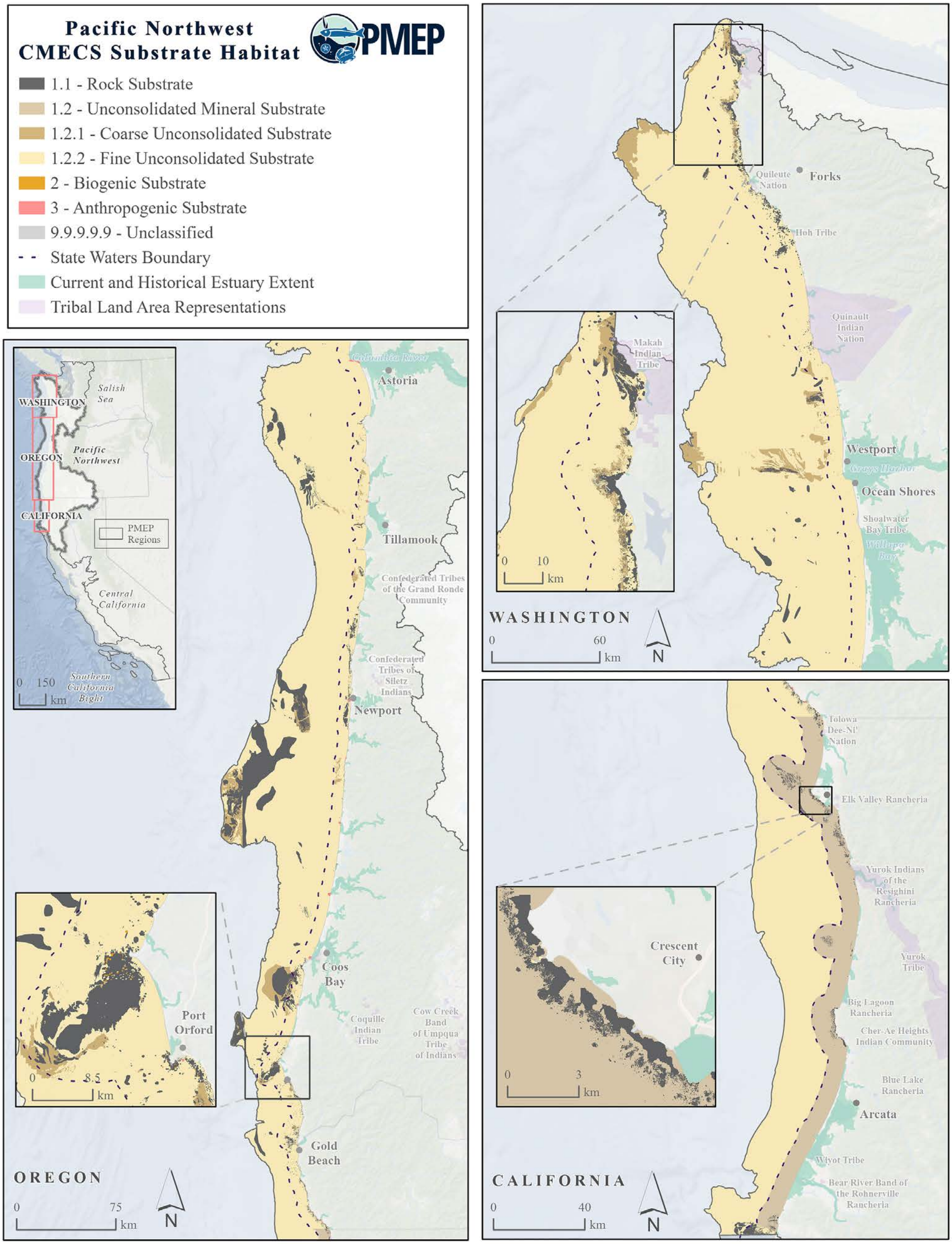


Figure 11. Distribution of CMECS substrate habitats in the Pacific Northwest Ecoregion.

Table 14. Total estimated mapped area based on the maximum observed extent of a habitat type, relative percentage of total zone area, and data completeness status for each CMECS biotic category off the Pacific Northwest.

Biotic Category	CMECS Habitat Details (Group)	Core Zone		Seaward Zone		Spatial Data Completeness
		Area (ha)	Area (%)	Area (ha)	Area (%)	
2 - Benthic / Attached Biota		6,935	1.8%	75	0.0%	Limited or incomplete mapping
2.2 - Faunal Bed		1,011	0.3%	12	0.0%	Limited or incomplete mapping
2.5 - Aquatic Vegetation Bed		6,265	1.6%	0	0.0%	Limited or incomplete mapping
Benthic Macroalgae	2.5.1.2 - Canopy-Forming Algal Bed (Kelp)	5,852	1.5%	67	0.0%	Region-wide mapping
	2.5.1 - Other (Unclassified)	413	0.1%	0	0.0%	Limited or incomplete mapping
Aquatic Vascular Vegetation	2.5.2 - Seagrass Bed	0	0.0%	0	0.0%	No data
	Total Zone Area	**386,568**		**1,354,155**		

Note. Because they are more specific, subcategories may have a greater amount of mapped area than more generalized categories in which they are contained. The biotic area estimates are limited by data availability; certain biotic datasets have more extensive and complete habitat mapping than others and are ranked for data completeness using the following categories:

- **No data**: No spatial-extent data were available
- **Limited or incomplete mapping**: Mapping of habitat is limited in scope and is known to be an insufficient estimate of area
- **Local or subregion-level mapping**: Mapping efforts exist at the local/subregion scale, and the regional area calculation is likely an underestimate
- **Region-wide mapping**: Mapping efforts exist across the region and provide a coarse estimate of area

Most of the Core Zone water of the Pacific Northwest Ecoregion is unclassified with respect to biotic habitat (98.2%). Among classified biotic habitats, the *aquatic vegetation beds* category contributes to an estimated 1.6% and consists mainly of canopy-forming kelp beds distributed along the coastal regions of each state (Table 14, Fig. 12). The kelp bed data are mapped per the maximum observed extent from past surveys, but there have been recent declines in kelp beds in some parts of the ecoregion. Trivial amounts of faunal bed and some unclassified benthic/attached biota categories were mapped. There were no data showing the full extent of seagrasses in the region (Table 14).

Seaward Zone

The great majority (87.5%) of the classified substrate off the Pacific Northwest consists of fine unconsolidated sediment. Sand (48.9%) and mud (18.9%) are this category's most commonly documented substrate types, with a much greater proportion of mud and less sand represented in the Core Zone (Table 13). A relatively small proportion of coarse unconsolidated substrate (2.5%), mainly including gravel-based sediment types, was mapped in this ecoregion's Seaward Zone. Rock substrate, as in the Core Zone, was rarely documented (5.8%). Rock was mapped mainly in offshore banks and reefs in Oregon waters and, to a lesser extent, sporadically through the Seaward Zone of Washington (Fig. 11). Unconsolidated mineral substrate contributes an estimated 4.2% to the total area of the Seaward Zone. This substrate type is unclassified and largely occurs off Northern California (Fig. 11). Trivial amounts of biogenic substrate and no anthropogenic substrate were documented in the Seaward Zone (Table 13).

Except for faunal beds and aquatic vegetation beds, which were each documented in negligible amounts (< 0.01%), biotic habitats were unclassified throughout the entire Seaward portion of the Pacific Northwest Ecoregion (Table 14, Fig. 12).

Landward Zone

The Landward Zone of the Pacific Northwest Ecoregion contains a diverse assortment of habitat types and morphologies, with a mixture of marine terraces, sand dunes, and rock outcrops. This ecoregion's coastline is incised by numerous rivers and streams, as well as estuaries, lagoons, and embayments. Most of the coastline is exposed. Wave energy, storm impacts, and freshwater runoff, especially during winter months, can mobilize unconsolidated sediments and dramatically alter beach structure and composition (Ruggiero et al. 2013). Approximately 80 riverine estuaries empty into the Pacific Northwest Ecoregion, ranging in size from less than 0.5 ha to more than 46,000 hectares in association with the Columbia River (Vander Schaaf et al. 2013; Brophy et al. 2019). Most of the beaches are fine- to medium-grained sand, coarse-grained sand, gravel, or a mixture of these sediment types. Physical disturbance of sandy beaches may alter substrate type and negatively impact wildlife in Oregon (Shelby and Tokarczyx 2002).

Pacific Sand Lance (*Ammodytes personatus*). (J. Tomelleri)

Rocky shorelines are mainly found off northern Washington and through Oregon but are rarely encountered off Northern California. Exposed rocky cliffs are also well represented, but sheltered rocky shores are rare and mainly restricted to bays and estuaries. Coastal marshes and tidal flats are commonly found in association with the bays and estuaries of this ecoregion. In addition, many areas have been modified by shoreline armoring or dredging to maintain port and marine facilities (Vander Schaaf et al. 2006).

Algae at low tide, Cascade Head Marine Reserve, 07/02/2019. (ODFW)

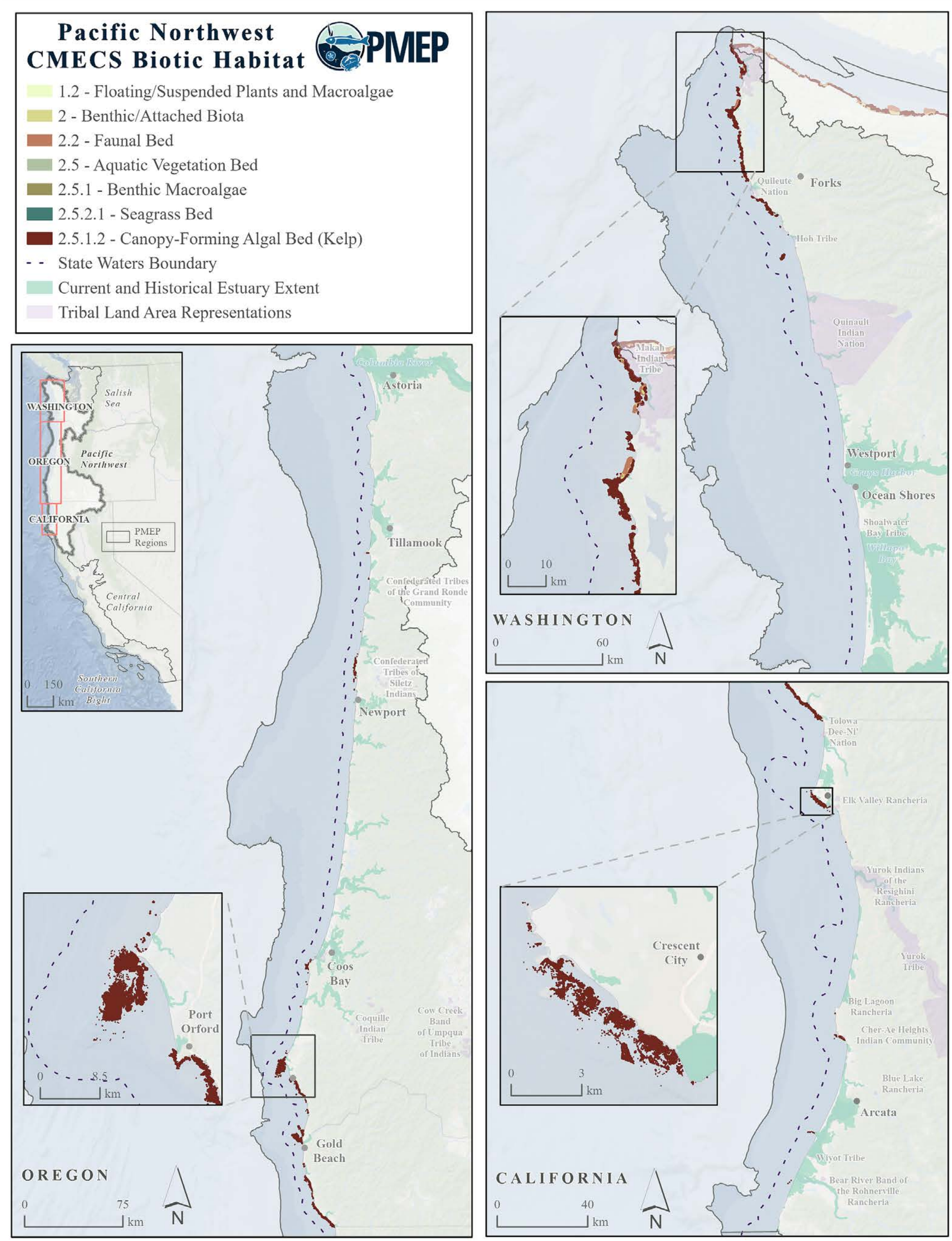
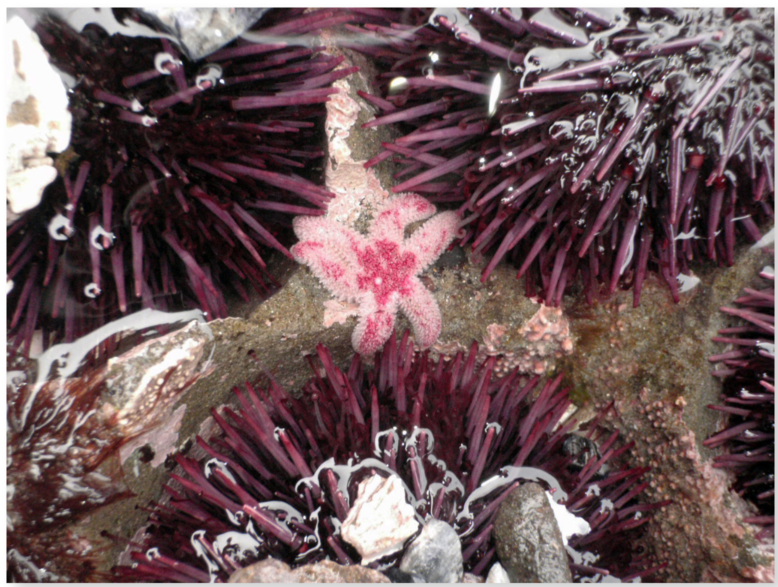


Figure 12. Distribution of CMECS biotic habitats in the Pacific Northwest Ecoregion.

RECENT DISRUPTION OF ECOLOGICAL INTERACTIONS AMONG ROCKY REEF COMMUNITIES

by Steve Rumrill, Oregon Department of Fish and Wildlife

The nearshore ocean has undergone recent changes along the Pacific Northwest coast, and the shift in ocean conditions has been coupled with broadscale impacts to marine habitats and interactions among members of ecological communities. For example, the Pacific Northwest Marine Ecoregion was bathed in the unprecedented coast-wide mass of warm ocean waters that extended from Alaska to Mexico (2014–2016; aka "the Blob"). Major components of the marine ecosystem were affected by the massive marine heatwave, including the productivity of phytoplankton, development of harmful algal blooms, formation of hypoxic marine waters, and disruption of the complex trophic relationships in a diversity of marine habitats. It is widely recognized that these warmer ocean waters stimulated the largest harmful algal bloom ever recorded along the Pacific coast, resulting in seasonal shutdowns of commercial and recreationally valuable Dungeness Crab (*Metacarcinus magister*) and Razor Clam (*Siliqua patula*) fisheries along the open coast and sandy beaches. It is less known, however, that the shift in ocean conditions was also associated with an unprecedented perturbation of ecological communities that inhabit nearshore rocky reef areas, characterized by kelp, seaweeds, sea stars, and sea urchins.



Urchins and juvenile sea star, 05/15/2018. (ODFW)

The mass mortality of several species of sea stars (Asteroidea: Echinodermata) has been attributed to Sea Star Wasting Disease in the Pacific Northwest from 2014 to the present. It is thought that the disease was initially caused by an infectious virus or exacerbated by decreased availability of dissolved oxygen at the surface of the asteroid epidermis. Regardless of the proximal cause of death, it is now recognized that Sea Star Wasting Disease resulted in the functional extinction of an important keystone predator. Populations of the Sunflower Sea Star (*Pycnopodia helianthoides*) declined precipitously in the shallow subtidal zone, and NOAA Fisheries is currently considering their designation as a threatened or endangered species.

The elimination of predatory sea stars disrupted trophic relationships within rocky reef habitats and contributed to a complex cascade of impacts to marine benthic communities. Purple Sea Urchins (*Strongylocentrotus purpuratus*) increased dramatically in abundance in many locations. At the same time, several iconic species—such as Red Sea Urchins (*Mesocentrotus franciscanus*), Red Abalone (*Haliotis rufescens*), and Pinto Abalone (*H. kamtschatkana*)—exhibited unusual decreases in abundance. Moreover, in most cases, the shifts in these species are linked with concurrent and widespread reductions in the spatial extent of Bull Kelp beds (*Nereocystis luetkeana*). The demise of Sunflower Sea Stars is thought to be coupled directly or indirectly to substantial increases in Purple Sea

Urchins and the overgrazing of macroalgae, eliminating kelp and understory seaweeds entirely from some areas. For example, the Purple Sea Urchin population at a single reef in Oregon (Orford Reef, which formerly supported an extensive kelp habitat) increased 10,000-fold, from approximately 35,000 to 350 million animals, in less than five years. At the same time, the reef saw an approximately 90% reduction in the spatial extent of Bull Kelp.

Increased densities of Purple Sea Urchins and the concurrent decline in kelp and other macroalgae are considered an alternative stable state for the kelp ecosystem. Taken together, the magnitude of ecological changes to Bull Kelp bed habitat and the dependent community of marine invertebrates and fishes is unprecedented in recorded history. Limited observations hamper a detailed understanding of the impacts to marine benthic communities, and the spatial extent and resilience of these iconic species and their habitats are currently unknown.

Quillback Rockfish (*Sebastes maliger*). (J. Tomelleri)

Fish Fauna, Fish Assemblages, and Selected Invertebrates: Summary Points

The primary nearshore ichthyofauna of the Pacific Northwest is species rich, comprising 314 species among 27 orders and 85 families. It is dominated by scorpionfishes (Scorpaeniformes, 142 species), especially rockfishes and thornyheads (Scorpaenidae, 52 species) and marine sculpins (Psychrolutidae, 32 species).

Species richness is comparable among Pacific Northwest subregions (i.e., Cape Lookout to Cape Blanco = 294, Point Grenville to Cape Lookout = 286) and depth zones (Core Zone = 288 total, 101 common or abundant; Seaward Zone = 280 total, 89 common or abundant).

The number of common and abundant fishes among Pacific Northwest assemblages in the Core Zone is greatest in the subtidal area (n = 101) but similar in the intertidal area (n = 91) and lower in the Seaward Zone (n = 89).

Three selected invertebrate fauna of the Pacific Northwest and the Salish Sea are similar in composition. Unique Pacific Northwest species (i.e., Razor Clam, Siliqua patula; Red Abalone, Haliotis rufescens; Pacific Sand Crab, Emerita analoga) are associated with high-energy shorelines that are largely absent in the Salish Sea.

Pinto Abalone is listed as a state endangered species in Washington and has also declined precipitously in Northern California.

Red Abalone populations off the Pacific Northwest have suffered severe recent declines because of the Withering Syndrome associated with ocean warming and loss of kelp habitat, but they are not considered to be state or federally endangered.

Ecological shifts, driven by environmental changes and dramatic decreases in predatory sea stars due to Sea Star Wasting Disease, have resulted in an increase in Purple Sea Urchins along the Oregon and Northern California coasts.

Pacific Northwest Ichthyofaunal Characteristics and Fish Assemblages

Pacific Northwest Ichthyofauna

The established nearshore ichthyofauna of the Pacific Northwest's outer coast consists of an estimated 314 species among 27 orders and 85 families (Appendix 7). The most diverse taxa are Scorpaeniformes (scorpionfishes, 142 species), Scorpaenidae (rockfishes and thornyheads, 52 species), and Psychrolutidae (marine sculpins, 32 species). Species richness off the Pacific Northwest coast also includes a number of elasmobranch species (sharks, skates, and rays) and a more taxonomically diversified ichthyofauna in nearshore regions (Appendices 5 & 7). The great majority of established nearshore fishes in this ecoregion have solely marine distributions (90.8%); however, 19 are anadromous (6.1%), including nine salmonids, and 10 also occur in freshwater (3.1%; e.g., Arrow Goby, Prickly Sculpin; Appendix 8). Most of the nearshore ichthyofauna is exclusively or primarily benthic or demersal (82.7%), whereas 12.1% are pelagic, and 5.4% occur throughout the water column (Appendix 8). Four introduced species (American Shad, Threadfin Shad, Rainwater Killifish, Striped Bass) are included in the Pacific Northwest ichthyofauna.

The marine environment off the Pacific Northwest is highly dynamic and energetic, with steep offshore depth gradients and an extensive amount of tidepool habitat. Freshwater influence along the outer coast varies with the Columbia River plume, creating offshore salinity and nutrient gradients over large parts of the ocean. Many other coastal rivers also influence salinity and turbidity in the winter months. The northern extent of the Pacific Northwest Ecoregion is located at a divergence in the eastward-flowing North Pacific Current, which bifurcates to create the northern-flowing Alaska Current and the southern-flowing California Current. This divergence generally marks a faunal barrier, with the fishes of the Pacific Northwest and Central California Ecoregions combined into one cold-temperate fauna (Briggs 1974; Horn et al. 2006). Faunal breaks largely correspond to temperature differences because temperature is a primary driver of large-scale distribution patterns for marine fishes (Hubbs 1960). The California Current and inshore countercurrents (Davidson Current, California Undercurrent) transport the early life stages of fishes and influence the movement patterns of larger fishes. In addition, upwelling, typically during the spring and summer months, results in cool surface waters and high nutrient inputs that create foraging opportunities and influence YOY fishes' recruitment dynamics. The relative strengths of upwelling and current patterns vary with periodic oceanographic events (e.g., El Niño–Southern Oscillation [ENSO], La Niña, marine heatwaves), potentially influencing substantial shifts in species compositions and ecological interactions. Northern latitudinal shifts in marine fishes are documented and expected to increase with warming ocean conditions, especially at high latitudes (Compana et al. 2020).

Chinook Salmon (*Oncorhynchus tshawytscha*), female. (J. Tomelleri)

Some nearshore fishes (e.g., salmonids, Eulachon) in the Pacific Northwest Ecoregion have suffered substantial population declines and are included on state or federal endangered species lists. In Washington, specific stocks of Chinook, Chum, Sockeye, Steelhead, and Bull Trout are candidate species, but no outer coast fishes are currently listed as threatened or endangered (WDFW 2020). Pacific Lamprey is a Washington species of concern. Off Oregon, Coho Salmon are endangered, and Snake River Chinook are threatened (ODFW 2021). Some salmon stocks from the Pacific Northwest are federally endangered (e.g., Chinook Salmon, Sockeye Salmon–Snake River) or threatened (e.g., Chum Salmon–Columbia River and Hood Canal summer run, Coho Salmon–Oregon and Northern California Coast, Steelhead Trout–Northern California). Additionally, Bull Trout, Eulachon Southern DPS, and Green Sturgeon are federally threatened throughout the region considered here.

Regional and Subregional Characteristics of Pacific Northwest Ichthyofauna

The numbers of established fishes and common and abundant fishes are relatively consistent among Pacific Northwest subregions (Fig. 13). Species richness is marginally greater from Cape Lookout to Cape Blanco, Oregon (n = 294), whereas the subregion from Point Grenville, Washington, to Cape Lookout (n = 286) has the fewest nearshore fish species. The subregion from the Canadian border to Point Grenville has the most common and abundant species (n = 128), and the fewest have been documented between Cape Blanco and Cape Mendocino, California (n = 117; Fig. 13). Thirty-nine percent of the established nearshore fish species are reported as common or abundant throughout this ecoregion (n = 124).

Off the Pacific Northwest coast, species richness is slightly greater in the Core Zone (288 total, 101 common) than in the Seaward Zone (280 total, 89 common; Fig. 13). The number of common and abundant fishes is similar within the Core and Seaward Zones for all subregions, with a slight decline evident south of Cape Lookout (Fig. 14). Habitat types and temperature regimes are similar among subregions of the Pacific Northwest, and the diversity of the Core Zone fishes is probably more influenced by small-scale habitat availability (e.g., rock or sand substrates), which may explain the relatively lower spatial variability. The one exception is the subregion from Point Grenville to Cape Lookout, which contains

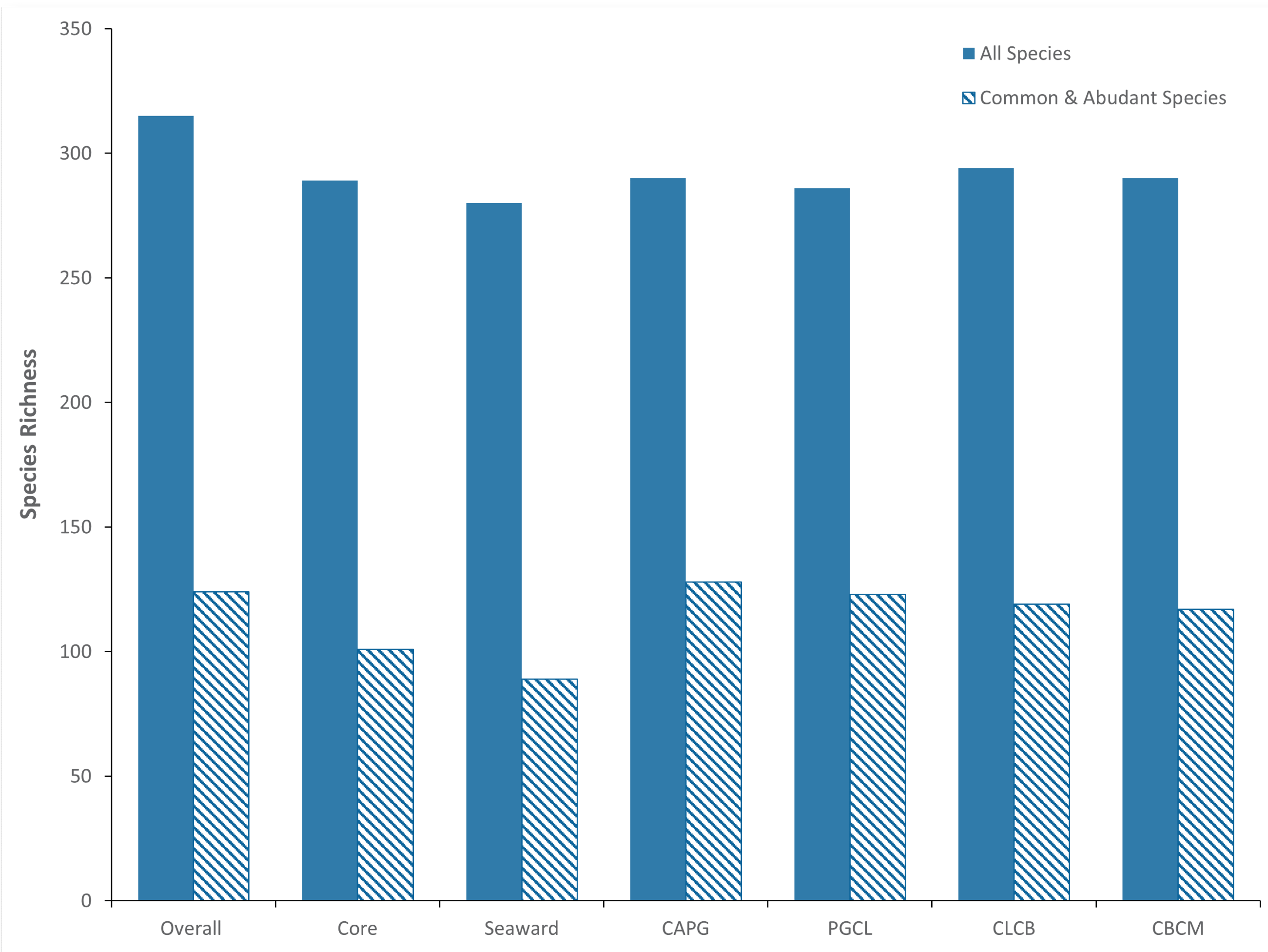


Figure 13. Number of established (All Species) and common or abundant (Common and Abundant Species) fish species off the Pacific Northwest (Overall), in the Core and Seaward Zones, and among subregions.

Note. CAPG = Canadian Border to Point Grenville, PGCL = Point Grenville to Cape Lookout, CLCB = Cape Lookout to Cape Blanco, CBCM = Cape Blanco to Cape Mendocino.

two large embayments (Grays Harbor, Willapa Bay) and the Columbia River outflow. It largely consists of sandy seafloors with little rock. For many species, there is a latitudinal gradient apparent, with cold-water-associated species becoming less common further south and vice versa. As such, the consistency of the assemblage varies considerably between northern Washington and northern California, even though the richness remains relatively constant.

Most Pacific Northwest fishes were associated with hard seafloors, followed by biotic habitat and soft sediment seafloors (Fig. 15A). In addition, 85 species use two different primary habitat types, and 32 are habitat generalists that use all three primary habitat types (Appendix 9). The secondary use of soft bottom habitats was most frequent, with hard seafloors the least frequent (Fig. 15A).

Among soft seafloor habitats, sand and mud are utilized by similar numbers of fishes and were much more often documented than gravel (or pebble) and shell habitats (Fig. 15B). Most fishes associated with hard seafloor habitats use consolidated rather than unconsolidated rock types (Fig. 15B). Among biotic habitats, the use of algae and vascular plants (seagrasses) are documented to a much greater degree than SFMI associations (Fig. 15B).

Pacific Northwest Fish Assemblages: Depth Zonation

Core Zone: Intertidal

At least 91 fish species that are common or abundant in the Core Zone of the Pacific Northwest Ecoregion are found in the intertidal zone, including 43 species that pri-

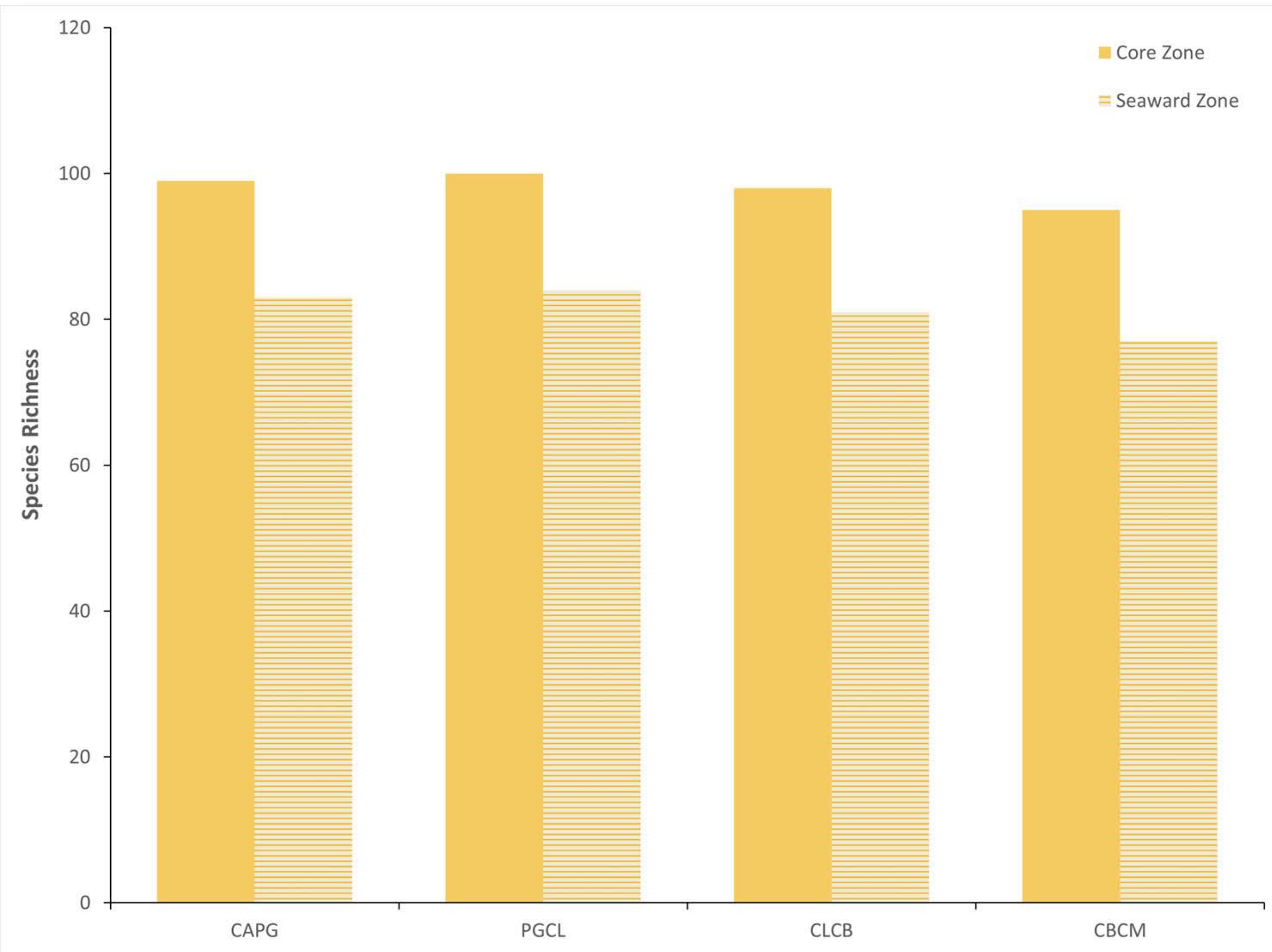


Figure 14. Number of common and abundant fish species in the Core and Seaward Zones of each subregion in the Pacific Northwest Ecoregion.

Note. CAPG = Canadian Border to Point Grenville, PGCL = Point Grenville to Cape Lookout, CLCB = Cape Lookout to Cape Blanco, CBCM = Cape Blanco to Cape Mendocino.

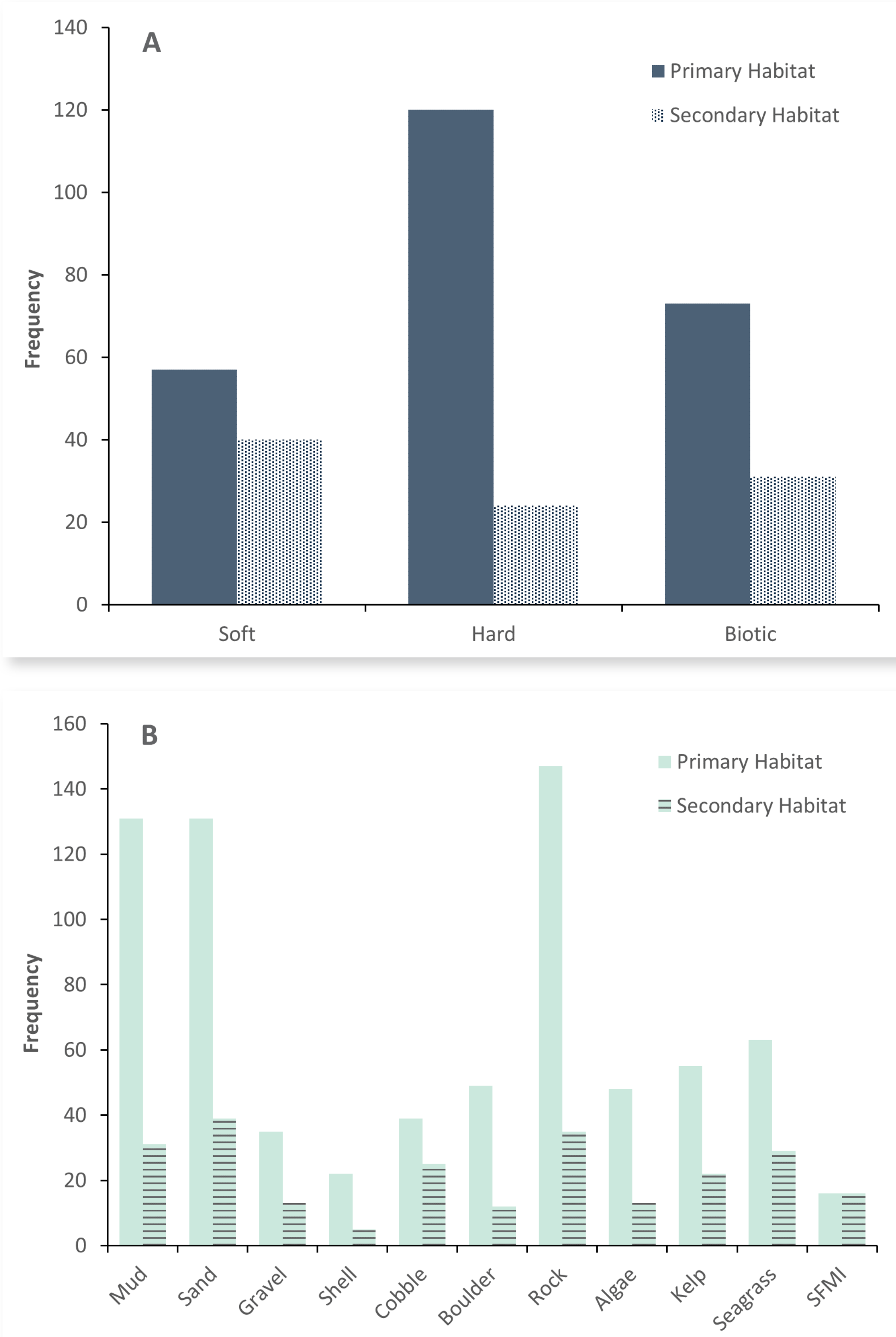
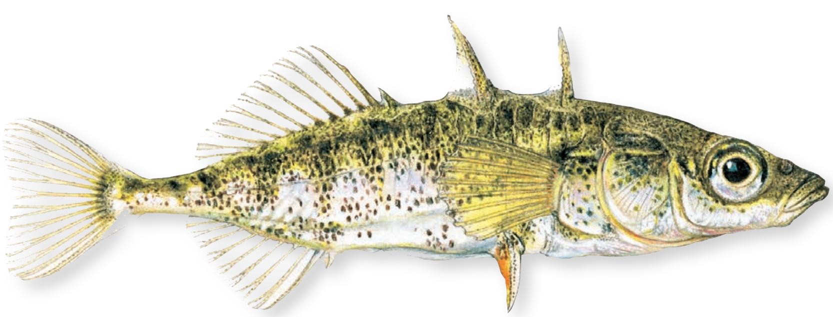


Figure 15. General (A) and specific (B) benthic habitat use by established fishes in the Pacific Northwest Ecoregion.

Note. Fishes can have multiple primary and secondary habitats (e.g., mud, sand, and gravel). Soft = Mud, Sand, and Gravel. Hard = Cobble, Boulder, and Rock. Biotic = Algae, Kelp, Seagrass, and SFMI. Gravel = gravel and pebbles. Algae = attached and drift algae other than kelp. Seagrass = eelgrass and surfgrass. SFMI = structure-forming marine invertebrates.

marily use this dynamic environment (Lamb and Edgell 2010; Love 2011; Kells et al. 2016; Love et al. 2021). Fifty-eight of these species also are found in the Salish Sea intertidal ichthyofauna (Appendices 6 & 8). Intertidal ichthyofauna typically represents a combination of mostly small resident species; the juvenile stages of larger, deeper-dwelling adults; roaming predators; and episodic spawners. Fishes that occupy intertidal habitats throughout life stages include sculpins (e.g., Sharpnose Sculpin, Fluffy Sculpin), poachers (e.g., Sturgeon Poacher, Northern Spearnose Poacher), snailfishes (e.g., Slimy Snailfish, Tidepool Snailfish), surfperches (e.g., Shiner Perch, Kelp Perch), and flatfishes (e.g., English Sole, Sand Sole). Sculpins are especially common and diverse (n = 17) in intertidal regions of the Pacific Northwest. Tidepools along the outer coast are utilized throughout the life history by small, cryptic species, such as gunnels (e.g., enpoint Gunnel, Rockweed Gunnel) and pricklebacks (e.g., Black Prickleback, Rock Prickleback), and as nursery grounds for numerous marine and estuarine fishes (e.g., salmonids, smelts, gadids, sculpins, flatfishes). Roaming predators in intertidal regions of the Pacific Northwest include White Sturgeon, Green Sturgeon, and Pacific Spiny Dogfish. White Sturgeon and Green Sturgeon move into intertidal waters during high tides to forage on the benthos, such as Green Sturgeon excavating infaunal Ghost



Threespine Stickleback (*Gasterosteus aculeatus*). J. Tomelleri)

Shrimp from intertidal mudflats (Stillwater 2018). During the summer months in the Pacific Northwest, Pacific Spiny Dogfish commonly forage on young and spawning forage fishes (e.g., Pacific Herring, salmonids, Pacific Sand Lance) in intertidal waters (Love 2011).

Core Zone: Subtidal

An estimated 101 fishes frequent the subtidal waters of the Core Zone (Appendix 7), including all species listed in the intertidal zone. Sixty-three of these species are also common or abundant in subtidal waters of the Salish Sea (Appendices 5 & 7). In the Pacific Northwest, the depth distributions of at least 40 common and abundant species, including 15 sculpins (e.g., Scalyhead Sculpin, Saddleback Sculpin), are centered in the subtidal portion of the Core Zone (Appendices 7 & 8; Love 2011; Love et al. 2021). The maximum depth observed for 20 of these species (e.g., Bay Pipefish, Manacled Sculpin) does not extend into the Seaward Zone (Appendix 8). The most abundant fishes in subtidal waters of the Core Zone include important forage species (e.g., Northern Anchovy, Pacific Herring, Topsmelt, Pacific Sand Lance); small benthic species (Blackeye Goby, Rockweed Gunnel); and species strongly associated with seagrass habitats (e.g., Bay Pipefish, Tubesnout, Shiner Perch; Appendices 7 & 8). The subtidal portion of the Core Zone is an important nursery region for salmonids (e.g., Chinook Salmon, Chum Salmon, Coho Salmon), rockfishes (e.g., Black Rockfish, Vermillion Rockfish), and flatfishes (e.g., English Sole, Pacific Sanddab).

Seaward Zone

At least 89 fishes are common or abundant in the Seaward Zone of the Pacific Northwest, including 62 species that also regularly inhabit the Core Zone (Appendix 7). The Seaward Zone contains two common Scorpaenidae species (Rougheye Rockfish, Pacific Ocean Perch) that do not occur in the Core Zone and eight species (e.g., Pygmy Rockfish, Longnose Skate) that are more common in deeper waters (Appendix 8). Ten species considered abundant in the Seaward Zone comprise phylogenetically diverse taxa (e.g., Pacific Spiny Dogfish, Pacific Herring, Yellowtail Rockfish, Wolf Eel, Pacific Sanddab). Several rockfishes (n = 13), sculpins (n = 9), flatfishes (n = 9), and elasmobranchs (n = 8) are also common or abundant in the Seaward Zone of the Pacific Northwest (Appendix 8). Unlike the intertidal or subtidal regions of the Core Zone, biotic habitat in the Seaward Zone consists largely of drift algae or SFMI. The general trend of increasing fish size with depth extends into the Seaward Zone, with larger, pelagic fauna from deeper or offshore waters more common (e.g., Pacific Hake, Blue Shark).

Pacific Northwest Fish Assemblages: Habitat Associations

Among soft bottom assemblages in nearshore regions of the Pacific Northwest, the total numbers of species increase along a depth gradient (Table 15). The soft bottom intertidal assemblage includes early life stages of bottom fishes (e.g., Brown Smoothhound, Pacific Sanddab, Sand Sole), highly mobile fauna (e.g., Redtail Surfperch, Pacific Pompano), and small benthic species (e.g., Roughback Sculpin, Northern Spearnose Poacher). Sand and mud are the principal habitats of all these species except Pacific Sand Lance, which burrows into sand and gravel; Pacific Sanddab, which is also commonly found on shell hash; and four species that primarily associate with sand (Redtail Surfperch, Spotfin Surfperch, Pacific Pompano, Sand Sole; Table 15). The soft bottom biotic intertidal assemblage includes 10 species, including all five from the equivalent Salish Sea assemblage (Table 6). Species in this assemblage inhabit soft bottom environments with

Table 15. Pacific Northwest soft bottom and soft bottom biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Threespine Stickleback	*Gasterosteus aculeatus*	A	X	X	
Soft Bottom	Pacific Sand Lance	*Ammodytes personatus*	A	X	X	A
Soft Bottom	Pacific Sanddab	*Citharichthys sordidus*	A	X	X	A
Soft Bottom	Brown Smoothhound	*Mustelus henlei*	C	X	X	C
Soft Bottom	Big Skate	*Beringraja binoculata*	C		X	C
Soft Bottom	Eulachon	*Thaleichthys pacificus*	C		X	C
Soft Bottom	Walleye Pollock	*Gadus chalcogrammus*	C	X	X	C
Soft Bottom	Roughback Sculpin	*Chitonotus pugetensis*	C	X	X	R
Soft Bottom	Northern Spearnose Poacher	*Agonopsis vulsa*	C	X	X	C
Soft Bottom	Pygmy Poacher	*Odontopyxis trispinosa*	C		X	C
Soft Bottom	Showy Snailfish	*Liparis pulchellus*	C	X	X	C
Soft Bottom	Redtail Surfperch	*Amphistichus rhodoterus*	C	X	X	
Soft Bottom	Spotfin Surfperch	*Hypocritichthys analis*	C	X	X	R
Soft Bottom	Pacific Pompano	*Peprilus simillimus*	C	X	X	C
Soft Bottom	Speckled Sanddab	*Citharichthys stigmaeus*	C	X	X	C
Soft Bottom	Sand Sole	*Psettichthys melanostictus*	C	X	X	C
Soft Bottom	Pacific Hagfish	*Eptatretus stoutii*	R			C
Soft Bottom	Longnose Skate	*Beringraja rhina*	R			C
Soft Bottom	Spotted Cusk-eel	*Chilara taylori*	R			C
Soft Bottom	Spotfin Sculpin	*Icelinus tenuis*	R			C
Soft Bottom	Spinycheek Starsnout	*Bathyagonus infraspinatus*	R			C

Table 15. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Blackbelly Eelpout	*Lycodes pacificus*	R			C
Soft Bottom	Dwarf Wrymouth	*Cryptacanthodes aleutensis*	R			C
Soft Bottom	Arrowtooth Flounder	*Atheresthes stomias*	R			C
Soft Bottom	Flathead Sole	*Hippoglossoides elassodon*	R			C
Soft Bottom	Pacific Halibut	*Hippoglossus stenolepis*	R			C
Soft Bottom	Butter Sole	*Isopsetta isolepis*	R			C
Soft Bottom	Curlfin Sole	*Pleuronichthys decurrens*	R			C
Soft Bottom Biotic	Bay Pipefish	*Syngnathus leptorhynchus*	A	X	X	
Soft Bottom Biotic	Shiner Perch	*Cymatogaster aggregata*	A	X	X	A
Soft Bottom Biotic	Surf Smelt	*Hypomesus pretiosus*	C	X	X	C
Soft Bottom Biotic	Pacific Staghorn Sculpin	*Leptocottus armatus*	C	X	X	R
Soft Bottom Biotic	Tubenose Poacher	*Pallasina barbata*	C	X	X	C
Soft Bottom Biotic	Sturgeon Poacher	*Podothecus accipenserinus*	C	X	X	C
Soft Bottom Biotic	Arrow Goby	*Clevelandia ios*	C	X	X	R
Soft Bottom Biotic	Bay Goby	*Lepidogobius lepidus*	C	X	X	C
Soft Bottom Biotic	English Sole	*Parophrys vetulus*	C	X	X	C
Soft Bottom Biotic	Starry Flounder	*Platichthys stellatus*	C	X	X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Pacific Staghorn Sculpin (*Leptocottus armatus*). (J. Tomelleri) attached seagrasses, especially surfgrass (Appendix 8). Three species also commonly use kelp or other algal habitats (Surf Smelt, Tubenose Poacher, Sturgeon Poacher).

All members of the soft bottom intertidal assemblage extend to the subtidal assemblage, in addition to all life stages of three additional species (Big Skate, Eulachon, Pygmy Poacher) that are primarily found on sand and mud (Table 15). Twelve species in this assemblage are also found in the Salish Sea assemblage, which has greater species richness (n = 23). The soft bottom biotic subtidal assemblage has the same species richness as the intertidal (Table 15) and exhibits similarities with the Salish Sea assemblage (Table 6). In the Seaward Zone of the Pacific Northwest, 12 species that primarily have deeper distributions (e.g., Longnose Skate, Blackbelly Eelpout, Arrowtooth Flounder) are also found in the soft bottom subtidal assemblage (Table 15).

Species composition of the soft bottom biotic assemblage in the Seaward Zone is the same as the subtidal with the exception of the Bay Pipefish, which has not been reported deeper than 18 m (Love et al. 2021). There are strong similarities in species composition between the soft bottom Seaward Zone assemblages in the Pacific Northwest and Salish Sea.

In contrast to soft bottom assemblages, common and abundant fishes in the Pacific Northwest that associate strongly with both hard bottom and biotic habitats are more diverse than those that primarily utilize only hard bottom habitats (Tables 15 & 16). Eight fishes, primarily consisting of scorpaeniforms (e.g., Copper Rockfish, Painted Greenling, Mosshead Sculpin), represent the hard bottom intertidal assemblage (Table 16). All members of this assemblage primarily use consolidated rock bottoms of varying rugosity, but Copper Rockfish are also strongly associated with boulders (Appendix 8). Twenty common and abundant hard-bottom-associated species in intertidal waters also frequently use biotic habitats (Table 7). These are mostly small, cryptic species that utilize heavily vegetated algal and seagrass seafloors (e.g., Rockweed Gunnel, Fluffy Sculpin, Red Gunnel) and, to a lesser degree, YOY (e.g., Black Rockfish) and various life stages (e.g., Rock Greenling) of Scorpaeniformes.

Wolf-Eel (*Anarrhichthys ocellatus*). (J. Tomelleri)

Table 16. Pacific Northwest hard bottom and hard bottom biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom	Wolf-Eel	*Anarrhichthys ocellatus*	A	X	X	A
Hard Bottom	Copper Rockfish	*Sebastes caurinus*	C	X	X	C
Hard Bottom	Deacon Rockfish	*Sebastes diaconus*	C		X	C
Hard Bottom	Vermilion Rockfish	*Sebastes miniatus*	C		X	C
Hard Bottom	Painted Greenling	*Oxylebius pictus*	C	X	X	C
Hard Bottom	Cabezon	*Scorpaenichthys marmoratus*	C	X	X	C
Hard Bottom	Grunt Sculpin	*Rhamphocottus richardsonii*	C	X	X	C
Hard Bottom	Padded Sculpin	*Artedius fenestralis*	C	X	X	R
Hard Bottom	Mosshead Sculpin	*Clinocottus globiceps*	C	X	X	R
Hard Bottom	Northern Clingfish	*Gobiesox maeandricus*	C	X	X	
Hard Bottom	Widow Rockfish	*Sebastes entomelas*	R	X	X	C

Table 16. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom	Tiger Rockfish	*Sebastes nigrocinctus*	R		X	C
Hard Bottom	Canary Rockfish	*Sebastes pinniger*	R		X	C
Hard Bottom	Yelloweye Rockfish	*Sebastes ruberrimus*	R		X	C
Hard Bottom	Rougheye Rockfish	*Sebastes aleutianus*			X	C
Hard Bottom Biotic	Rockweed Gunnel	*Apodichthys fucorum*	A	X	X	
Hard Bottom Biotic	Puget Sound Rockfish	*Sebastes emphaeus*	C		X	C
Hard Bottom Biotic	Quillback Rockfish	*Sebastes maliger*	C	X	X	C
Hard Bottom Biotic	Black Rockfish	*Sebastes melanops*	C	X	X	C
Hard Bottom Biotic	China Rockfish	*Sebastes nebulosus*	C		X	C
Hard Bottom Biotic	Kelp Greenling	*Hexagrammos decagrammus*	C	X	X	C
Hard Bottom Biotic	Rock Greenling	*Hexagrammos lagocephalus*	C	X	X	C
Hard Bottom Biotic	Longfin Sculpin	*Jordania zonope*	C	X	X	R
Hard Bottom Biotic	Scalyhead Sculpin	*Artedius harringtoni*	C	X	X	R
Hard Bottom Biotic	Fluffy Sculpin	*Oligocottus snyderi*	C	X	X	
Hard Bottom Biotic	Manacled Sculpin	*Synchirus gilli*	C	X	X	
Hard Bottom Biotic	Silverspotted Sculpin	*Blepsias cirrhosus*	C	X	X	C
Hard Bottom Biotic	Brown Irish Lord	*Hemilepidotus spinosus*	C	X	X	C
Hard Bottom Biotic	Sailfin Sculpin	*Nautichthys oculofasciatus*	C	X	X	C
Hard Bottom Biotic	Slimy Snailfish	*Liparis mucosus*	C	X	X	
Hard Bottom Biotic	Kelp Perch	*Brachyistius frenatus*	C	X	X	R
Hard Bottom Biotic	Silver Surfperch	*Hyperprosopon ellipticum*	C	X	X	R
Hard Bottom Biotic	Pile Perch	*Phanerodon vacca*	C	X	X	C
Hard Bottom Biotic	Decorated Warbonnet	*Chirolophis decoratus*	C		X	C
Hard Bottom Biotic	Rock Prickleback	*Xiphister mucosus*	C	X	X	
Hard Bottom Biotic	Red Gunnel	*Pholis schultzi*	C	X	X	R
Hard Bottom Biotic	Crevice Kelpfish	*Gibbonsia montereyensis*	C	X	X	R
Hard Bottom Biotic	Kelp Clingfish	*Rimicola muscarum*	C	X	X	
Hard Bottom Biotic	Yellowtail Rockfish	*Sebastes flavidus*	R	X	X	A

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R= rare, and blank = absent.

All fishes of the hard bottom intertidal assemblage of the Core Zone extend to the subtidal assemblage, including Deacon Rockfish and Vermillion Rockfish (Table 16). Six of seven fishes of the hard bottom subtidal assemblage from the Salish Sea are also included in the larger Pacific Northwest hard bottom subtidal assemblage (Table 7). The hard bottom biotic subtidal assemblage of the Core Zone is similar to the intertidal, with three additional species (e.g., Puget Sound Rockfish, China Rockfish, Decorated Warbonnet; Table 16). It exhibits some similarities to the Salish Sea assemblage but with more than twice the species richness (Tables 7 & 16). Species composition of the Pacific Northwest hard bottom Seaward Zone assemblage differs from that of the subtidal by excluding three shallower-dwelling benthic fishes (Padded Sculpin, Mosshead Sculpin, Northern Clingfish) and including five deeper-dwelling rockfishes (e.g., Rougheye Rockfish, Yelloweye Rockfish). Species composition of the hard bottom biotic assemblage in the Seaward Zone of the Pacific Northwest is less diverse than the corresponding Core Zone subtidal assemblage, with one additional species (Yellowtail Rockfish) but 12 species omitted (Table 16).

Pacific Northwest assemblages of soft- and hard-bottom-associated fishes and habitat generalists exhibit similarities in species between Core and Seaward Zones (Tables 17 & 18). The soft and hard bottom intertidal assemblage is limited to three small benthic species (Blackeye Goby, Slipskin Snailfish, Mosshead Warbonnet) also included in the corresponding subtidal assemblage, in addition to three large, mobile predators (Green Sturgeon, White Sturgeon, Bluntnose Sixgill Shark). Most soft and hard bottom subtidal fishes use multiple habitat types among these categories, but Mosshead Warbonnet and Slipskin Snailfish primarily utilize rock and shell seafloors (Appendix 8). Intertidal and subtidal assemblages of habitat generalists have equivalent fishes in the Core Zone, consisting of 21 mainly small, cryptic species (e.g., Rosylip Sculpin, Saddleback Gunnel; Table 18).

Green Sturgeon (*Acipenser medirostris*). (J. Tomelleri)

There are similarities in species between habitat generalist assemblages in intertidal and subtidal waters of the Pacific Northwest and Salish Sea, with 11 shared species between intertidal assemblages and 15 shared species between subtidal assemblages (Tables 9 & 18). In the Seaward Zone of the Pacific Northwest, common and

Table 17. Pacific Northwest soft-hard bottom fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Blackeye Goby	*Rhinogobiops nicholsii*	A	X	X	A
Bluntnose Sixgill Shark	*Hexanchus griseus*	C		X	C
Green Sturgeon	*Acipenser medirostris*	C		X	C
White Sturgeon	*Acipenser transmontanus*	C		X	C
Slipskin Snailfish	*Liparis fucensis*	C	X	X	C
Mosshead Warbonnet	*Chirolophis nugator*	C	X	X	C
Spotted Ratfish	*Hydrolagus colliei*	R	X	X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Table 18. Pacific Northwest habitat generalist fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Tubesnout	*Aulorhynchus flavidus*	A	X	X	R
Tidepool Sculpin	*Oligocottus maculosus*	A	X	X	
High Cockscomb	*Anoplarchus purpurescens*	A	X	X	R
Penpoint Gunnel	*Apodichthys flavidus*	A	X	X	
Pacific Spiny Dogfish	*Squalus suckleyi*	C	X	X	A
Pacific Cod	*Gadus macrocephalus*	C	X	X	C
Lingcod	*Ophiodon elongatus*	C	X	X	C
Smoothhead Sculpin	*Artedius lateralis*	C	X	X	R
Rosylip Sculpin	*Ascelichthys rhodorus*	C	X	X	R
Sharpnose Sculpin	*Clinocottus acuticeps*	C	X	X	R
Calico Sculpin	*Clinocottus embryum*	C	X	X	
Buffalo Sculpin	*Enophrys bison*	C	X	X	R
Saddleback Sculpin	*Oligocottus rimensis*	C	X	X	
Red Irish Lord	*Hemilepidotus hemilepidotus*	C	X	X	C
Ribbon Snailfish	*Liparis cyclopus*	C	X	X	R
Tidepool Snailfish	*Liparis florae*	C	X	X	
White Seaperch	*Phanerodon furcatus*	C	X	X	C
Snake Prickleback	*Lumpenus sagitta*	C	X	X	C
Black Prickleback	*Xiphister atropurpureus*	C	X	X	
Saddleback Gunnel	*Pholis ornata*	C	X	X	R
C-O Sole	*Pleuronichthys coenosus*	C	X	X	R
Pygmy Rockfish	*Sebastes wilsoni*	R		X	A
Pacific Ocean Perch	*Sebastes alutus*				C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent. Generalist = similar use of soft, hard, and biotic habitats.

abundant soft- and hard-bottom-associated fishes and habitat generalists form relatively small assemblages. The soft and hard bottom assemblage of the Seaward Zone contains Spotted Ratfish but is otherwise similar to the subtidal assemblage in the Core Zone. By contrast, the habitat generalists in the Seaward Zone are less diverse than the corresponding Core Zone subtidal assemblage, with one novel species (Pacific Ocean Perch) added and 15 species absent. Several species co-occur in the soft and hard bottom and habitat generalist assemblages of the Salish Sea and Pacific Northwest Ecoregions (e.g., White Sturgeon, Bluntnose Sixgill Shark, Snake Prickleback; Tables 17 & 18).

Pelagic fish assemblages in the Pacific Northwest exhibit similarities among depth zones (Table 19). The intertidal assemblage is mainly represented by forage fishes (e.g., Pacific Herring, Jacksmelt, Northern Anchovy) with early juvenile life stages of out-migrating salmon (e.g., Chinook Salmon, Coho Salmon) seasonally common in association with river drainages. Species composition of the subtidal pelagic assemblage contains one additional species (Whitebait Smelt) but is otherwise consistent with that of the intertidal. The pelagic assemblage of the Seaward Zone is similar to the pelagic subtidal assemblage; 13 species co-occur, three species with mainly offshore distributions (Salmon Shark, Blue Shark, Pacific Hake) are included, and two coastally oriented species (Jacksmelt, Topsmelt) are excluded. Ten of 15 species in the pelagic assemblage of the Salish Sea Seaward Zone are also found in the Pacific Northwest assemblage (Tables 10 & 19).

Pacific Cod (*Gadus macrocephalus*). (J. Tomelleri)

Selected Marine Invertebrates

The selected invertebrate fauna of the Pacific Northwest Ecoregion consists of 13 species (Table 20). Regional variation in the selected fauna is somewhat driven by habitat differences. For example, the Razor Clam, Red Abalone, and Pacific Sand Crab are associated with the high-energy waters of the Pacific Northwest's outer coast. The great majority of the selected invertebrates in the Pacific Northwest are primarily distributed in intertidal or subtidal waters of the Core Zone (Table 20). However, the California Market Squid mainly occurs in the Seaward Zone, and the Dungeness Crab and Red Rock Crab occur in both the Core and Seaward Zones (Table 20). Pinto Abalone is considered a state-listed endangered species in Washington and has declined precipitously in Northern California but is not federally listed (WDFW 2020). Other selected invertebrates also have declined in abundance in the Pacific Northwest. For example, Red Abalone populations have suffered severe recent declines because of Withering Syndrome associated with ocean warming (Hart et al. 2020). Additionally, ecological shifts have resulted in an increase in Purple Sea Urchins along the Oregon and Northern California coasts; these shifts have been driven by environmental changes and dramatic decreases in Ochre Star, Sunflower Sea Star, and other predator sea stars due to Sea Star Wasting Disease (Rogers-Bennett and Catton 2019; D. Fox, pers. comm.).

Molluscs are the most species rich of the selected Pacific Northwest fauna and have been well studied in the Pacific Northwest Ecoregion. Razor Clams are harvested commercially and recreationally in the Pacific Northwest. In this ecoregion, this species spawns in late spring and early summer and settles mainly onto fine, sandy habitats in the lower intertidal after approximately 10 weeks in a planktonic larval phase (Bourne and Qualye 1970; Lassuy and Simons 1989). Razor Clams can move rapidly through sand (up to 0.30 m/min) and burrow to approximately 1.5 m in depth, although they typically are found about 0.30 m below the surface (Lassuy and Simons 1989). This behavior affords some measure of protection from their many predators, including shorebirds, fishes, and Dungeness Crabs, which prey on juveniles, and Sea Otters and bears, which consume adults (Bishop and Powers 2003; Smith and Partridge 2004).

The recreational Razor Clam fishery represents a significant economic resource, especially along the outer coast of Washington State. Also, Red Abalone historically supported an economically important dive fishery in Northern California (~$44 million/year; Reid et al.

Northern Anchovy (*Engraulis mordax*). (J. Tomelleri)

Table 19. Pacific Northwest pelagic fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Taxon	Core	Intertidal	Subtidal	Seaward
Northern Anchovy	*Engraulis mordax*	A	X	X	A
Pacific Herring	*Clupea pallasii*	A	X	X	A
Topsmelt	*Atherinops affinis*	A	X	X	
Pacific Sardine	*Sardinops sagax*	C	X	X	C
Whitebait Smelt	*Allosmerus elongatus*	C		X	C
Night Smelt	*Spirinchus starksi*	C	X	X	C
Longfin Smelt	*Spirinchus thaleichthys*	C	X	X	C
Chum Salmon	*Oncorhynchus keta*	C	X	X	C
Coho Salmon	*Oncorhynchus kisutch*	C	X	X	C
Steelhead	*Oncorhynchus mykiss*	C	X	X	C
Sockeye Salmon	*Oncorhynchus nerka*	C	X	X	C
Chinook Salmon	*Oncorhynchus tshawytscha*	C	X	X	C
Pacific Saury	*Cololabis saira*	C	X	X	C
Pacific Chub Mackerel	*Scomber japonicus*	C	X	X	C
Jacksmelt	*Atherinopsis californiensis*	C	X	X	
Salmon Shark	*Lamna ditropis*	R		X	C
Blue Shark	*Prionace glauca*	R		X	C
Pacific Hake	*Merluccius productus*	R		X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

2016); however, the fishery was closed in 2018 after the 2014-2016 marine heatwave decimated kelp forests and associated abalone throughout this region (Hart et al. 2020). The Red Abalone recreational fishery in Oregon also closed in 2018 for similar reasons. The Pinto Abalone is a state-listed endangered species in Washington, and populations have declined precipitously in Northern California but seem to be increasing in Oregon (D. Fox, pers. comm.). Although many factors have contributed to species declines (e.g., ocean acidification, Withering Syndrome, Sea Otter predation), fishery harvest appears to be the primary driver (Neuman et al. 2018). In pelagic surveys conducted off the Oregon coast, Market Squid is most strongly associated with the low salinity from the Columbia River plume's water. The inner shelf assemblage includes yearling and adult Coho salmon, Wolf Eel larvae, and Tope Sharks (Brodeur et al. 2005). There is also fishery-independent evidence that the abundance of Market Squid has substantially increased in the Pacific Northwest, with marine heat waves being a major factor (Chasco et al. 2022). The fishery in Oregon increased from almost no harvest in 2015 to an annual average harvest of 7.6 million pounds (3.45 million kg) between 2018 and 2021 (ODFW commercial fishery landings statistics 2022). Red Octopus off the Oregon coast were found on flat seafloors composed of soft sediments, in surveys conducted on the mid and outer continental shelf and upper continental slope (Hemery et al. 2018). Because of its fisheries importance, considerable recent attention has been devoted to Dungeness Crab in the

Pacific Northwest Ecoregion. Juvenile Dungeness Crabs are most commonly found in unstructured intertidal habitats, compared with Eelgrass (*Zostera marina*) or Pacific Oyster (*Crassostrea gigas*) habitats, for nocturnal foraging during high tide in Wilapa Bay, Washington. Juvenile Dungeness Crabs were also negatively correlated with the occurrence of Red Rock Crabs (Holsman et al. 2006).

The habitat associations of early life stages and potential effects of climate change have recently been studied for cancrid crabs (especially Dungeness Crab) in the Pacific Northwest Ecoregion. Two ecosystem models predicted similar declines in future Dungeness Crab populations off the Pacific Northwest because of prey loss resulting from ocean acidification with corresponding predicted losses to fisheries revenue (Marshall et al. 2017, Hodgson et al. 2018). The Pacific Sand Crab (or Mole Crab) is the dominant macrofauna on exposed beaches of the Northern California coast and is preyed upon by a variety of shorebirds and fishes throughout its range (Straughan 1983; Horn et al. 2019).

The combined recent effects of Sea Star Wasting Disease and the northeast Pacific marine heatwave have rippled through rocky intertidal and subtidal communities in the Pacific Northwest. The West Coast experienced a record-breaking marine heatwave beginning in 2013–2015 (Rogers-Bennett and Catton, 2019). In addition, Sea Star Wasting Disease resulted in the functional extinction of an important predator, the Sunflower Sea Star (Eisenlord et al. 2015; Miner et al. 2018; Harvell et al. 2019), which declined coast-wide by 90.6%

Sea star with Sea Star Wasting Disease, 10/05/2018. (ODFW)

Sea star in the genus *Henricia*, Otter Rock Marine Reserve surveys, 06/14/2017. (ODFW)

(Gravem et al. 2021). Ochre Sea Stars, and numerous other sea star species, were also hit by the disease but not to such a substantial level. These changes in nearshore ocean conditions and the functional elimination of key predators contributed to a complex cascade of impacts on several nearshore species and habitats, including Purple Sea Urchins, Red Sea Urchins, Red Abalone, and kelp beds. Purple Sea Urchin populations in the Pacific Northwest and the northern portion of the Central California Ecoregion increased dramatically during this time frame (Rogers-Bennett and Catton 2019). Purple Sea Urchins, which formerly were largely found in the intertidal, have expanded to form dense aggregations in subtidal waters and are now the dominant sea urchin throughout much of the Pacific Northwest. The elevated water temperatures and increased grazing pressure from Purple Sea Urchins caused dramatic reductions in the extent of Bull Kelp beds (*Nereocystis luetkeana*), especially in northern California and southern Oregon. Reductions in Bull Kelp resulted in the mass starvation of Red Abalone, greatly reducing their populations off Northern California (Rogers-Bennett and Catton 2019). Red Sea Urchin populations increased during this time, but the lack of their principal food source, Bull Kelp, has kept them in a semi-starved state. Their low body mass makes them unmarketable as a commercially harvested species and has resulted in the collapse of the commercial urchin fishery in many areas.

Whereas recent bottom-up effects on echinoderms and associated species in the Pacific Northwest have been well studied, associated top-down effects have been more difficult to interpret because they may be spatially variable and influenced by the demographics of predator populations. Adult populations of Ochre Sea Stars and Sunflower Sea Star, both keystone predators in rocky intertidal communities of the Pacific Northwest, were disproportionately impacted by the combined effects of elevated temperatures (> 19 °C) and Sea Star Wasting Disease compared to juveniles. They declined 75% in abundance among Washington sampling locations (Eisenlord et al. 2015). Although Ochre Sea Star population numbers in the Pacific Northwest have largely recovered, biomass remains low since much of the current population consists of smaller, newly recruited individuals. As a result, predation pressure on a common prey species, the Blue Mussel (*Mytilus californianus*) remains low (Moritsch and Raimondi 2018). Additionally, competitive interactions between Ochre Sea Star and Six-Armed Sea Star (*Leptasterias* sp.) were found to vary where direct food competition was found in Washington but not in Oregon. However, an anticipated competitive release of *Leptasterias* sp. in Oregon waters did not occur (Sullivan-Stack and Menge 2020). Continued declines of the Sunflower Sea Star are expected, potentially altering top-down control of Purple Sea Urchins (Bonvari et al. 2017).

Table 20. Occurrence of selected invertebrates in the Pacific Northwest Ecoregion among nearshore zones and established coastal regions.

Higher Taxon/Species	Core: Intertidal	Core: Subtidal	Seaward
MOLLUSCA			
Razor Clam (*Siliqua patula*)	Primary	Secondary	Tertiary
Pinto Abalone (*Haliotis kamtschatkana*)	Primary	Primary	Absent
Red Abalone (*Haliotis rufescens*)	Tertiary	Primary	Secondary
California Market Squid (*Doryteuthis opalescens*)	Absent	Secondary	Primary
Giant Pacific Octopus (*Enteroctopus dofleini*)	Secondary	Primary	Secondary
Red Octopus (*Octopus rubescens*)	Primary	Secondary	Tertiary
CRUSTACEA			
Pacific Sand Crab (*Emerita analoga*)	Primary	Secondary	Absent
Dungeness Crab (*Metacarcinus magister*)	Primary	Primary	Primary
Red Rock Crab (*Cancer productus*)	Primary	Primary	Primary
ECHINODERMATA			
Ochre Sea Star (*Pisaster ochraceus*)	Primary	Primary	Absent
Sunflower Sea Star (*Pycnopodia helianthoides*)	Secondary	Primary	Secondary
Purple Sea Urchin (*Strongylocentrotus purpuratus*)	Primary	Primary	Secondary
Red Sea Urchin (*Mesocentrotus franciscanus*)	Tertiary	Primary	Secondary

Note. When possible, regional depth distributions were used. Intertidal = Splash Zone to MLLW, Subtidal = MLLW to 30 m, and Inner Shelf = 30–100 m. Black = primary depth range, dark gray with vertical hatch marks = secondary depth range, light gray with diagonal hatch marks = tertiary depth range, and white = absent. All utilized citations are provided in the text.

Kelp greenling, 10/05/2018. (ODFW)

CENTRAL CALIFORNIA MARINE ECOREGION

CENTRAL CALIFORNIA MARINE ECOREGION

Distribution and Abundance of CMECS Habitat Types Among Nearshore Zones

The Central California region extends south from Cape Mendocino in Northern California to Point Conception, including three of the Channel Islands (San Miguel, Santa Rosa, and San Nicolas Islands; Fig. 2). Nearly half of the marine surface area within the PMEP Scope Boundary off Central California occurs in the Seaward Zone (Table 21). A slightly smaller surface area is included in more offshore, oceanic waters, whereas only 13.0% is associated with this region's Core Zone (Table 21). Like it does off the Pacific Northwest, the Core Zone hugs the coastline except for its occurrence off islands (e.g., Farallon Islands, western Channel Islands). Although it is typically within 3 km of the coast (93% in state waters), the Core Zone extends 10–15 km offshore west of Point Reyes, off San Francisco Bay, in northern Monterey Bay, and in San Luis Obispo Bay (Fig. 16). The Seaward Zone is relatively narrow in the northern portion of the Central California Ecoregion but widens near Point Arena and extends far offshore (to a maximum of ~40 km) from just north of Point Reyes through Monterey Bay and in the region south of Morro Bay (Fig. 16). Approximately 47% of the Seaward Zone is in state waters. The offshore extent of the Outer Shelf is greatest where the waters of the Seaward Zone are relatively narrow (e.g., north of Point Reyes) due to the Monterey Bay Submarine Canyon, as well as just south of Morro Bay (Fig. 16). A far greater portion of the Outer Shelf Zone (13%) is located in the state waters off Central California than those in the Pacific Northwest Ecoregion.

Habitat Data Source Summary

Twenty source datasets contributed to the substrate compilation in Central California (Appendix 4, region CC), with the most significant spatial area contributions coming from a UCSC predicted substrate map created for the CDFW (Datasets 12 & 13 from Appendix 4), the USGS California State Waters Map Series data (Datasets 26–32, 34–41, 43–50, & 61 from Appendix 4), and the EFH SGH Substrate dataset (Dataset 3 from Appendix 4). The USGS datasets and EFH SGH dataset allowed for more detailed CMECS categories: Some of the source datasets were already crosswalked into CMECS; otherwise, the source habitat information was crosswalked into more detailed levels (subclass, group, or subgroup) of CMECS. The USGS datasets were all considered of high quality and generally allowed for at least CMECS subclass-level classification. The EFH SGH dataset was coast-wide; however, it was spatially variable in terms of data quality. Some of the source data south of Fort Bragg had low quality and high spatial resolution and, therefore, provided coarse substrate predictions for certain areas. The UCSC dataset was of high quality and good resolution but only classified into two categories (rock or sediment). It was therefore crosswalked to two high-level (class) classification levels in CMECS.

Table 21. Total area and relative percentage of CMECS Aquatic Setting types in PMEP Scope Boundary within the nearshore zones of Central California.

Nearshore Zone		CMECS Aquatic Setting	Area (ha)	Area (%)
Core Zone		3.1 Marine Nearshore	242,843	13.0%
	Subtotal		**242,843**	**13.0%**
Seaward Zone		3.2 Marine Offshore	890,197	47.7%
	Subtotal		**890,197**	**47.7%**
Outer Shelf		3.3 Oceanic	733,168	39.3%
	Subtotal		**733,168**	**39.3%**
	Total		**1,866,208**	**100.0%**

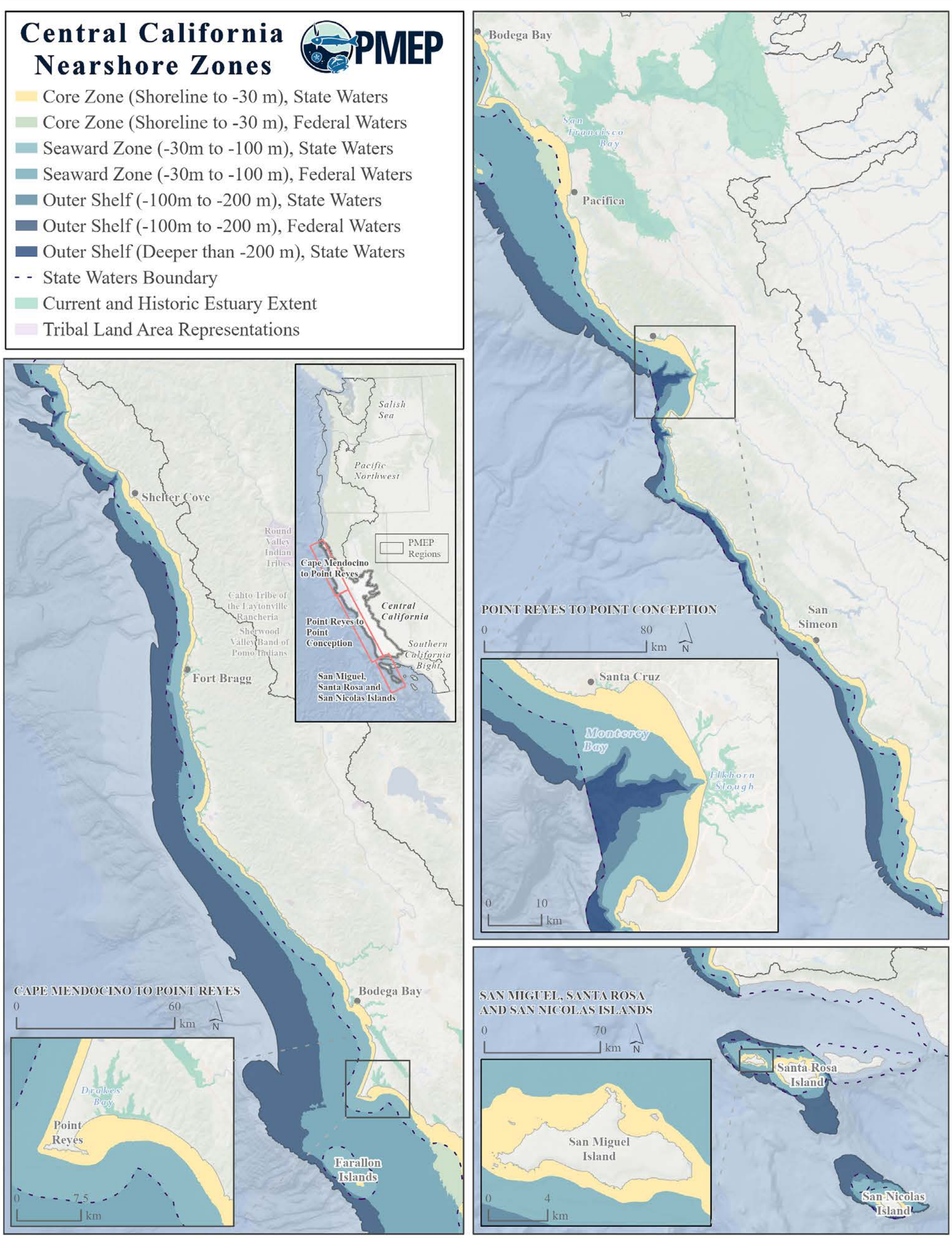


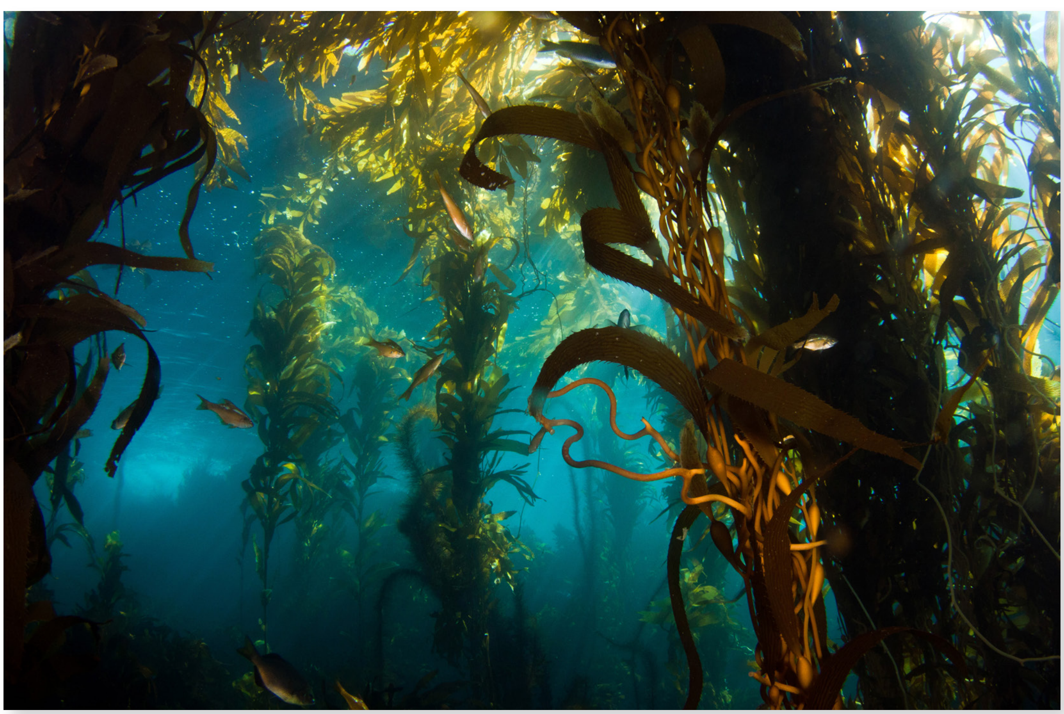
Figure 16. Distribution of nearshore zones and adjacent offshore and inshore regions in the Central California Ecoregion.

Other datasets that contributed information to the substrate component included an Ocean Imaging multispectral imagery dataset for the south coast (Dataset 16 in Appendix 4), a San Diego County nearshore substrate habitat map (Dataset 14 in Appendix 4), and a Channel Islands National Park habitat map (Dataset 63 & 64 in Appendix 4). All three of these datasets allowed for subclass-level classification in CMECS or more detailed levels.

Eight source datasets contributed to the PMEP Nearshore biotic habitat dataset in Central California. Four datasets contributed to the canopy-forming macroalgae (kelp) category (Datasets 16, 17, 19, & 23 in Appendix 4) and came from moderate- to high-quality regionwide datasets. There were three relatively low-quality datasets for faunal beds (Datasets 69, 70, & 72 in Appendix 4); all three sources were from the Environmental Sensitivity Index, where area extent was estimated by expert opinion. There were three seagrass datasets of moderate quality (Datasets 16, 17, & 22 in Appendix 4): Ocean Imaging's North Coast and South Coast datasets, which include extent information for surfgrass (*Phylospadix* spp.), and NOAA's national seagrass dataset, which includes CMECS group-level information on seagrass as a generalized category. NWI and the two Ocean Imaging datasets (Datasets 4, 16, & 17 in Appendix 4) contained data for multiple biotic habitat types; therefore, other CMECS communities or groups, such as other macroalgae, included in the dataset were derived from these two sources.

Core Zone

Most of the classified substrate in Core Zone waters off Central California consists of unconsolidated sediment. The majority is fine unconsolidated sediment (46.7%), which is primarily composed of sand (29.2%) and medium sand (13.2%). These substrates are mostly mapped north of the Monterey Peninsula (Table 22). Unclassified unconsolidated mineral substrate, characterizing 31.3% of the Core Zone seabed, dominates this region south of the Monterey Peninsula. This zone's lack of classification of the unconsolidated substrate results from limitations in the source data. Coarse unconsolidated substrate, mainly gravelly sand, contributes a trivial amount (1.9%) to the Core Zone area. Rock is relatively common in this region compared to the other types of unconsolidated substrate, composing 19.3% of the total Core Zone area off Central California. It is concentrated in the northern and southern regions of Monterey Bay and sporadically along the coast, especially in association with the Farallon Islands and the Core Zone region from north of Point Reyes to Monterey Bay (Fig. 17). Biogenic substrate was not documented. The Core Zone region off Central California has the most documented anthropogenic substrate of all the regions and zones, largely due to the USGS and National Park datasets that include anthropogenic substrate classification information in the source habitat attributes. However, anthropogenic and unclassified substrates contribute a trivial portion to the total Core Zone area.



Kelp forest. (A. Obaza, Paua Marine Research Group)

Benthic macroalgae, consisting largely of canopy-forming algal beds (i.e., kelp), are estimated to compose 10.1% of the mapped Core Zone off Central California (Table 23) and are

Table 22. Total area and relative percentage of CMECS substrate types in the Core and Seaward Zones of Central California.

CMECS Substrate Category	Substrate Details	Core Zone Area (ha)	Core Zone Area (%)	Seaward Zone Area (ha)	Seaward Zone Area (%)
Rock substrate	Bedrock	24,098	9.92	21,460	2.41
	Unclassified	22,781	9.38	34,087	3.83
	Subtotal	**46,879**	**19.30**	**55,547**	**6.24**
Unconsolidated mineral substrate	Unclassified	**76,118**	**31.34**	**298,688**	**33.55**
Coarse unconsolidated substrate	Boulder	220	0.09	469	0.05
	Cobble	5	0.00	0	0.00
	Gravel	207	0.09	0	0.00
	Gravel mix	6	0.00	63	0.01
	Sandy gravel	<1	0.00	98	0.01
	Muddy Gravel	0	0.00	5	0.00
	Gravelly sand	4,148	1.71	9,267	1.04
	Gravelly muddy sand	0	0.00	1	0.00
	Subtotal	**4,587**	**1.89**	**9,902**	**1.11**
Fine unconsolidated substrate	Slightly gravelly sand	390	0.16	2	0.00
	Slightly gravelly muddy sand	35	0.01	0	0.00
	Sand	71,001	29.24	435,618	48.93
	Medium Sand	31,941	13.15	13,003	1.46
	Fine sand	0	0.00	<1	0.00
	Sandy mud	9,941	4.09	71,224	8.00
	Sandy Silt-Clay	<1	0.00	1,408	0.16
	Mud	40	0.02	4,371	0.49
	Unclassified	0	0.00	86	0.01
	Subtotal	113,349	46.68	525,711	59.06
Biogenic substrate	Very Coarse Woody Debris	0	0.00	0	0.00
	Subtotal	**0**	**0.00**	**0**	**0.00**
Anthropogenic substrate	Anthropogenic rock	3	0.00	0	0.00
	Anthropogenic rock rubble	<1	0.00	0	0.00
	Anthropogenic wood	**<1**	**0.00**	**0**	**0.00**
	Metal	22	0.01	8	0.00
	Unclassified	**885**	**0.36**	**50**	**0.01**
	Subtotal	**910**	**0.37**	**58**	**0.01**
Unclassified	**Unclassified**	**1,001**	**0.41**	**290**	**0.03**
	Total	**242,843**	**100.00**	**890,197**	**100.00**

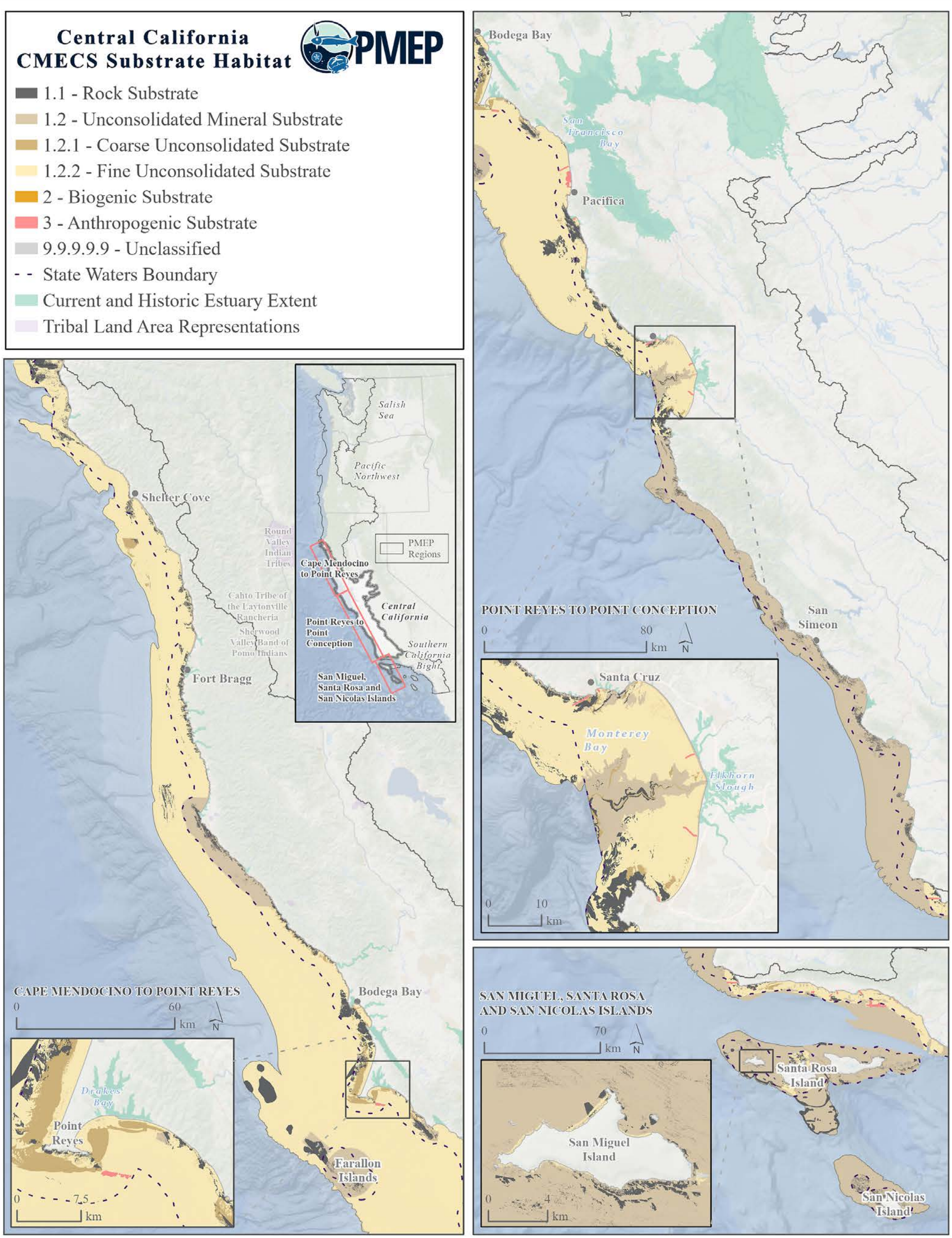


Figure 17. Distribution of CMECS substrate habitats in the Central California Ecoregion.

Table 23. Total estimated mapped area based on the maximum observed extent of a habitat type, relative percentage of total zone area, and data completeness status for each CMECS biotic category off Central California.

Biotic Category	CMECS Habitat Details (Group)	Core Zone		Seaward Zone		Spatial Data Completeness
		Area (ha)	Area (%)	Area (ha)	Area (%)	
1 - Floating / Suspended Plants and Biota		6	0.0%	0	0.0%	Limited or incomplete mapping
2 - Benthic / Attached Biota		25,182	10.4%	67	0.0%	Limited or incomplete mapping
2.2 - Faunal Bed		0	0.0%	0	0.0%	No data
2.5 - Aquatic Vegetation Bed		25,173	10.4%	0	0.0%	Limited or incomplete mapping
Benthic Macroalgae	2.5.1.2 - Canopy-Forming Algal Bed (Kelp)	24,072	9.9%	67	0.0%	Region-wide mapping
	2.5.1 - Other (Unclassified)	563	0.2%	0	0.0%	Limited or incomplete mapping
Aquatic Vascular Vegetation	2.5.2 - Seagrass Bed	**92**	**0.0%**	**0**	0.0%	Local or subregion-level mapping
	Total Zone Area	**242,843**		**890,197**		

Note. Because they are more specific, subcategories may have a greater amount of mapped area than more generalized categories in which they are contained. The biotic area estimates are limited by data availability; certain biotic datasets have more extensive and complete habitat mapping than others and are ranked for data completeness using the following categories:

- **No data**: No spatial-extent data were available
- **Limited or incomplete mapping**: Mapping of habitat is limited in scope and is known to be an insufficient estimate of area
- **Local or subregion-level mapping**: Mapping efforts exist at the local/subregion scale, and the regional area calculation is likely an underestimate
- **Region-wide mapping**: Mapping efforts exist across the region and provide a coarse estimate of area

mapped region-wide because of monitoring efforts. Kelp beds were documented throughout the Core Zone but are mostly absent in Monterey Bay, between San Luis Obispo Bay and Point Conception, and in the extreme northern portion of this ecoregion (Fig. 18). Kelp beds surround most of the western Channel Islands and San Nicolas Island but are largely absent at the Farallons (Fig. 18). Seagrass data has limited or incomplete mapping for this region; eelgrass (*Zostera* spp.) data are largely absent in the nearshore of this region. A few seagrass surveys conducted pursuant to the California Eelgrass Mitigation Policy have revealed the presence of eelgrass in some nearshore locations, such as Vandenberg Air Force Base, Port San Luis, and Pillar Point (B. Chesney, pers. comm.). In addition, surfgrass has limited extent data in this area. Despite surfgrass beds being more extensive than eelgrass in this region, there is a lack of mapped data. Other biotic habitat types have limited or incomplete mapping, including floating/suspended plants and biota (representative of beach wrack), faunal beds, and other unclassified species of macroalgae (Table 23). These remaining habitat types contribute to less than 0.5% of the total mapped area. Uncategorized aquatic vegetation beds, which may include biotic categories such as seagrass and macroalgae that do not have a more detailed classification level, accounted for 0.3% of the zone. The great majority of the Central California Core Zone is unclassified for biotic habitat types (89.6%).

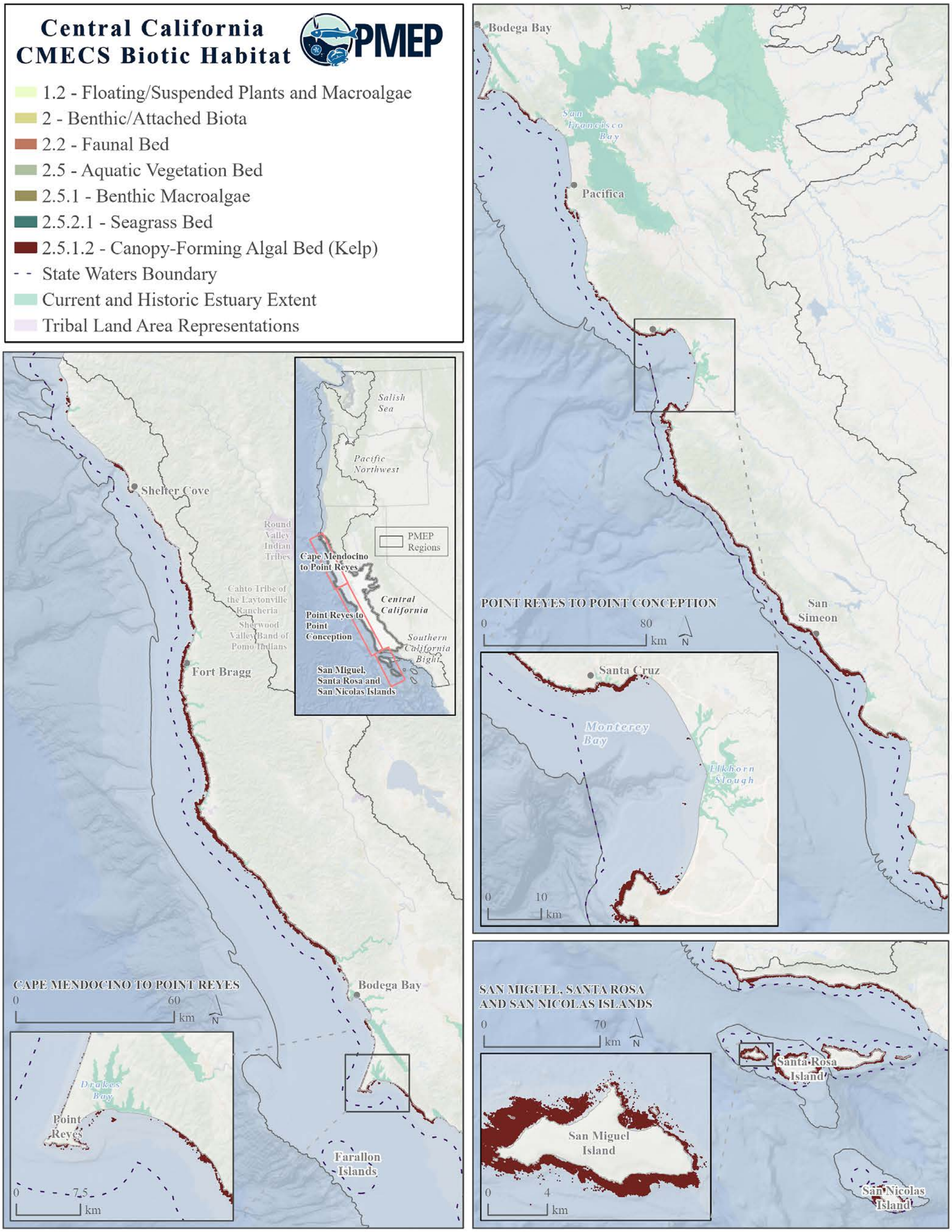


Figure 18. Distribution of CMECS biotic habitats in the Central California Ecoregion.

Seaward Zone

Like that of the Core Zone, most of the classified substrate in Seaward Zone waters off Central California is composed of unconsolidated sediment. The amount of fine unconsolidated sediment in the Seaward Zone is greater than that of the Core Zone (59.1%), with the majority mapped as sand (48.9%) followed by sandy mud (8.0%). As in the Core Zone, most fine unconsolidated sediment is mapped from Monterey Bay to the north, with wide expanses of this sediment type stretching from south of San Francisco Bay to north of Point Reyes (Fig. 17). Unconsolidated mineral substrate, all unclassified, contributes an estimated 33.6% of the total area of the Seaward Zone seabed and is most pronounced in the vicinity of Point Arena, the Farallon Islands, and especially south of Monterey Bay (Fig. 17). Coarse unconsolidated sediment, mainly characterized as gravelly sand, was only documented in trivial amounts (Table 22). Rock substrate is considerably reduced in the Seaward Zone of Central California (6.2%) compared to the Core Zone (Table 22). Much of the documented rock in the Seaward Zone is mapped at the northern and southern edges of Monterey Bay, associated with the Farallon Islands and Fanny Shoal. It otherwise occurs sporadically throughout this Zone. Biogenic substrate was not documented, and the contribution of anthropogenic and unclassified substrates is trivial (Table 22).

Except for benthic macroalgae, which only contributed 0.01% to the total mapped area of the Seaward Zone off Central California, biotic habitats are unclassified throughout this ecoregion (Table 23, Fig. 18).

Landward Zone

The Landward Zone of Central California contains a diverse assortment of habitat types and morphologies. The coastline of this ecoregion is incised by numerous rivers and streams, as well as estuaries, lagoons, and embayments. These waters vary substantially in size and orientation and include the largest coastal estuary on the U.S. Pacific Coast (San Francisco Bay). Marine terraces and sand dunes are also common throughout much of the Central California shoreline (Johnson et al. 2020). Unconsolidated sand and gravel beaches represent the most common habitat type in the Landward Zone of Central California (Gleason et al. 2006). Most of these beaches are fine- to medium-grained sand, coarse-grained sand, gravel, or a mixture of these sediments. Rocky shores are relatively common in Central California and are mainly present in the form of wave-cut platforms, with or without associated beaches (Gleason et al. 2006). Exposed rocky cliffs are also well represented, but sheltered rocky shores are rare and mainly restricted to bays and estuaries. Coastal marshes and tidal flats are commonly found in association with bays and estuaries of this ecoregion. The Landward Zone associated with tidal flats is mainly composed of sand and mud in exposed regions but largely consists of mudflats in sheltered regions.

Pacific Sanddab (*Citharichthys sordidus*). (J. Tomelleri)

Coastal areas in Central California support many rare or endangered plant and animal species, especially in San Francisco Bay (Gleason et al. 2006). Most of the population of California lives near the coast, but the population density between Marin and Santa Barbara Counties is much greater than that to the north. In these populous regions, physical disturbances to beaches may alter substrate type and negatively impact wildlife (e.g., seabirds; Neuman et al. 2008). In addition, many areas have been modified by shoreline armoring or dredging to maintain port and marine facilities. These coastal regions typically experience a loss of riparian vegetation, a high number of invasive species (e.g., San Francisco Bay; Cohen and Carlton 1998), and elevated pollution levels.

ECOLOGICAL CONNECTIONS BETWEEN NEARSHORE AND OFFSHORE SPECIES GUILDS

by Dr. Dayv Lowry, NOAA Fisheries

The Seaward Zone of the nearshore region, as defined here, extends to a −100 m water depth relative to mean lower low water and encompasses the majority of marine habitat directly affected by terrestrial processes such as erosion and runoff. While a diverse faunal assemblage characterizes this zone, variability in oceanic conditions and animal behavior result in episodic occurrences within the nearshore of organisms that typically occupy offshore ecoregions.

Though not discussed elsewhere in this report, various species of tuna (family Scombridae), billfishes (families Istiophoridae and Xiphiidae), and other highly mobile predators foray into the nearshore as they pursue aggregations of forage species, whose distributions are correlated with water temperature and upwelling intensity. Other pursuit predators, such as the Longnose Lancetfish (*Alepisaurus ferox*) are also occasionally hooked by anglers or found washed up on coastal beaches. Ocean Sunfish (*Mola mola*), which may reach 2 m total length and weigh several thousand pounds, also occur in the nearshore as they roam in search of jellyfish.

In addition to fishes, a broad array of pelagic and/or planktonic invertebrates, ranging from crustaceans to jellyfishes, occur in both the nearshore and offshore regions of the West Coast. Since 2015, the "sea pickle" (*Pyrosoma atlanticum*) has been making headlines as unprecedented blooms of the colonial tunicate have swamped fishing nets and washed up on beaches from Northern California to Alaska. Dozens of species of birds and marine mam-

Kelp forest and ichthyofauna. (A. Obaza, Paua Marine Research Group) mals also occupy both regions, though residency in the nearshore is often seasonal as they migrate for feeding, procreation, and birthing/nesting.

A complete review of the trophic connectivity between nearshore and offshore species guilds is beyond the scope of this document and has received substantial treatment elsewhere. However, it is important to note that substantial linkages exist that are fundamental to maintaining ecological integrity. As oceanic and climate conditions vary in the coming decades, it will be crucial to continue and expand the monitoring of these connections to adequately understand and conserve these food webs such that sustainable exploitation is possible. Interstate and international cooperation will continue to be key to this pursuit.

Fish Fauna, Fish Assemblages, and Selected Invertebrates: Summary Points

The principal nearshore ichthyofauna of Central California includes more species (n = 404) than those of the Pacific Northwest (n = 314) or Salish Sea (n = 173). Taxa comprise 34 orders and 110 families, with scorpionfishes still the most numerous (n = 143) but Perciformes contributing a similar number of species (n = 133).

Species richness varies somewhat among Central California subregions (Point Reyes to Point Sur = 367, Cape Mendocino to Point Reyes = 327). More species are documented in the Core Zone (373 total, 115 common) than in the Seaward Zone (341 total, 93 common).

The number of common and abundant fishes among Central California assemblages is greatest at subtidal depths of the Core Zone (n = 115), slightly reduced at intertidal depths, and lowest in the Seaward Zone (n = 93).

Most nearshore Central California fishes are primarily associated with soft or biotic seafloors, but among common and abundant species, hard bottom assemblages are the most species rich.

The selected invertebrate fauna of the Central California Ecoregion overlaps considerably with that of the Pacific Northwest, indicating strong similarity in perceived importance between these regions.

As in the more northern ecoregions, most of the selected invertebrates are primarily distributed in intertidal or subtidal waters of the Core Zone.

Complex, competitive interactions among Red Abalone, Red Sea Urchin, and Purple Sea Urchin, combined with the effects of climate change and disease, drive this ecoregion's realized distribution patterns.

Lingcod (*Ophiodon elongatus*). (J. Tomelleri)

Central California Ichthyofaunal Characteristics and Fish Assemblages

Central California Ichthyofauna

Off Central California, the nearshore ichthyofauna consists of 404 fishes distributed among 34 orders and 110 families (Appendix 9). The most species-rich taxa are Scorpaeniformes (scorpionfishes, 143 species), Perciformes (perches, 133 species), Scorpaenidae (rockfishes and thornyheads, 62 species), and Psychrolutidae (marine sculpins, 22 species). Compared to the ichthyofauna of the Pacific Northwest and Salish Sea, there is a considerable expansion of perciform taxa and species in the Central California fauna. The great majority of established nearshore fishes off Central California inhabit marine or estuarine waters (91.3%); however, 15 are anadromous (3.7%), including six salmonids, and 20 also occur in freshwater (5.0%; California Killifish, Striped Mullet).

Blackeye Goby (*Rhinogobiops nicholsii*). (J. Tomelleri)

Nearshore fishes in the Central California marine ecoregion mostly occupy benthic and demersal waters (81.4%), whereas 12.9% are pelagic, and 5.7% swim throughout the water column (Appendix 10). Eight exotic species are established in this ecoregion, including two shads and three species of goby (Appendix 10).

The marine environment of the Central California marine subregion is similar to that of the Pacific Northwest. The California Current is the main driver of large-scale distribution patterns for most nearshore marine fishes. On a smaller scale, there are more large rivers off the Pacific Northwest, but Central California encompasses San Francisco Bay, the largest coastal estuary along the West Coast. The continental shelf, which is generally narrow to the north, broadens considerably between Point Reyes to San Francisco Bay to create extensive nearshore sedimentary beds. Additionally, the Monterey Bay Submarine Canyon, the deepest submarine canyon on the Pacific Coast (> 9,000 m), extends to within a few hundred meters of the shoreline. Oceanic and deepwater fishes sometimes make nearshore excursions from this feature or are pushed shoreward by currents (Burton and Lea 2019).

Endangered and threatened fishes off Central California include mainly anadromous species. Spawning populations of Green Sturgeon south of Eel River were designated as federally threatened in 2006. Longfin smelt is a state threatened and federal candidate species (CDFW 2021b), whereas Eulachon is a federal-listed threatened species. Coho Salmon is a state endangered species south of Humboldt County and a state threatened species north to the Oregon border (CDFW 2021b). It is also federally listed as endangered from San Francisco Bay to Humboldt County and federally listed as threatened in the northern part of this ecoregion. Bull Trout and winter-run Chinook Salmon are state endangered species, but Bull Trout is believed to be extirpated in California. Other Chinook stocks are state and federally listed as threatened species (Sacramento River) or species of concern (Klamath-Trinity River; CDFW 2021b). Summer-run Steelhead is a state species of concern, and the Central California stock is federally threatened (CDFW 2021b). Tidewater Goby has been a federal endangered species throughout its range since 1994 but is afforded no state designation (CDFW 2021b). The Unarmored Threespine Stickleback (Gasterosteus aculeatus williamsoni) is a state and federal endangered species but is a nominal subspecies that has not been empirically distinguished from the Threespine Stickleback (CDFW 2021a).

Regional and Subregional Characteristics of Central California Ichthyofauna

The number of established fishes and common and abundant fishes is somewhat variable among Central California subregions (Fig. 19). The total number of nearshore fishes (n = 367) and the number that are common or abundant (n = 143) are both greatest from Point Reyes to Point Sur. The subregion from Cape Mendocino to Point Reyes has the fewest nearshore fishes (n = 327), whereas the Point Arguello South subregion has the fewest common and abundant species (n = 109). Thirty-four percent of established nearshore fish species are commonly reported throughout this ecoregion (n = 138).

Species richness is greater in the Core Zone (373 total, 115 common) than in the Seaward Zone (341 total, 93 common; Fig. 19). The number of common and abundant fishes is greatest from Point Reyes to Point Sur (Fig. 20) for both Core and Seaward Zones, in part because of several estuarine and introduced fishes (e.g., Striped Bass, Shokihaze Goby) that are associated with San Francisco Bay. The richness of common and abundant species in the Core (n = 76) and Seaward Zones (n = 62) is lowest in the Point Arguello South subregion. Variability in common and abundant species is more pronounced among Central California subregions than those to the north (Fig. 8, 14, & 20).

Most Central California fishes are primarily associated with soft or biotic seafloors, whereas relatively few are associated primarily with rock (Fig. 21A). In addition, 119 species use two different primary habitat types, and 35 habitat generalists use all three primary habitat types (Appendix 9). The secondary use of hard bottom habitats was most frequent, with comparable secondary use of soft and biotic seafloor habitats (Fig. 21A). Among soft seafloor habitats, sand and mud are utilized by similar numbers of fishes and were much more often documented than gravel (or pebble) and shell habitats (Fig. 21B). Most fishes associated with hard seafloor habitats use consolidated rather than unconsolidated rock

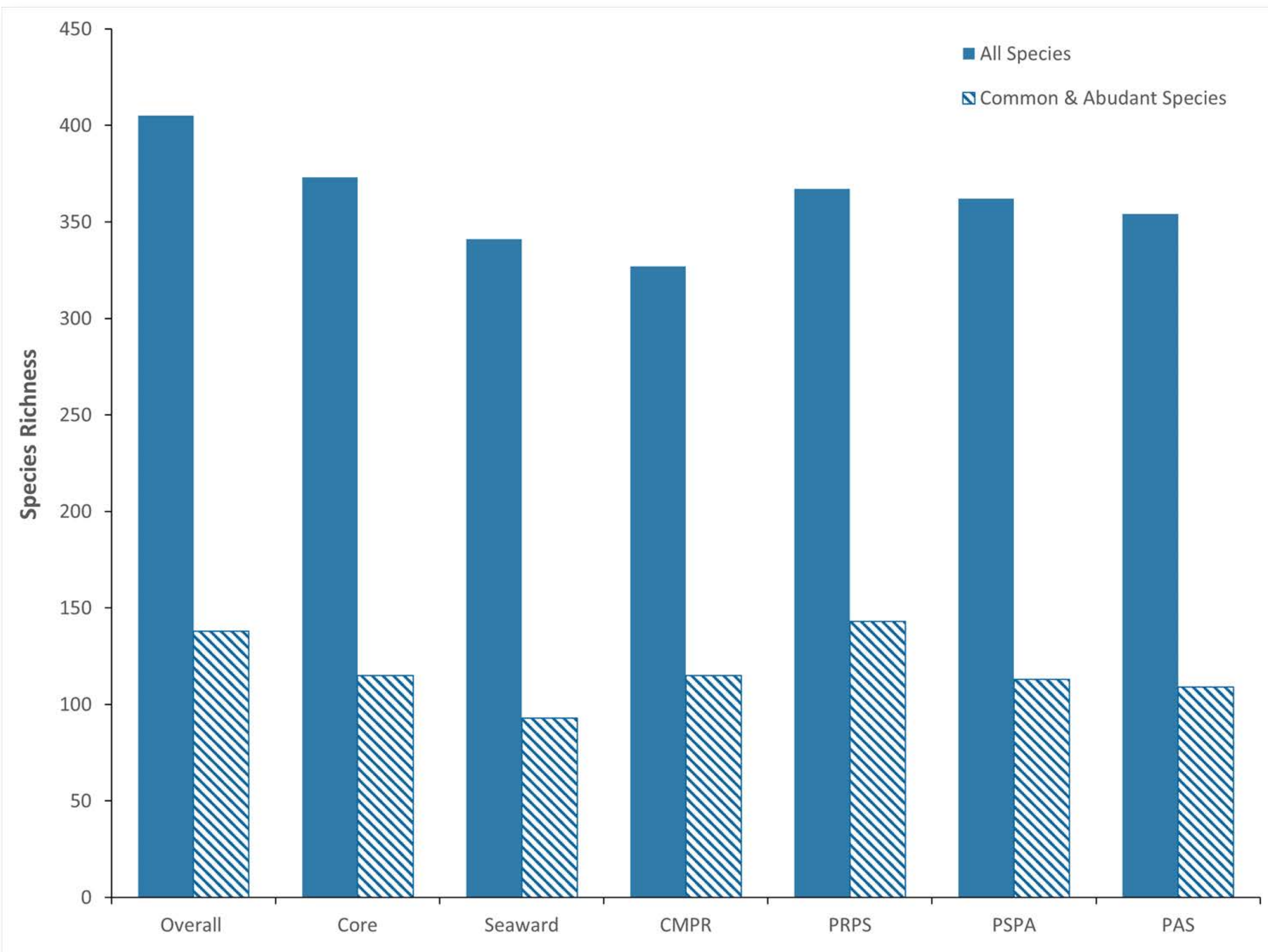


Figure 19. Number of established (All Species) and common or abundant (Common and Abundant Species) fish species off Central California (Overall), in the Core and Seaward Zones, and among subregions.

Note. CMPR = Cape Mendocino to Point Reyes, PRPS = Point Reyes to Point Sur, PSPA = Point Sur to Point Arguello, PAS = Point Arguello South.

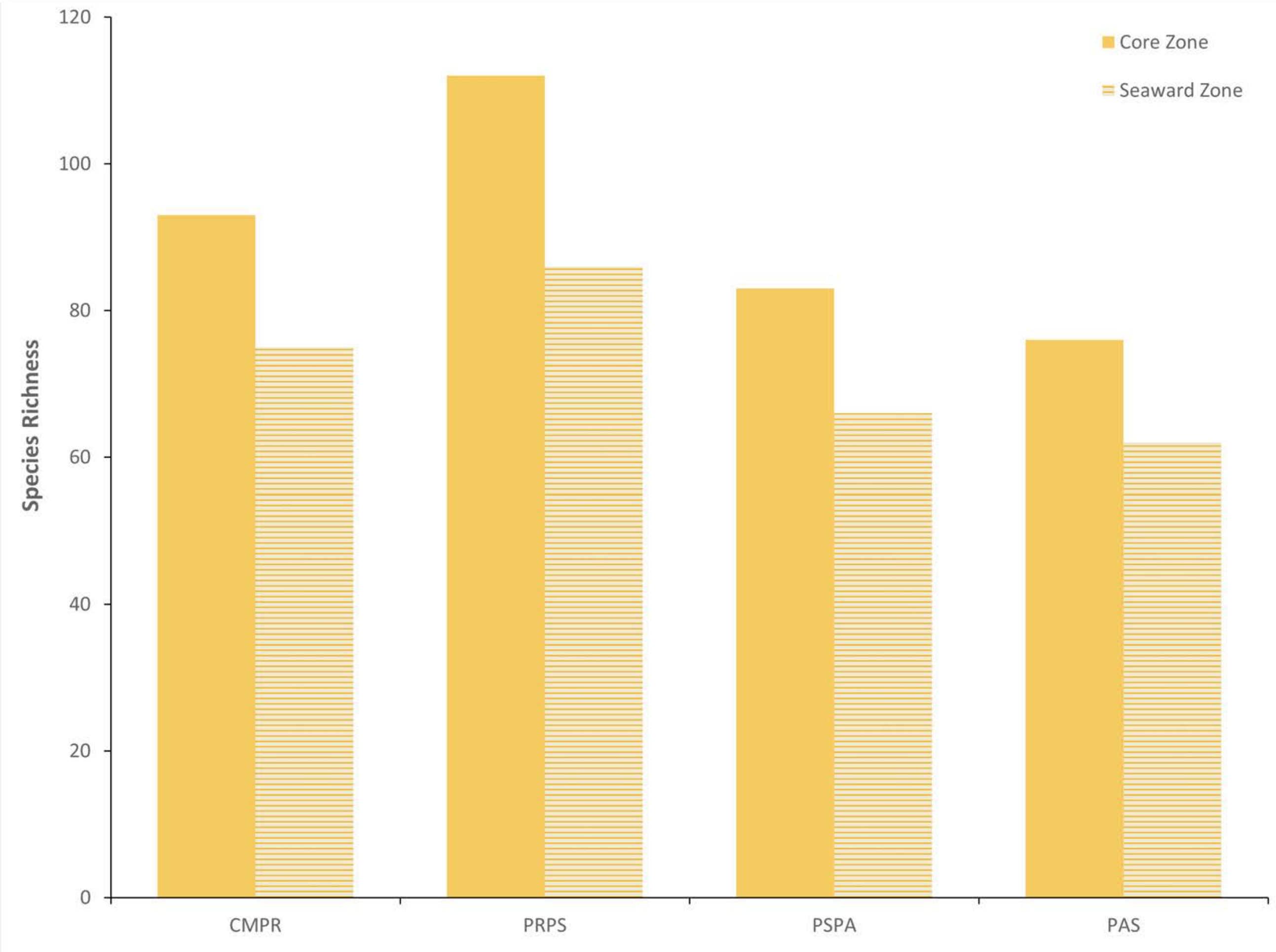


Figure 20. Number of common and abundant fish species in the Core and Seaward Zones of each subregion in the Central California Ecoregion.

Note. CMPR = Cape Mendocino to Point Reyes, PRPS = Point Reyes to Point Sur, PSPA = Point Sur to Point Arguello, PAS = Point Arguello South.

types (Fig. 21B). Among biotic habitats, the use of algae and vascular plants (seagrasses) are documented to a much greater degree than SFMI associations (Fig. 21B).

Central California Fish Assemblages: Depth Zonation

Core Zone: Intertidal

At least 106 common or abundant fishes are documented from intertidal waters of the Central California marine ecoregion, including 48 species that primarily utilize this zone (Miller and Lea 1972; Love 2011; Kells et al. 2016; Love et al. 2021,). Sixty-eight of these species are included in the common and abundant intertidal ichthyofauna of the Pacific Northwest (Appendices 7 & 9). Surfperches (n = 15), marine sculpins (n = 11), and rockfishes (n = 7) are the most diverse families of common intertidal fishes in Central California waters. Perciform taxa are more heavily represented in the Central California fauna than the Pacific Northwest fauna. In addition to surfperches, they largely include cryptic benthic species (e.g., pricklebacks, gunnels, clinids, gobies, clingfishes, gobies) and flatfishes (e.g., Pacific Sanddab, California Halibut; Appendices 9 & 10).

Core Zone: Subtidal

An estimated 115 fishes in the Central California Ecoregion are designated as common and abundant in subtidal waters of the Core Zone (Appendices 9 & 10), including all members of the intertidal fauna. Seventy-five of these species also frequent subtidal waters of the Pacific Northwest (Appendices 7, 8, 9, & 10). In Central California,

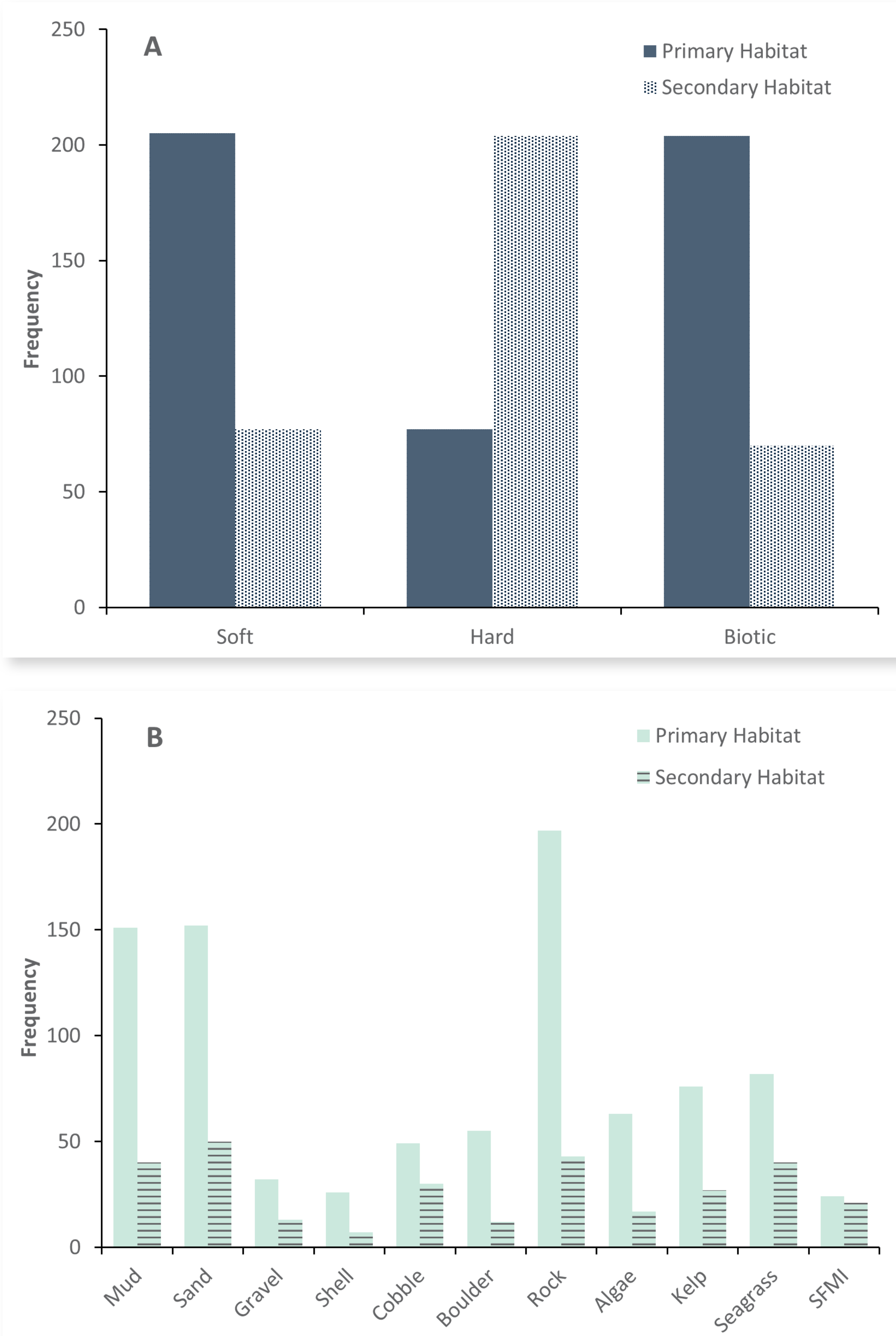


Figure 21. General (A) and specific (B) benthic habitat use by established fishes in the Central California ecoregion.

Note. Fishes can have multiple primary and secondary habitats (e.g., mud, sand, and gravel). Soft = Mud, Sand, and Gravel. Hard = Cobble, Boulder, and Rock. Biotic = Algae, Kelp, Seagrass, and SFMI. Gravel = gravel and pebbles. Algae = attached and drift algae other than kelp. Seagrass = eelgrass and surfgrass. SFMI = structure-forming marine invertebrates.

the depth distributions of at least 70 common and abundant species are centered in the subtidal component of the Core Zone (Appendices 9 & 10; Love 2011; Love et al. 2021). These include scorpionfishes (e.g., Blue Rockfish, Wooly Sculpin), surfperches (e.g., Rainbow Seaperch, Calico Surfperch), and a variety of additional taxa represented by spawning adults (e.g., Surf Smelt), juvenile anadromous fish (e.g., Coho Salmon), and a combination of resident YOY, juvenile, and adult (e.g., Black Rockfish) life stages. The maximum depth of 27 common or abundant Core Zone fishes (e.g., Tidepool Snailfish, Bay Pipefish) do not extend into the Seaward Zone (Appendices 9 & 10). The most abundant fishes in subtidal waters of the Core Zone include important forage species (e.g., Northern Anchovy, Pacific Herring, Pacific Sardine, Topsmelt), small benthic species (e.g., Penpoint Gunnel, Wooly Sculpin), bottom fishes (e.g., Olive Rockfish, White Croaker), and surfperches (Rainbow Seaperch, Shiner Perch; Appendices 9 & 10). Many large, mobile predators are common or abundant in subtidal waters of Central California, including the Bluntnose Sixgill Shark, Big Skate, Green Sturgeon, and Lingcod (Appendix 9).

Seaward Zone

At least 93 fishes are common or abundant in the Seaward Zone of Central California, including 62 species that also frequently inhabit the shallower depths of the Core Zone (Appendix 9). Twenty-five common or abundant subtidal fishes do not occur in the Seaward Zone, dominated by small benthic species, such as sculpins (e.g., Fluffy Sculpin), snailfishes (e.g., Slimy Snailfish), pricklebacks (e.g., Black Prickleback), and clingfishes (e.g., Kelp Clingfish). A few pelagic species (e.g., Topsmelt, Jacksmelt) and small gasterosteiform species that utilize the entire water column (e.g., Kelp Pipefish, Threespine Stickleback) also are common or abundant in the Core Zone but absent in the Seaward Zone. Conversely, no fishes common or abundant in the Seaward Zone are absent from the Core Zone (Appendices 9 & 10). Three common or abundant Seaward Zone fishes (Longnose Skate, Pygmy Rockfish, Shortspine Combfish) most frequently occur in waters beyond the Seaward Zone (Appendices 9 & 10). The most diverse taxa in this region comprises rockfishes (n = 20), elasmobranchs (n = 14), and flatfishes (n = 9; Appendices 9 & 10).

Central California Fish Assemblages: Habitat Associations

In the Central California Ecoregion, common and abundant soft-bottom-associated fishes are diverse but rarely documented in association with biotic habitats (Table 24). The soft bottom intertidal assemblage contains 18 species, half of which are shared with the Pacific Northwest assemblage (Tables 15 & 24). Novel species include sharks and rays (e.g., Gray Smoothhound, Bat Ray), small benthic fishes (e.g., Plainfin Midshipman, Spotted Cusk-Eel), and important fisheries species (e.g., White Croaker, California Halibut; Table 24). The subtidal soft bottom assemblage of the Core Zone con-

Table 24. Central California soft bottom and soft bottom biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Brown Smoothhound	*Mustelus henlei*	A	X	X	A
Soft Bottom	Spotted Cusk-eel	*Chilara taylori*	A	X	X	A
Soft Bottom	White Croaker	*Genyonemus lineatus*	A	X	X	A
Soft Bottom	Pacific Sanddab	*Citharichthys sordidus*	A	X	X	A
Soft Bottom	Gray Smoothhound	*Mustelus californicus*	C	X	X	R
Soft Bottom	Big Skate	*Beringraja binoculata*	C		X	C
Soft Bottom	Thornback Ray	*Platyrhinoidis triseriata*	C	X	X	R
Soft Bottom	Bat Ray	*Myliobatis californica*	C	X	X	C
Soft Bottom	Plainfin Midshipman	*Porichthys notatus*	C	X	X	C

Table 24. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Threespine Stickleback	*Gasterosteus aculeatus*	C	X	X	
Soft Bottom	Roughback Sculpin	*Chitonotus pugetensis*	C	X	X	R
Soft Bottom	Pygmy Poacher	*Odontopyxis trispinosa*	C		X	C
Soft Bottom	Showy Snailfish	*Liparis pulchellus*	C	X	X	C
Soft Bottom	Calico Surfperch	*Amphistichus koelzi*	C	X	X	
Soft Bottom	Spotfin Surfperch	*Hypocritichthys analis*	C	X	X	R
Soft Bottom	Pacific Sand Lance	*Ammodytes personatus*	C	X	X	C
Soft Bottom	Longjaw Mudsucker	*Gillichthys mirabilis*	C	X	X	
Soft Bottom	Speckled Sanddab	*Citharichthys stigmaeus*	C	X	X	C
Soft Bottom	California Halibut	*Paralichthys californicus*	C	X	X	C
Soft Bottom	Hornyhead Turbot	*Pleuronichthys verticalis*	C		X	C
Soft Bottom	Sand Sole	*Psettichthys melanostictus*	C	X	X	C
Soft Bottom	Pacific Hagfish	*Eptatretus stoutii*	R		X	C
Soft Bottom	California Skate	*Beringraja inornata*	R		X	C
Soft Bottom	Longnose Skate	*Beringraja rhina*	R		X	C
Soft Bottom	Longspine Combfish	*Zaniolepis latipinnis*	R		X	C
Soft Bottom	Spotfin Sculpin	*Icelinus tenuis*	R		X	C
Soft Bottom	Spinycheek Starsnout	*Bathyagonus infraspinatus*	R		X	C
Soft Bottom	Blackbelly Eelpout	*Lycodes pacificus*	R		X	C
Soft Bottom	Curlfin Sole	*Pleuronichthys decurrens*	R	X	X	C
Soft Bottom Biotic	Bay Pipefish	*Syngnathus leptorhynchus*	A	X	X	
Soft Bottom Biotic	Pacific Staghorn Sculpin	*Leptocottus armatus*	C	X	X	R
Soft Bottom Biotic	Barred Surfperch	*Amphistichus argenteus*	C	X	X	R
Soft Bottom Biotic	Arrow Goby	*Clevelandia ios*	C	X	X	R
Soft Bottom Biotic	Bay Goby	*Lepidogobius lepidus*	C	X	X	C
Soft Bottom Biotic	English Sole	*Parophrys vetulus*	C	X	X	C
Soft Bottom Biotic	Diamond Turbot	*Pleuronichthys guttulatus*	C	X	X	R
Soft Bottom Biotic	California Tonguefish	*Symphurus atricauda*	C	X	X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

tains all the corresponding intertidal fishes plus Big Skate, Pygmy Poacher, and Hornyhead Turbot (Table 24). It shares 11 species with the Pacific Northwest assemblage. All of these species primarily use a combination of sand and mud habitats except Pacific Sanddab (mud, sand, shell hash), Pacific Sand Lance (sand, gravel), Longjaw Mudsucker (mud), and three sand-associated species (Calico Surfperch, Spotfin Surfperch, Hornyhead Turbot; Appendix 10). Soft bottom biotic intertidal and subtidal assemblages consist of some of the same species that commonly use seagrass habitats, with five species shared between the Pacific Northwest assemblage (Tables 15 & 24). Five of these fishes also are primarily associated with mud and sand. In contrast, the Pacific Staghorn Sculpin also commonly associates with shell hash, the Barred Surfperch is found mainly over sand, and the Bay Pipefish is most strongly associated with seagrasses (especially eelgrass; Appendix 10). In the Seaward Zone of Central California, eight species that primarily have deeper distributions (e.g., California Skate, Longspine Combfish, Curlfin Sole) are also found in the soft bottom subtidal assemblage, and four others are present but rare in the Seaward Zone (e.g., Gray Smoothhound, Roughback Sculpin; Table 24). The soft bottom biotic assemblage of the Seaward Zone consists only of three species (Bay Goby, English Sole, California Tonguefish), all of which also are included in the corresponding subtidal assemblage (Table 24).

Hard bottom and especially hard bottom biotic assemblages in Central California exhibit high species richness but limited similarities between those of the Core and Seaward Zones (Table 25). Eight species, consisting mainly of scorpionfishes (e.g., Olive Rockfish, Cabezon, Painted Greenling), represent the intertidal hard bottom assemblage. Two additional rockfishes (Deacon Rockfish, Vermillion Rockfish) combine with the designated intertidal hard bottom assemblage to form the corresponding subtidal group in the Core Zone (Table 25). Eight of the 10 species in the hard bottom subtidal assemblage of Central California also are found in the Pacific Northwest fauna (Tables 16 & 25). All members of this assemblage primarily use consolidated rock bottoms of varying rugosity, but Copper Rockfish and Painted Greenling also are strongly associated with boulders, and the Vermillion Rockfish commonly utilizes cobbles, boulders, and rock outcrops (Appendix 10).

English Sole (*Parophrys vetulus*). (J. Tomelleri)

Cabezon (*Scorpaenichthys marmoratus*). (J. Tomelleri)

Thirty-one common and abundant hard-bottom-associated species in intertidal waters also frequently use biotic habitats (Table 25). Three additional species (Monkeyface Prickleback, China Rockfish, Kelp Rockfish) are also found in this assemblage to form the comparable subtidal assemblage (Table 25). Twenty-four of these species are strongly associated with kelp (e.g., Black Rockfish, Blue Rockfish, White Seabass, Kelp Pipefish), with 18, including eight kelp-associated fishes, also commonly inhabiting other algal habitats (e.g., Kelp Clingfish, Crevice Kelpfish; Appendix 10). Twenty hard bottom subtidal biotic species commonly utilize seagrass habitats in addition to rock, but all of these species also frequent other biotic habitats (e.g., Opaleye, Señorita, Fluffy Sculpin; Appendix 10). Primary use of SFMI is reported for Scalyhead Sculpin (anemones, barnacles) and Quillback Rockfish (cloud sponges). There is a high similarity with the hard bottom biotic subtidal assemblage of the Pacific Northwest, with 19 of the 23 species in that assemblage also included in the larger Central California assemblage (Tables 16 & 25).

The hard bottom Seaward Zone assemblage of Central California contains 13 species, seven of which also are

Table 25. Central California Hard Bottom and Hard Bottom Biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom	Olive Rockfish	*Sebastes serranoides*	A	X	X	A
Hard Bottom	Vermilion Rockfish	*Sebastes miniatus*	A		X	A
Hard Bottom	Bald Sculpin	*Clinocottus recalvus*	C	X	X	
Hard Bottom	Cabezon	*Scorpaenichthys marmoratus*	C	X	X	C
Hard Bottom	Copper Rockfish	*Sebastes caurinus*	C	X	X	C
Hard Bottom	Deacon Rockfish	*Sebastes diaconus*	C		X	C
Hard Bottom	Mosshead Sculpin	*Clinocottus globiceps*	C	X	X	R
Hard Bottom	Northern Clingfish	*Gobiesox maeandricus*	C	X	X	
Hard Bottom	Painted Greenling	*Oxylebius pictus*	C	X	X	C
Hard Bottom	Wolf-Eel	*Anarrhichthys ocellatus*	C	X	X	C
Hard Bottom	Calico Rockfish	*Sebastes dallii*	R	X	X	C
Hard Bottom	Canary Rockfish	*Sebastes pinniger*	R		X	C
Hard Bottom	Rosy Rockfish	*Sebastes rosaceus*	R		X	C
Hard Bottom	Squarespot Rockfish	*Sebastes hopkinsi*	R		X	C
Hard Bottom	Starry Rockfish	*Sebastes constellatus*	R		X	C
Hard Bottom	Widow Rockfish	*Sebastes entomelas*	R	X	X	C
Hard Bottom Biotic	Rockweed Gunnel	*Apodichthys fucorum*	A	X	X	
Hard Bottom Biotic	Snubnose Sculpin	*Orthonopias triacis*	C	X	X	
Hard Bottom Biotic	Brown Irish Lord	*Hemilepidotus spinosus*	C	X	X	C
Hard Bottom Biotic	Kelp Perch	*Brachyistius frenatus*	C	X	X	R
Hard Bottom Biotic	Monkeyface Prickleback	*Cebidichthys violaceus*	C		X	R
Hard Bottom Biotic	Crevice Kelpfish	*Gibbonsia montereyensis*	C	X	X	R
Hard Bottom Biotic	Kelp Greenling	*Hexagrammos decagrammus*	C	X	X	C
Hard Bottom Biotic	Manacled Sculpin	*Synchirus gilli*	C	X	X	
Hard Bottom Biotic	Spotted Kelpfish	*Gibbonsia elegans*	C	X	X	R
Hard Bottom Biotic	Striped Seaperch	*Embiotoca lateralis*	C	X	X	R
Hard Bottom Biotic	Kelp Clingfish	*Rimicola muscarum*	C	X	X	
Hard Bottom Biotic	Rock Prickleback	*Xiphister mucosus*	C	X	X	
Hard Bottom Biotic	Dwarf Perch	*Micrometrus minimus*	C	X	X	R
Hard Bottom Biotic	Reef Perch	*Micrometrus aurora*	C	X	X	

Table 25. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom Biotic	Slimy Snailfish	*Liparis mucosus*	C	X	X	
Hard Bottom Biotic	Rock Greenling	*Hexagrammos lagocephalus*	C	X	X	C
Hard Bottom Biotic	Fluffy Sculpin	*Oligocottus snyderi*	C	X	X	
Hard Bottom Biotic	Scalyhead Sculpin	*Artedius harringtoni*	C	X	X	R
Hard Bottom Biotic	Rubberlip Seaperch	*Rhacochilus toxotes*	C	X	X	C
Hard Bottom Biotic	Silverspotted Sculpin	*Blepsias cirrhosus*	C	X	X	C
Hard Bottom Biotic	Black Rockfish	*Sebastes melanops*	C	X	X	C
Hard Bottom Biotic	Black-and-Yellow Rockfish	*Sebastes chrysomelas*	C	X	X	R
Hard Bottom Biotic	Blue Rockfish	*Sebastes mystinus*	C	X	X	C
Hard Bottom Biotic	China Rockfish	*Sebastes nebulosus*	C		X	C
Hard Bottom Biotic	Gopher Rockfish	*Sebastes carnatus*	C	X	X	C
Hard Bottom Biotic	Kelp Rockfish	*Sebastes atrovirens*	C		X	R
Hard Bottom Biotic	White Seabass	*Atractoscion nobilis*	C	X	X	C
Hard Bottom Biotic	Kelp Pipefish	*Syngnathus californiensis*	C	X	X	
Hard Bottom Biotic	Opaleye	*Girella nigricans*	C	X	X	R
Hard Bottom Biotic	Pile Perch	*Phanerodon vacca*	C	X	X	C
Hard Bottom Biotic	Sailfin Sculpin	*Nautichthys oculofasciatus*	C	X	X	C
Hard Bottom Biotic	Señorita	*Halichoeres californicus*	C	X	X	C
Hard Bottom Biotic	Silver Surfperch	*Hyperprosopon ellipticum*	C	X	X	R
Hard Bottom Biotic	Quillback Rockfish	*Sebastes maliger*	C	X	X	C
Hard Bottom Biotic	Bocaccio	*Sebastes paucispinis*	R		X	C
Hard Bottom Biotic	Flag Rockfish	*Sebastes rubrivinctus*	R		X	C
Hard Bottom Biotic	Yellowtail Rockfish	*Sebastes flavidus*	R	X	X	A

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R= rare, and blank = absent.

Deacon Rockfish (*Sebastes diaconus*). (J. Tomelleri)

included in the corresponding subtidal Core Zone assemblage (Table 25). Additional species include six rockfishes with primarily offshore distributions (e.g., Calico Rockfish, Widow Rockfish), whereas three shallower-dwelling benthic species are excluded (Mosshead Sculpin, Bald Sculpin, Northern Clingfish; Table 25). The hard bottom biotic assemblage of the Seaward Zone contains only half the species common to the subtidal region (Table 25). Three rockfishes (Yellowtail Rockfish, Bocaccio, Flag Rockfish) rare in Core Zone subtidal waters commonly occur in the Seaward Zone (Table 25). There is a moderate similarity in species composition between hard bottom Seaward Zone assemblages in Central California, the Pacific Northwest, and Salish Sea, with about half of the total species in these assemblages shared between regions (Tables 16 & 25).

Central California soft- and hard-bottom-associated fishes and habitat generalists exhibit a limited similarity between Core and Seaward Zones (Tables 26 & 27). The soft and hard bottom intertidal assemblage consists of four taxonomically and ecologically diverse fishes (Pacific Electric Ray, Striped Bass, Mosshead Warbonnet, Blackeye Goby). Three additional large, mobile predators (Bluntnose Sixgill Shark, Green Sturgeon, White Sturgeon) complete the Core Zone subtidal assemblage (Table 26). Five of these species also are found in the Pacific Northwest soft and hard bottom subtidal assemblage (Tables 17 & 26). The Seaward Zone assemblage, which consists of all such subtidal species and five others (e.g., Halfbanded Rockfish, Spotted Ratfish, Pink Seaperch), is the largest among soft- and hard-bottom-associated fishes in Central California. Species richness of the hard bottom biotic intertidal and subtidal assemblages are equivalent and include several species of scorpionfish (e.g., Wooly Sculpin, Lingcod) and surfperch (e.g.,

Table 26. Central California Soft-Hard Bottom fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Blackeye Goby	*Rhinogobiops nicholsii*	A	X	X	A
Bluntnose Sixgill Shark	*Hexanchus griseus*	C		X	C
Pacific Electric Ray	*Tetronarce californica*	C	X	X	C
Green Sturgeon	*Acipenser medirostris*	C		X	C
White Sturgeon	*Acipenser transmontanus*	C		X	C
Striped Bass	*Morone saxatilis*	C	X	X	C
Mosshead Warbonnet	*Chirolophis nugator*	C	X	X	C
Spotted Ratfish	*Hydrolagus colliei*	R	X	X	C
Starry Skate	*Beringraja stellulata*	R		X	C
Halfbanded Rockfish	*Sebastes semicinctus*	R		X	A
Shortspine Combfish	*Zaniolepis frenata*	R		X	C
Pink Seaperch	*Zalembius rosaceus*	R	X	X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Table 27. Central California Habitat Generalist fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
High Cockscomb	*Anoplarchus purpurescens*	A	X	X	R
Leopard Shark	*Triakis semifasciata*	A	X	X	C
Penpoint Gunnel	*Apodichthys flavidus*	A	X	X	
Rainbow Seaperch	*Embiotoca caryi*	A	X	X	A
Tubesnout	*Aulorhynchus flavidus*	A	X	X	R
Woolly Sculpin	*Clinocottus analis*	A	X	X	
Black Perch	*Embiotoca jacksoni*	C	X	X	R
Black Prickleback	*Xiphister atropurpureus*	C	X	X	
C-O Sole	*Pleuronichthys coenosus*	C	X	X	R
Lingcod	*Ophiodon elongatus*	C	X	X	C
Onespot Fringehead	*Neoclinus uninotatus*	C	X	X	R
Saddleback Sculpin	*Oligocottus rimensis*	C	X	X	
Smoothhead Sculpin	*Artedius lateralis*	C	X	X	R
Tidepool Sculpin	*Oligocottus maculosus*	C	X	X	
Tidepool Snailfish	*Liparis florae*	C	X	X	
Walleye Surfperch	*Hyperprosopon argenteum*	C	X	X	R
White Seaperch	*Phanerodon furcatus*	C	X	X	C
Yellowfin Fringehead	*Neoclinus stephensae*	C	X	X	
Pacific Spiny Dogfish	*Squalus suckleyi*	R	X	X	C
Pygmy Rockfish	*Sebastes wilsoni*	R		X	A

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent. Generalist = similar use of soft, hard, and biotic habitats.

Bluntnose Sixgill Shark (*Hexanchus griseus*). (J. Tomelleri)


White Seabass (*Atractoscion nobilis*). (J. Tomelleri)

Rainbow Seaperch, Black Perch; Table 27). Nearly half of these species also are found in the hard bottom biotic subtidal assemblage of the Pacific Northwest (Tables 18 & 27). Unlike the hard and soft bottom Seaward Zone assemblage, habitat generalists in this region include similar species in comparison to Core Zone assemblages. The Seaward Zone habitat generalist fauna consists of six species, all but two of which (Pacific Spiny Dogfish, Pygmy Rockfish) also are members of the subtidal assemblage (Table 27). Half of the habitat generalist fishes in the Seaward Zone waters of the Pacific Northwest also are found in the Central California assemblage (Tables 18 & 27).

Pelagic fish assemblages in Central California, like those of the Salish Sea and Pacific Northwest, exhibit strong similarities across depth zones (Table 28). The intertidal assemblage is mainly represented by forage fishes (e.g., Pacific Herring, Pacific Sardine, Northern Anchovy) with early juvenile life stages of out-migrating salmon (e.g., Coho Salmon, Steelhead, Chinook Salmon) sporadically common in association with rivers and estuaries. Species composition of the subtidal pelagic assemblage contains one additional species (Whitebait Smelt) but is otherwise consistent with that of the intertidal. All fishes in the pelagic intertidal and subtidal assemblages of Central California also are found in the Pacific Northwest assemblage, which contains two additional salmonids (e.g., Chum Salmon, Sockeye Salmon; Tables 19 & 28). This continues a trend of decreasing salmonid representation among pelagic fish assemblages with decreasing latitude (Tables 10, 19, & 28). The pelagic assemblage of the Seaward Zone is very similar to that of the pelagic subtidal assemblage of the Core Zone (13 shared species) and is the same as the Pacific Northwest assemblage (Tables 19 & 28). Three species with mainly deeper, offshore distributions (Salmon Shark, Blue Shark, Pacific Hake) are incorporated, whereas two coastally oriented species (Jacksmelt, Topsmelt) are omitted.

Selected Marine Invertebrates

More than half of the invertebrates selected for the Central California Ecoregion are molluscs (Table 29). Three of these species (Owl Limpet, Lottia gigantea; Black Abalone, Haliotis cracherodii; and Pismo Clam, Tivela stultorum) were new to this ecoregion, but the other five selected species were also included in the Pacific Northwest fauna. All but the Red Abalone was additionally found in the Salish Sea (Table 2). The same crustacean fauna and echinoderm fauna were selected for Central California and the Pacific Northwest, indicating the importance of these species from the Canadian border to Point Conception. This similarity in species composition is not surprising, as general coastal habitat characteristics also are similar between regions. As in the more northern ecoregions, the great majority of selected invertebrates are primarily distributed in intertidal or subtidal waters of the Core Zone (Table 29). However, the California Market Squid mainly occurs in the Seaward Zone, and the Dungeness Crab and Red Rock Crab are commonly found from the intertidal to the inner continental shelf (Table 29). The Black Abalone is federally listed under the ESA, listed by NOAA Fisheries in 2009 and the U.S. Fish and Wildlife Service in 2011 (Raimondi et al. 2015).


Longfin Smelt (*Spirinchus thaleichthys*). (J. Tomelleri)

Table 28. Central California pelagic fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Taxon	Core	Intertidal	Subtidal	Seaward
Northern Anchovy	*Engraulis mordax*	A	X	X	A
Pacific Herring	*Clupea pallasii*	A	X	X	A
Pacific Sardine	*Sardinops sagax*	A	X	X	A
Topsmelt	*Atherinops affinis*	A	X	X	
Jacksmelt	*Atherinopsis californiensis*	A	X	X	
Whitebait Smelt	*Allosmerus elongatus*	C		X	C
Night Smelt	*Spirinchus starksi*	C	X	X	C
Longfin Smelt	*Spirinchus thaleichthys*	C	X	X	C
Coho Salmon	*Oncorhynchus kisutch*	C	X	X	C
Steelhead	*Oncorhynchus mykiss*	C	X	X	C
Chinook Salmon	*Oncorhynchus tshawytscha*	C	X	X	C
Pacific Saury	*Cololabis saira*	C	X	X	C
Pacific Chub Mackerel	*Scomber japonicus*	C	X	X	C
Salmon Shark	*Lamna ditropis*	R		X	C
Blue Shark	*Prionace glauca*	R		X	C
Pacific Hake	*Merluccius productus*	R		X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Recent research on selected Central California molluscs provides relative abundance and habitat information for Market Squid and describes the status and potential recovery of Red, Black, and Pinto Abalones. In pelagic trawl surveys conducted from Central California to southern Washington, Market Squid abundance was greater in Central California (36.5–40.5° N) than in the Pacific Northwest (Friedman et al. 2018). Additionally, the spawning habitat for Market Squid in Central California was documented between 13–61 m, significantly shallower than deposition sites in Southern California (20–93 m). Off Central California, spawning was largely restricted to sand seafloors at temperatures between 10–12 °C (Zeidberg et al. 2011). Recruitment of Red Abalone in Monterey Bay, where it naturally occurs in highly aggregated, low-density populations because of Sea Otter predation, was generally consistent from 2012–2016 and documented to occur year-round (Hart et al. 2020). In Central California, where populations were unaffected by Withering Syndrome, Black Abalone density is high despite high Sea Otter density, as Black Abalone typically occupy habitat that provides refuge from predation (Raimondi et al. 2015). Black Abalone was once extremely abundant south of Point Lobos, California, but has experienced severe recent declines in Southern California because of Withering Syndrome (Ault et al. 1985; Ben-Horin et al. 2013), which has substantially reduced the species' ecological impact (Raimondi et al. 2015). These declines led the NOAA Fisheries to designate it as a federal endangered species in 2009. In Mendocino and Sonoma Counties, Pinto Abalone densities were greatest at depths greater than 10 m and above the threshold for successful reproduction. Recruitment to the more abundant Mendocino population also was documented (Neuman et al. 2018).

A harvest moratorium and MPAs demonstrated differential effects for abalone conservation and restoration. No trends in Red Abalone abundance or size were documented in Monterey County during 32 years of monitoring in the absence of harvesting; however, Black Abalone were larger and Red Abalone were more abundant in MPAs than in open-access sites. These results suggest that illegal poaching may be hampering the recovery of Red Abalone outside of no-take zones in Central California (Micheli et al. 2008). Furthermore, Rogers-Bennett et al. (2013) caution against the use of temporal no-take zones after documenting precipitous declines in size and abundance of Red Abalone at a reserve in Mendocino County within three years of the onset of harvesting.

Owl Limpet and Pismo Clam populations in Central California have been reduced, and their life histories have been altered by recreational and commercial harvesting. A long history of size-selective harvesting of the

Table 29. Occurrence of selected invertebrates in the Central California Ecoregion among nearshore zones and established coastal regions.

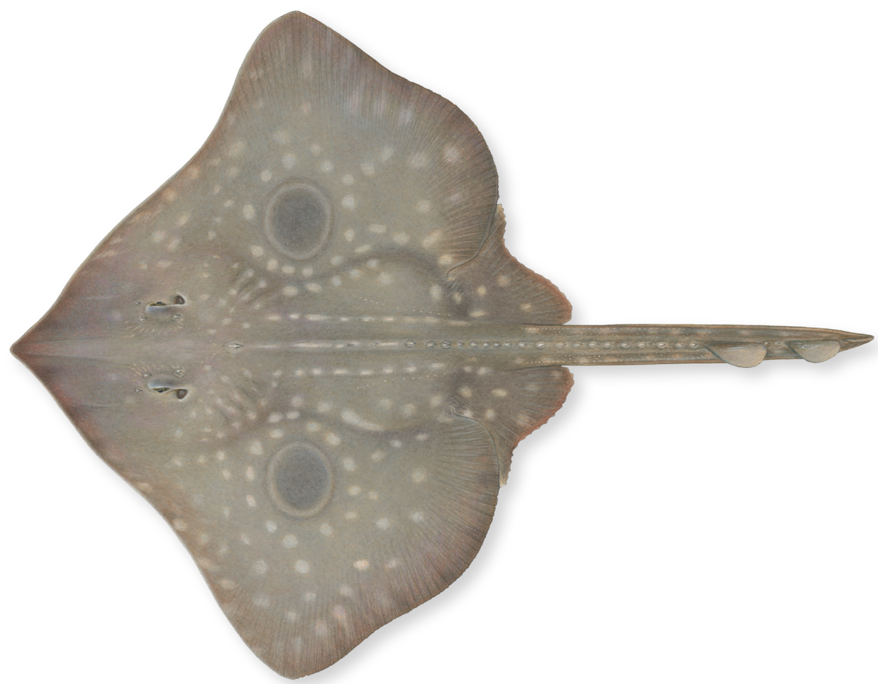
	Core		
Higher Taxon/Species	**Intertidal**	**Subtidal**	**Seaward**
MOLLUSCA			
Owl Limpet (*Lottia gigantea*)	Black		
Black Abalone (*Haliotis cracherodii*)	Black	Vertical hatch	
Pinto Abalone (*Haliotis kamtschatkana*)	Black	Black	
Red Abalone (*Haliotis rufescens*)	Vertical hatch	Black	Diagonal hatch
Pismo Clam (*Tivela stultorm*)	Black	Vertical hatch	
California Market Squid (*Doryteuthis opalescens*)		Vertical hatch	Black
Giant Pacific Octopus (*Enteroctopus dofleini*)	Vertical hatch	Black	Vertical hatch
Red Octopus (*Octopus rubescens*)	Black	Vertical hatch	Diagonal hatch
CRUSTACEA			
Pacific Sand Crab (*Emerita analoga*)	Black	Vertical hatch	
Dungeness Crab (*Metacarcinus magister*)	Black	Black	Black
Red Rock Crab (*Cancer productus*)	Black	Black	Black
ECHINODERMATA			
Ochre Sea Star (*Pisaster ochraceus*)	Black	Black	
Sunflower Sea Star (*Pycnopodia helianthoides*)	Vertical hatch	Black	Vertical hatch
Purple Sea Urchin (*Strongylocentrotus purpuratus*)	Black	Black	Vertical hatch
Red Sea Urchin (*Mesocentrotus franciscanus*)	Diagonal hatch	Black	Vertical hatch

Note. When possible, regional depth distributions were used. Intertidal = Splash Zone to MLLW, Subtidal = MLLW to 30 m, and Inner Shelf = 30–100 m. Black = primary depth range, dark gray with vertical hatch marks = secondary depth range, light gray with diagonal hatch marks = tertiary depth range, and white = absent. All utilized citations are provided in the text.

California Owl Limpet has resulted in differences in life history, body size, and demography among exploited and protected populations; however, evidence of high rates of gene flow among California Owl Limpet populations indicates that these differences are largely due to phenotypic plasticity (Fenberg et al. 2010). During 2014–2016, massive increases in the recruitment of Owl Limpets occurred in the Bodega Marine Reserve in Northern California in association with more favorable temperature regimes driven by the marine heatwave (Sanford et al. 2019). The Pismo Clam once supported a significant commercial fishery in California (1916–1947), along with an extremely popular recreational fishery. A combination of overharvesting and Sea Otter predation have reduced populations of Pismo Clams and overall clam size; consequently, the recreational fishery is largely inactive because clams that meet size requirements for legal take remain exceedingly rare (Pattison and Lampson 2008; CDFW 2021a).

Paralytic shellfish toxins are produced by HABs, which are becoming more frequent in the eastern North Pacific (Zhu et al. 2017). High concentrations of these toxins were detected in Red Rock Crab and Pacific Sand Crab from Central California (Bretz et al. 2002; Jester et al. 2009). These species may represent important disease vectors, as they are abundant throughout Central California and are preyed upon by a suite of predators in the middle and upper levels of the trophic cascade. Additionally, Bretz et al. (2002) demonstrated that Pacific Sand Crab could be used as an effective bioindicator species in sandy regions where the typically utilized California Mussel does not occur. Throughout the Central California coast, Diehl et al. (2007) demonstrated that wind stress and its influence on the timing and extent of upwelling affects the magnitude and variability of recruitment of Pacific Sand Crabs to intertidal nursery habitats (Diehl et al. 2007).

Ecological associations and interactions of Purple Sea Urchin, Red Sea Urchin, and Ochre Sea Star recently have been investigated off Central California. In the Bodega Marine Life Reserve, differences in density, depth, and food availability influenced the realized distributions of Red Sea Urchins and Red Abalone, whereas the distribution of Purple Sea Urchins were not correlated with the other species' distributions (Karpov et al. 2000). Laboratory experiments indicated that Purple Sea Urchin occupy cavities and pits in rocks at the expense of feeding and suggested that this species prioritizes protection habitat refugia over reproduction (Haas et al. 2018). Ochre Sea Stars were mainly found in thermal refugia during low tide in the Bodega Marine Life Reserve even when the risk of thermal stress was low, suggesting a similar risk avoidance strategy (Monaco et al. 2015). Red Sea Urchins and Purple Sea Urchins are tolerant of severe hypoxia but experience significant declines in grazing activity at oxygen levels below 5.5 mg/L (Low and Micheli 2018).



Big Skate (*Beringraja binoculataa*). (J. Tomelleri)

Based on recently documented oxygen levels in Monterey Bay, these urchins are unlikely to experience direct mortality but may experience protracted periods of sublethal effects that reduce grazing rates (Low and Micheli 2018). Ochre Sea Stars were determined to influence the distribution of Tegula snails in the northern portion of the Central California Ecoregion, while the presence of other predators did not have the same influence, demonstrating the importance of this keystone predator in the rocky nearshore habitats of north Central California (Murie and Bourdeau 2019).

Soupfin Shark. (A. Obaza, Paua Marine Research Group)

SOUTHERN CALIFORNIA BIGHT MARINE ECOREGION

Distribution and Abundance of CMECS Habitat Types Among Nearshore Zones

The Southern California Bight region extends south from Point Conception to the border of California and Mexico. It includes four of the Channel Islands (Santa Cruz, Santa Barbara, Santa Catalina, and San Clemente Islands; Fig. 2). The region constitutes the greatest relative area of the Core Zone (23.2%) among outer coast regions, with 92% of the zone in state waters (Table 30). The amounts of surface area contained in the Seaward Zone (39.7%) and in the Outer Shelf Zone (37.1%) are similar. The Core Zone extends farthest offshore in association with Long Beach (~9 km), north of Hueneme Canyon near Ventura (~11 km), and offshore of San Diego Bay (~8 km; Fig. 22). Unlike the islands off Central California, water depth drops off rapidly in association with the central and southern islands of the Southern California Bight (Santa Barbara, Santa Catalina, and San Clemente Islands), and in these areas, Core Zone waters are sparse (Fig. 22). The Seaward Zone extends and contracts throughout this region, with 65% of the surface area located in state waters. It ranges farthest offshore in association with embayments and is narrowest along relatively straight coastlines (Fig. 22). Outer Shelf Zone waters are mainly associated with the central and southern islands and are found in patches along the coast (Fig. 22). Consequently, a large portion (~68%) of the Outer Shelf Zone is contained within state waters.

Habitat Data Source Summary

Twenty source datasets contributed to the substrate compilation in Southern California Bight (Appendix 4, region SCB), with the most significant spatial area contributions coming from the UCSC predicted substrate map created for the CDFW (Datasets 12 & 13 in Appendix 4), the USGS California State Waters Map Series data (Datasets 26–32, 34–41, 43–50, & 61 in Appendix 4), and the EFH SGH dataset (Dataset 3 in Appendix 4). The USGS and EFH SGH datasets allowed for more detailed crosswalks to CMECS: Some of the source datasets were already crosswalked into CMECS; otherwise, the source habitat information was detailed to allow for finer levels (subclass, group, or subgroup) of classification. The USGS datasets were all considered of high quality and generally allowed for at least subclass-level classification. The EFH SGH dataset was West Coast–wide; however, it varied spatially in data quality. Some of the source datasets south of Fort Bragg had low quality and low resolution and therefore provided coarse substrate predictions for certain areas. The UCSC map, which included high-quality data of good resolution, was only classified into two categories (rock or sediment) and therefore could only be crosswalked to the CMECS class level.

Other datasets that contributed information to this study's substrate component included an Ocean Imaging multispectral imagery dataset for the south coast (Dataset 16 in Appendix 4), a San Diego County nearshore

Table 30. Total area and relative percentage of CMECS Aquatic Setting types in PMEP Scope Boundary within the nearshore zones of the Southern California Bight.

Nearshore Zone		CMECS Aquatic Setting	Area (ha)	Area (%)
Core Zone		3.1 Marine Nearshore	146,100	23.2%
	Subtotal		**146,100**	**23.2%**
Seaward Zone		3.2 Marine Offshore	249,957	39.7%
	Subtotal		**249,957**	**39.7%**
Outer Shelf		3.3 Oceanic	233,238	37.1%
	Subtotal		**233,238**	**37.1%**
	Total		**629,294**	**100.0%**

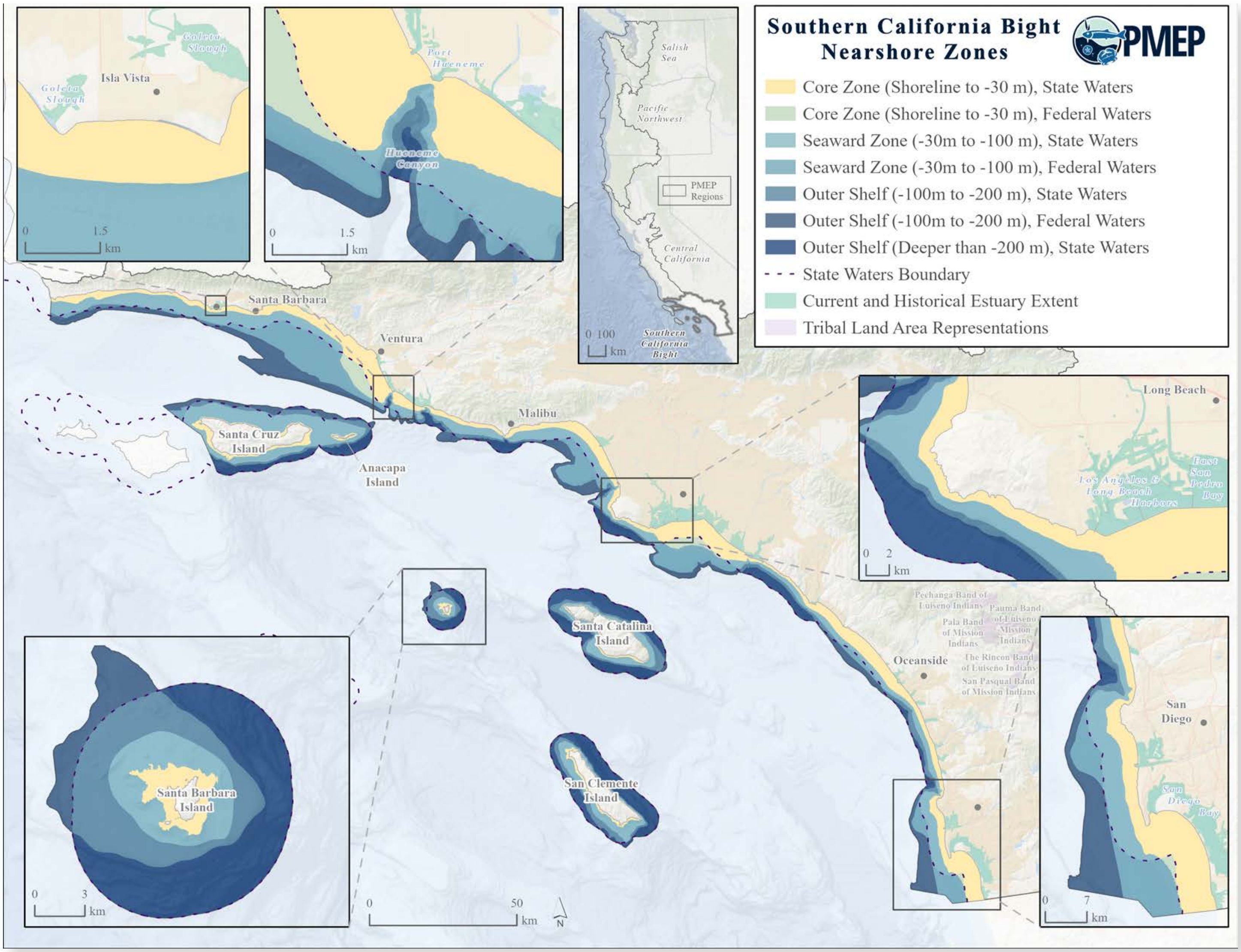


Figure 22. Distribution of nearshore zones and adjacent offshore and inshore regions in the Southern California Bight Ecoregion.

substrate habitat map (Dataset 14 in Appendix 4), and a Channel Islands National Park habitat map (Datasets 63 & 64 in Appendix 4). All three of these datasets allowed for at least CMECS subclass-level classification.

Eight source datasets contributed to the biotic component in the Southern California Bight region (Appendix 4, region SCB). Three high-quality, region-wide datasets contributed to the canopy-forming macroalgae (kelp) category (Datasets 17, 19, & 23 in Appendix 4). There was one dataset for faunal beds (70). It mainly included relatively low-quality clam bed data along the shoreline from the Environmental Sensitivity Index, where area extent was based on expert opinion. Three datasets mapped the extent of seagrass (Datasets 4, 17, 20, & 22 in Appendix 4), including Ocean Imaging's South Coast dataset, a high-quality dataset that maps the extent of surfgrass (*Phyllospadix* spp.); PMEP's U.S. West Coast eelgrass dataset, which is the most current and comprehensive summary of eelgrass in the region; and the Environmental Sensitivity Index benthic habitat dataset, which includes data on the extent of surfgrass along the U.S. West Coast. The NWI and NOAA's national-level seagrass dataset contributed class- and subclass-level classifications for aquatic beds and aquatic vascular vegetation but did not provide more detailed information to distinguish seagrass from macroalgae.

Core Zone

Similar to the Core Zones of the other ecoregions, the majority of the documented substrate types in the Southern California Bight are unconsolidated; however, most of the area is characterized in CMECS at the class level of unconsolidated mineral substrate (52.5%). These unclassified mineral substrates are a result of the simple two-category classification from the CDFW dataset. This substrate type dominates Core Zone regions throughout the middle of the ecoregion and in association with each depicted island (Fig. 23). Fine unconsolidated substrate in the Core Zone, consisting largely of sand (19.7%) and sandy mud (15.6%), was primarily mapped at the northern and southern portions of the bight and was found to contribute 36.8% of the total area (Fig. 23). In these regions, data from the USGS California State Waters Map Series and data from the San Diego Association of Governments (SANDAG) provided more detailed classifications of predicted substrate data to crosswalk to CMECS. As in other ecoregions, coarse unconsolidated substrate was rarely documented (2.1%) and consisted of similar proportions of cobble and gravel-based substrate types (Table 31). Rock habitat (8.6%) in the Core Zone was mainly documented in the northern part of the ecoregion, off the western side of San Clemente Island, off of Santa Barbara Island, and outside of San Diego

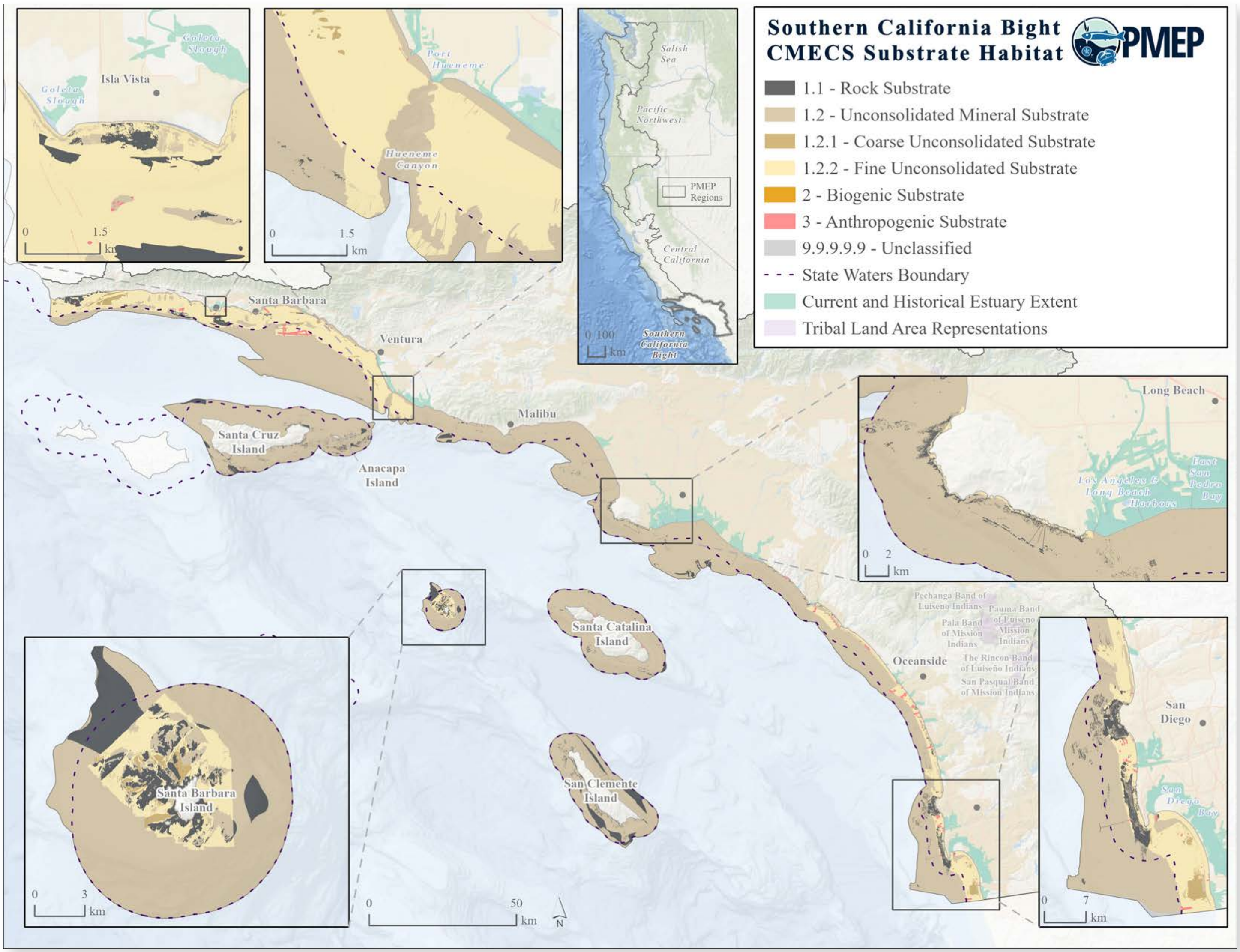


Figure 23. Distribution of CMECS substrate habitats in the Southern California Bight Ecoregion.

Table 31. Total area and relative percentage of CMECS substrate types in the Core and Seaward Zones of the Southern California Bight.

CMECS Substrate Category	Substrate Details	Core Zone Area (ha)	Core Zone Area (%)	Seaward Zone Area (ha)	Seaward Zone Area (%)
Rock substrate	Rock Substrate	7,406	5.07	5,620	2.25
	Bedrock	5,080	3.48	2,696	1.08
	Subtotal	**12,486**	**8.55**	**8,316**	**3.33**
Unconsolidated mineral substrate	Unclassified	**76,701**	**52.50**	**196,393**	**78.57**
Coarse unconsolidated substrate	Boulder	2	0.00	0	0.00
	Cobble	1,491	1.02	0	0.00
	Gravel	124	0.08	47	0.02
	Gravelly Sand	929	0.64	2,024	0.81
	Sandy gravel	479	0.33	216	0.09
	Subtotal	**3,025**	**2.07**	**2,288**	**0.92**
Fine unconsolidated substrate	Slightly Gravelly Sand	0	0.00	115	0.05
	Medium Sand	2,247	1.54	2,966	1.19
	Sand	28,736	19.67	6,223	2.49
	Silty Sand	1	0.00	186	0.07
	Sandy Mud	22,724	15.55	30,722	12.29
	Sandy Silt-Clay	0	0.00	1,862	0.75
	Mud	2	0.00	45	0.02
	Unclassified	81	0.06	78	0.03
	Subtotal	**53,790**	**36.82**	**42,198**	**16.88**
Biogenic substrate	Shell Hash	2	0.00	16	0.01
	Subtotal	**2**	**0.00**	**16**	**0.01**
Anthropogenic substrate	Anthropogenic Rock	1	0.00	39	0.02
	Metal	4	0.00	0	0.00
	Unclassified	59	0.04	46	0.02
	Subtotal	**64**	**0.04**	**85**	**0.03**
Unclassified	Unclassified	**33**	**0.02**	**660**	**0.26**
	Total	**146,100**	**100.00**	**249,957**	**100.00**

Bay (Fig. 23). Only minor amounts of organic (i.e., shell hash) and anthropogenic substrates were documented (Table 31).

Like the Core Zone off Central California, benthic macroalgae contributes approximately 10% to the total mapped area of biotic habitat types, with the great majority consisting of canopy-forming algae beds (i.e., kelp; 9.7%). Kelp beds are mapped throughout most of the Core Zone of the Southern California Bight. There is reduced coverage of kelp beds off Hueneme and Mugu Canyons, in Santa Monica Bay, and off Long Beach. There are expansive beds in the southern extent of the bight, off the western coast of San Clemente Island, and surrounding Santa Barbara Island (Fig. 24). Seagrass has local or subregion-level mapping and is documented throughout the Channel Islands, particularly Santa Cruz Island, Santa Catalina Island, from Point Conception to Santa Barbara, and around the shoreline between Carlsbad to San Diego Bay. Among the three outer coast ecoregions, each of which has good coverage, eelgrass (*Zostera* spp.) is primarily documented in only a few locations along the mainland coast of the Southern California Bight. In addition, multiple datasets, including Ocean Imaging's South Coast dataset and the Environmental Sensitivity Index, documented surfgrass in the region. Therefore, seagrass has more extensive documentation in the Southern California Bight than in the other regions of the outer coast. Other biotic habitat types, including floating/suspended plants and biota (representative of beach wrack), faunal beds, and other unclassified species of macroalgae, had limited or incomplete mapping and were only documented in trivial amounts (Table 32). The great majority of the region is unclassified for biotic habitat types (88.6%).

Seaward Zone

Most of the documented substrate types in the Seaward Zone of the Southern California Bight consist of unconsolidated mineral substrate (78.6%), with fine unconsolidated substrate also well represented (16.9%). Unconsolidated mineral substrate is found throughout the region, especially in the middle Bight and in association with Santa Cruz, Santa Catalina, and San Clemente Islands. Fine unconsolidated substrate, consisting

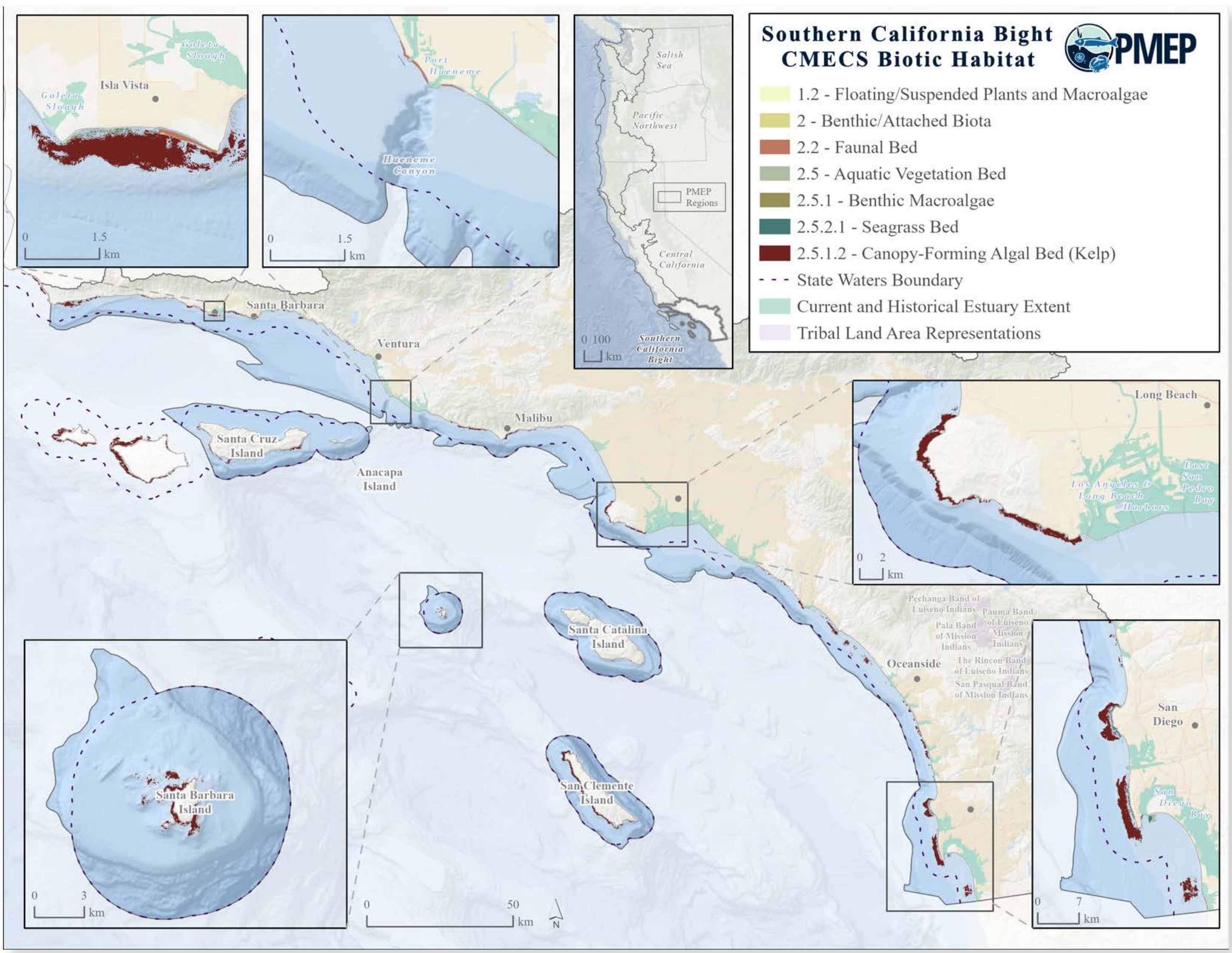


Figure 24. Distribution of CMECS biotic habitats in the Southern California Bight Ecoregion.

Table 32. Total estimated mapped area based on the maximum observed extent of a habitat type, relative percentage of total zone area, and data completeness status for each CMECS biotic category off the Southern California Bight.

Biotic Category	CMECS Habitat Details (Group)	Core Zone		Seaward Zone		Spatial Data Completeness
		Area (ha)	Area (%)	Area (ha)	Area (%)	
1 - Floating / Suspended Plants and Biota		0	0.0%	0	0.0%	Limited or incomplete mapping
2 - Benthic / Attached Biota		15,281	10.5%	116	0.0%	Limited or incomplete mapping
2.2 - Faunal Bed		5	0.0%	0	0.0%	Limited or incomplete mapping
2.5 - Aquatic Vegetation Bed		14,820	10.1%	0	0.0%	Limited or incomplete mapping
Benthic Macroalgae	2.5.1.2 - Canopy-Forming Algal Bed (Kelp)	14,221	9.7%	114	0.0%	Region-wide mapping
	2.5.1 - Other (Unclassified)	243	0.2%	1	0.0%	Limited or incomplete mapping
Aquatic Vascular Vegetation	2.5.2 - Seagrass Bed	**356**	**0.2%**	**0**	0.0%	Local or subregion-level mapping
	Total Zone Area	**146,100**		**249,957**		

Note. Because they are more specific, subcategories may have a greater amount of mapped area than more generalized categories in which they are contained. The biotic area estimates are limited by data availability; certain biotic datasets have more extensive and complete habitat mapping than others and are ranked for data completeness using the following categories:

- **No data**: No spatial-extent data were available
- **Limited or incomplete mapping**: Mapping of habitat is limited in scope and is known to be an insufficient estimate of area
- **Local or subregion-level mapping**: Mapping efforts exist at the local/subregion scale, and the regional area calculation is likely an underestimate
- **Region-wide mapping**: Mapping efforts exist across the region and provide a coarse estimate of area

primarily of sandy mud (12.3%), is largely restricted to the northern margin of the bight and off Santa Barbara Island (Fig. 23). These geographic differences in classification levels are similar to those of the Core Zone, where source dataset classification levels differed. The amount of mapped coarse unconsolidated substrate is trivial (0.9%), as is biogenic (0.01%), anthropogenic (0.03%), and unclassified (0.26%) substrate types. Rock substrate contributes 3.3% to the total mapped area and is mainly located off Santa Barbara and western San Clemente Island. It is otherwise scattered throughout the Seaward Zone of the bight.

Almost all of the mapped area in the Seaward Zone of the Southern California Bight is unclassified for biotic habitats (Table 32). Canopy-forming algal beds (i.e., kelp) contribute 0.05% to the total area. They are associated with Santa Catalina and San Clemente Islands and with small portions of the northern and southern extents of the bight. The only other documented biotic habitat type, consisting of a single hectare, is other (unclassified) benthic macroalgae (Table 32).

Landward Zone

The physical orientation of the Southern California Bight shoreline creates coastal habitat characteristics that distinguish it from the other outer coast ecoregions. This region is buffered from the effects of waves and large-scale patterns of water currents, mainly generated from the northwest, resulting in a relatively low-energy nearshore environment. In addition, freshwater runoff is limited by a relative lack of rainfall and riverine input. Consequently, the Landward Zone of this region is dominated by sandy beaches, sometimes including gravel (Gleason et al. 2004). Rocky portions of the Landward Zone are mainly limited to punctuated occurrences on offshore islands. The Southern California Bight is the most developed of the four West Coast ecoregions, with dense population centers along the coast. Shoreline armoring is especially pronounced in this region, encompassing 38% of the coastline (Griggs and Patsch 2019). Beach nourishment is also pronounced in this region and may bury shallow nearshore reefs and degrade beach habitat quality (Wooldridge et al. 2016). The Landward Zones of many estuaries in this region, which are largely associated with small stream outflows or lagoons (Magu Lagoon), have been substantially altered by shoreline hardening (Gleason et al. 2004). Furthermore, approximately 75%–78% of the wetland habitat in the Southern California Bight, including formerly extensive coastal marshes, has been lost, largely because of shoreline hardening, dredging, draining, and filling (e.g., San Diego Bay; Stein et al. 2014).

Pacific Pompano (*Peprilus simillimus*). (J. Tomelleri)

Quillback Rockfish, 10/05/2018. (ODFW)

DIVERSITY FROM A DYNAMIC CONFLUENCE

by Bryant Chesney, NOAA

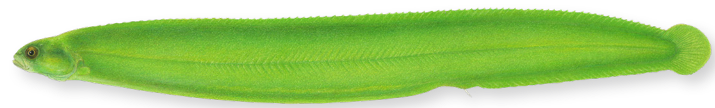
As the California Current flows southward, the adjacent shoreline encounters a sharp bend to the east near Points Arguello and Conception in California, and yields a unique ecoregion commonly called the Southern California Bight. The convergence of cold and warm temperate ocean water masses, the morphology of Southern California's shoreline and complex offshore geological formations, and the semi-arid Mediterranean climate contribute to unique oceanographic qualities that provide a dynamic backdrop for diverse fish assemblages. Traditional biogeographic faunal boundaries identify this ecoregion as a transitional area between the San Diegan Province that goes farther south into Mexico and the Oregonian Province that extends north to British Columbia, Canada. The transitional nature of the ecoregion supports the highest number of both southern- and northern-range end points for fish species along the West Coast of the continental United States.

As described in the main report, the Southern California Bight also harbors the highest number of fish species within the geographic scope of this study. In addition to a great diversity of rockfishes and associated groundfish species, nearshore marine habitats in the Bight support a higher abundance and diversity of warm temperate and subtropical species compared to ecoregions farther north. For example, there are more species of requiem sharks, croakers, jacks, mackerels, tunas, gobies, and blennies in the bight. In addition, various species of damselfish, wrasse, and sea bass are generally more abundant in the bight.

Similar to other ecoregions farther north, rocky reef and kelp habitats in the bight support diverse and productive fish assemblages. Some of these species have particular cultural, ecological, and/or economic importance to the region. In addition to the Southern California Bight's productive Giant Kelp (*Macrocystis pyrifera*) forest communities. Another foundational species of submerged aquatic vegetation relatively unique to the Bight is Pacific Eelgrass (*Zostera pacifica*), which occurs in various locations along the mainland and Channel Islands. Southern California is also famous for its surf and sandy beaches, and a unique coastal pelagic species takes advantage of this same habitat, but during the nighttime hours. California Grunion (*Leuresthes tenuis*) spawn along Southern California shorelines by completely emerging from the water at high tides to lay their eggs on sandy beach habitat.


A Garibaldi in the kelp forest. Santa Catalina Island, Goat Harbor, California. (A. Obaza, Paua Marine Research Group)

The ecoregion's nearshore habitat connectivity is particularly complex given the unique physical oceanography and the patchwork of deep ocean basins, islands, and submerged banks. Nearshore connectivity is highly dependent upon location, season, and interannual oceanographic variability. In some cases, limited dispersal and recruitment patterns associated with the Bight's complex circulation patterns can have important population ecology and conservation implications. In addition, the natural processes that support many of the Bight's historical estuaries and associated wetland habitats have been significantly altered, and the majority of the coastal landscape has been transformed by intensive coastal development. Thus, connectivity between the marine nearshore, estuaries, and their adjacent watersheds is significantly hampered by a gauntlet of infrastructure, habitat fragmentation and loss, fish passage impediments, and sediment management stressors.



Rockweed Gunnel (*Apodichthys fucorum*). (J. Tomelleri)

Fish Fauna, Fish Assemblages, and Selected Invertebrates: Summary Points

Species richness of nearshore ichthyofauna increases with decreasing latitude among ecoregions. The Southern California Bight Ecoregion is the most diverse, including 478 species among 38 orders and 135 families. Unlike the other three ecoregions, perches (Perciformes, 197 species) outnumber scorpionfishes (Scorpaeniformes, 118 species).

Species richness is greater in the Palos Verdes to Mexico subregion (n = 453) than in the Point Conception to Palos Verdes subregion (n = 406). Also, it is greater in the Core Zone (449 total, 120 common or abundant) than in the Seaward Zone (404 total, 102 common or abundant).

The number of common and abundant fishes among Southern California Bight assemblages is greatest in the subtidal area of the Core Zone (n = 119) and similar in the intertidal area (n = 99) and Seaward Zone (n = 103).

Mainly driven by the pronounced temperature discontinuity at Point Conception, fish assemblages in Southern California exhibit a moderate to low similarity to the more northern ecoregions.

Five invertebrate species were uniquely selected for the Southern California Bight Ecoregion (Spiny Lobster, *Panulirus interruptus*; Warty Sea Cucumber, *Apostichopus parvimensis*; Green Abalone, *Haliotis fulgens*; Pink Abalone, *H. corrugata*; and White Abalone, *H. sorenseni*). However, the other 11 species were found among the Central California fauna, and eight of these species also were found in the Pacific Northwest Ecoregion.

The elevated temperatures and sheltered coastlines of the South California Bight relative to more northern parts of the U.S. West Coast influenced the selection of invertebrates, as most of the newly selected species have warm-temperate and subtropical distributions and prefer quiescent waters.

Biological characteristics of abalones (e.g., episodic recruitment, extreme longevity) make them vulnerable to overexploitation and climate change and have resulted in population declines for all of the selected species in the Southern California Bight.

White Abalone was the first marine invertebrate to be federally listed as endangered by NOAA Fisheries in 2001. Black Abalone was listed as in 2009 (NMFS).

Southern California Bight Ichthyofaunal Characteristics and Fish Assemblages

Southern California Bight Ichthyofauna

The Southern California Bight has the greatest species richness among ecoregions, with 478 fishes frequenting waters less than or equal to 100 m (Appendix 11). These species are distributed among 38 orders and 135 families, with the most species-rich taxa being Perciformes (perches, 197 species), Scorpaeniformes (scorpionfishes, 118 species), Scorpaenidae (rockfishes and thornyheads, 62 species), and Psychrolutidae (marine sculpins, 26 species). The number of perciform higher taxa and species is higher in this ecoregion compared to others. The great majority of established nearshore fishes in the Southern California Bight inhabit marine or estuarine waters (91.3%); however, 12 are anadromous (2.5%), including four salmonids, and 28 also occur in freshwater (5.9%). Most nearshore fishes in the Southern California Bight Marine Ecoregion occupy benthic and demersal waters (77.6%), whereas 15.9% are pelagic, and 6.5% occur throughout the water column (Appendix 12). Seven exotic fishes have established populations in the Southern California Bight (Appendix 12).

Vermilion Rockfish (*Sebastes miniatus*). (J. Tomelleri)

The physical orientation of the Southern California Bight buffers it from wave energy associated with the California Current and creates more quiescent nearshore conditions than those of ecoregions to the north. Complex local current patterns are evident throughout this region, resulting from mixing the offshore California Current and weaker nearshore countercurrents. Point Conception is situated at a pronounced faunal break created by a strong temperature discontinuity (Briggs 1974; Horn et al. 2006). As a result, the Southern California Bight contains more warm-temperature ichthyofauna than the mainly cold-temperate fauna of the Pacific Northwest and Central California Ecoregions. Tropical fishes also commonly immigrate to this region during periods of warmer water from northward current flow (Hubbs 1960). The continental shelf broadens considerably in the Southern California Bight and contains a series of basins and islands (e.g., Channel Islands) of differing sizes and distances from offshore. Freshwater input is negligible in this area, and estuarine influences are limited compared to regions to the north. Because of its elevated temperatures, relatively high productivity, and lack of large predators, this region supports the nursery grounds of juveniles of several large coastal and pelagic shark species (e.g., Dewar et al. 2004; Cartamil et al. 2010). Giant Kelp forests are widespread in the Southern California Bight and serve as important habitats for many nearshore fishes.

The relative number of endangered and threatened fishes in the Southern California Bight is considerably less than that of other regions, mainly because of more limited freshwater drainages and an associated lack of anadromous fishes. The Northern Tidewater Goby and Southern California DPS of Steelhead are federally listed as endangered. Eulachon is federally listed as threatened throughout its range but rarely occurs in the Southern California Bight.

Regional and Subregional Characteristics of Southern California Bight Ichthyofauna

The total number of established nearshore fishes varies between Southern California Bight subregions, but the number of common and abundant species is similar (Fig. 25). Species richness is greater in the southern subregion (n = 453), from Palos Verdes to Mexico, where the immigration of tropical fishes is more frequent. More common and abundant species also inhabit this subregion, but the difference is slight (Fig. 25). Thirty-one percent of established nearshore fish species are commonly reported throughout the Southern California Bight (n = 146). This is the smallest proportion of common and abundant species among ecoregions, which

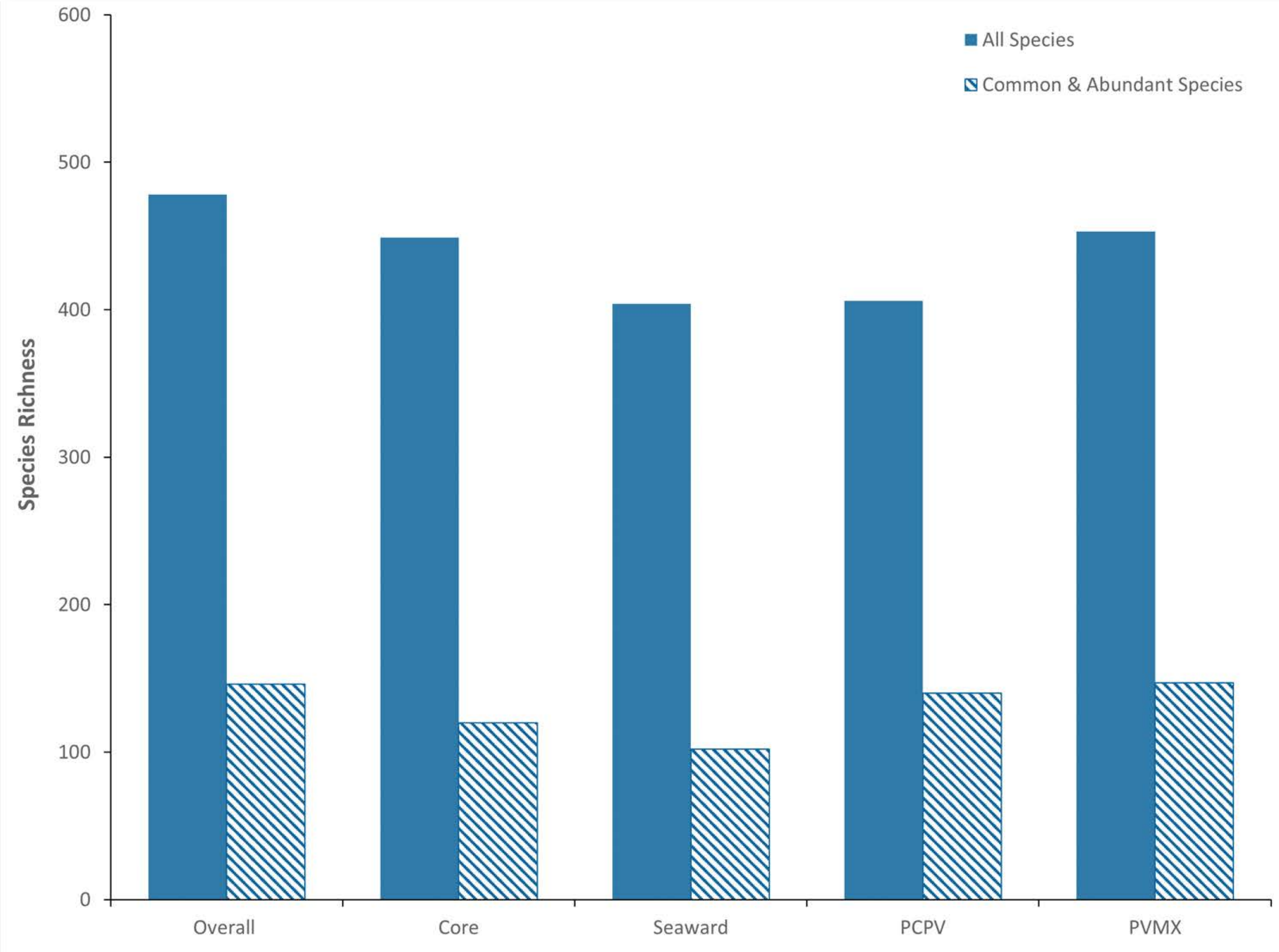


Figure 25. Number of established (All Species) and common or abundant (Common and Abundant Species) fish species in the Southern California Bight (Overall), in the Core and Seaward Zones, and among subregions.

Note. PCPV = Point Conception to Palos Verde. PVMX = Palos Verde to Mexican Border.

may reflect episodic immigration of cold-temperate and tropical fishes.

Species richness is slightly greater in the Core Zone (449 total, 120 common) of the Southern California Bight than in the Seaward Zone (404 total, 102 common; Fig. 25). The numbers of common and abundant fishes within Core and Seaward Zones are comparable between subregions (Fig. 26). Mainland habitat types and temperature regimes also are comparable between subregions; however, nearshore waters are colder in the western islands of the Point Conception to Palos Verdes subregion than the eastern islands of the Palos Verdes to Mexico subregion. This temperature difference results in shallower distributions among benthic fishes at the more offshore islands.

Slightly more Southern California Bight nearshore fishes are associated with hard seafloors than soft seafloors (Fig. 27A). The primary use of biotic habitats is relatively uncommon but is still an important factor influencing abundance and productivity. In addition, 118 species use two different primary habitat types, and 30 habitat generalists use all three primary habitat types (Appendix 12). The secondary use of soft bottom habitats was most frequent but not substantially greater than the use of biotic or hard habitats (Fig. 27A). Among soft seafloor habitats, sand was utilized by a slightly greater number of species than mud, and both of these habitat types were much more often documented than gravel (or pebble) or shell habitats (Fig. 27B). Consistent with use in other ecoregions, fishes associated with hard seafloor habitats in the

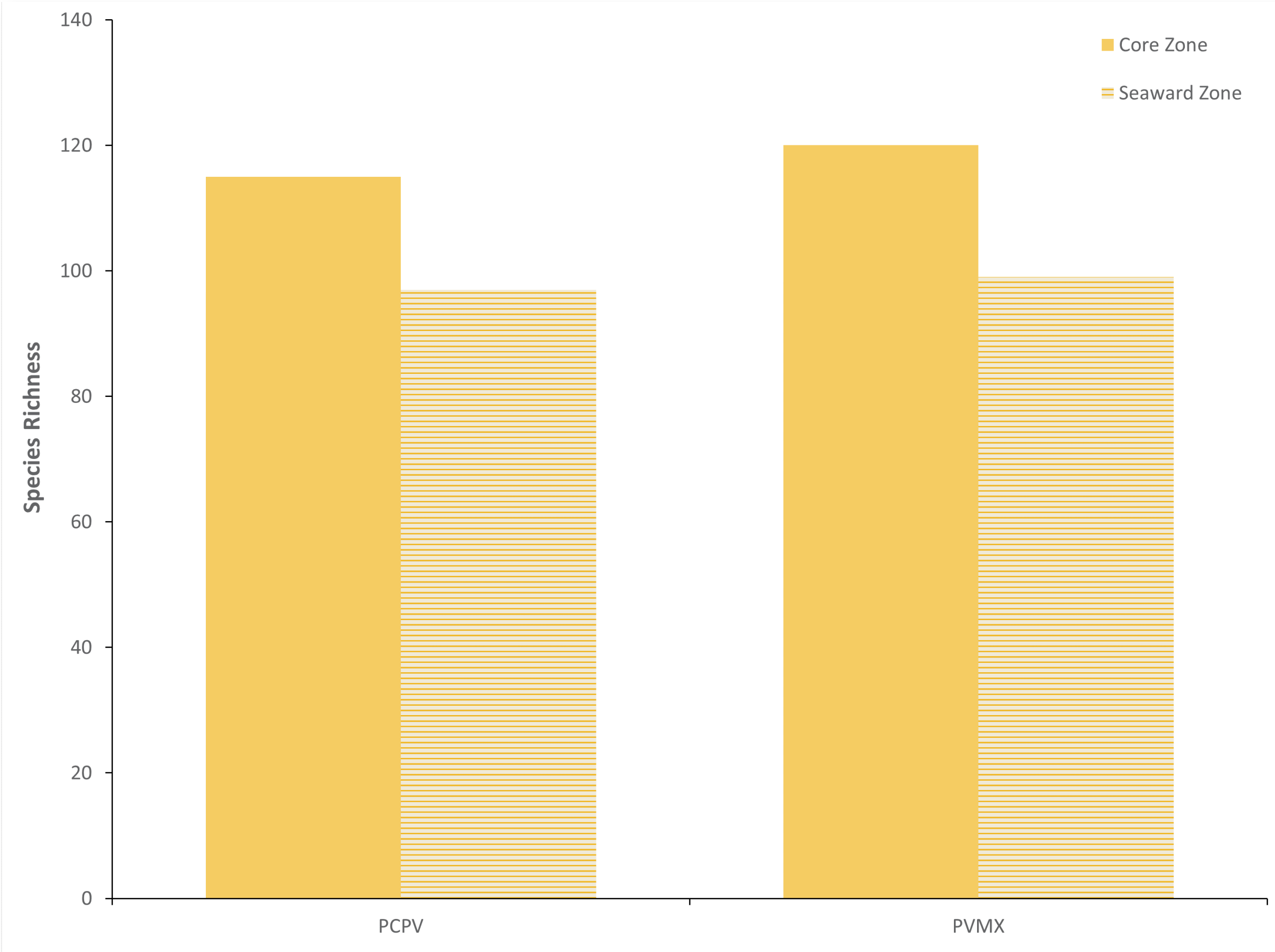


Figure 26. Number of common and abundant fish species in the Core and Seaward Zones of each subregion in the Southern California Bight Ecoregion.

Note. PCPV = Point Conception to Palos Verde. PVMX = Palos Verde to Mexican Border.

Red Abalone. (A. Obaza, Paua Marine Research Group)

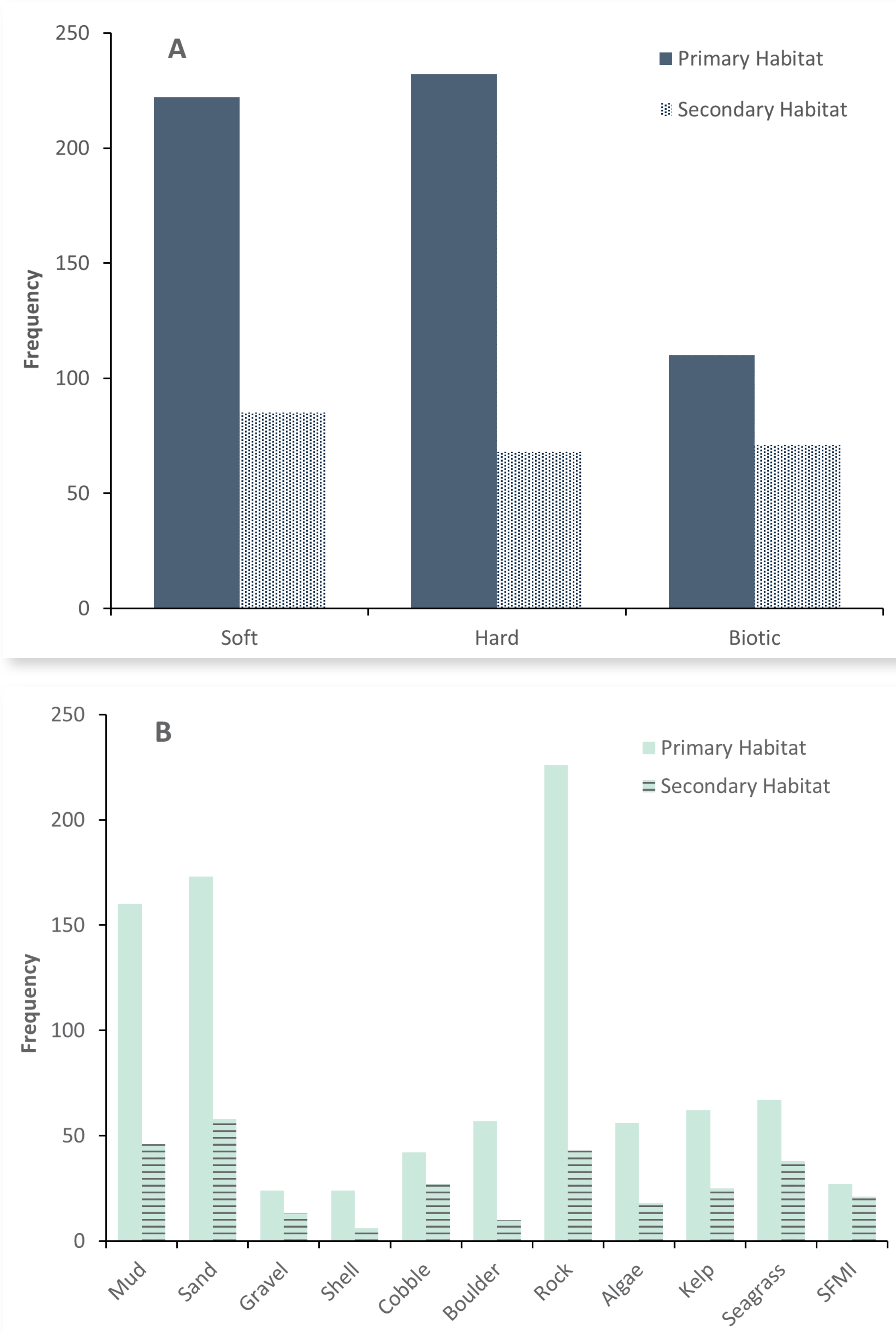


Figure 27. General (A) and specific (B) benthic habitat use by established fishes in the Southern California Bight Ecoregion.

Note. Fishes can have multiple primary and secondary habitats (e.g., mud, sand, and gravel). Soft = Mud, Sand, and Gravel. Hard = Cobble, Boulder, and Rock. Biotic = Algae, Kelp, Seagrass, and SFMI. Gravel = gravel and pebbles. Algae = attached and drift algae other than kelp. Seagrass = eelgrass and surfgrass. SFMI = structure-forming marine invertebrates.

Southern California Bight mainly use consolidated rather than unconsolidated rock types (Fig. 27B). Among biotic habitats, the use of algae and vascular plants (seagrasses) are documented much more than SFMI associations (Fig. 27B). Relative use of secondary habitat is similar to that of primary, with the exception of rock habitats, which are used much less frequently.

Southern California Bight Fish Assemblages: Depth Zonation

Core Zone: Intertidal

At least 99 common or abundant fishes are documented from intertidal regions of the Southern California Bight, including 65 species that primarily use this dynamic environment (Miller and Lea 1972; Love 2011; Kells et al. 2016; Love et al. 2021; Appendices 11 & 12). Fifty-two of these species also are common in intertidal regions of Central California (Appendix 10), but only 21 of these species also are found in the Pacific Northwest assemblage (Appendix 8). Southern California Bight intertidal ichthyofauna is dominated by a taxonomically diverse assemblage of perciforms (n = 46, e.g., Kelp Bass, Spotted Kelpfish, Pacific Chub Mackerel), with scorpaeniforms (n = 17, e.g., California Scorpionfish, Blue Rockfish, Roughcheek Sculpin) and elasmobranchs (n = 11, e.g., Brown Smoothhound, Bay Ray, Shovelnose Guitarfish) also well represented (Appendix 11). Fishes that occur in intertidal habitats throughout their life history include elasmobranchs (e.g., Shovelnose Guitarfish, Bat Ray), gasterosteiforms (e.g., Tubesnout, Bay Pipefish), scorpionfishes (e.g., Wooly Sculpin, Slimy Snailfish), surfperches (e.g., Walleye Surfperch, Reef Perch), blennies (e.g., Bay Blenny, Mussel Blenny), and flatfishes (e.g., English Sole, Diamond Turbot; Appendices 11 & 12). Several batoids (e.g., Shovelnose Guitarfish, Thornback Ray, Round Stingray, Bat Ray) enter soft bottom intertidal regions of the Southern California Bight during high tides to forage on epibenthic and infaunal invertebrates (Appendix 10; Ebert 2003).

Core Zone: Subtidal

An estimated 119 fishes in the Southern California Bight are designated as common and abundant in subtidal waters of the Core Zone (Appendix 11), including all fishes that occur in the intertidal zone. More than half of these species (n = 66) co-occur in the Central California assemblage. Only 32 of these species also frequent subtidal waters of the Pacific Northwest, indicating a considerable shift in the composition of subtidal ichthyofauna from that of the more similar northern ecoregions (Appendices 7, 9, & 11). In the Southern California Bight, the depth distributions of at least 69 common and abundant species are centered in the subtidal (Appendices 11 & 12; Love 2011; Love et al. 2021). These include mainly scorpionfishes (e.g., Kelp Rockfish, Painted Greenling), surfperches (e.g., Black Perch, Dwarf Perch), elasmobranchs (e.g., Swell Shark, Thornback Ray), and pleuronectiforms (e.g., C-O Sole, Spotted Turbot). The maximum depths of 20 of these species (e.g., California Grunion, Yellowfin Fringehead) do not extend into the Seaward Zone (Appendix 12). The most abundant fishes

California Lizardfish (*Synodus lucioceps*). (J. Tomelleri)

in subtidal waters of the Core Zone include important forage species (e.g., Northern Anchovy, Pacific Herring), small benthic species (e.g., Blackeye Goby, Spotted Cusk-Eel), and several schooling benthic and pelagic species (e.g., Sargo, Salema, Pacific Barracuda; Appendices 11 & 12). The subtidal component of the Core Zone of Central California is an important nursery region for elasmobranchs (e.g., Big Skate, Shovelnose Guitarfish), rockfishes (e.g., Copper Rockfish, Vermillion Rockfish), and flatfishes (e.g., English Sole, Speckled Sanddab).

Seaward Zone

At least 103 fishes are common or abundant in the Seaward Zone of the Southern California Bight, including 73 species that also frequently inhabit the shallower depths of the Core Zone (Appendix 11). Twenty common or abundant subtidal fishes, consisting of a combination of small benthic species (e.g., Rockpool Blenny, Rockweed Gunnel) and schooling benthic (e.g., California Corbina, Zebraperch) and pelagic (e.g., Topsmelt, Jacksmelt, Deepbody Anchovy) fishes are not found deeper than the Core Zone (Appendices 11 & 12). The minimum depth of three rockfishes (Speckled Rockfish, Flag Rockfish, Calico Rockfish) is 30 m (Love et al. 2021), but no fishes common or abundant in the Seaward Zone are absent from the Core Zone (Appendices 11 & 12). Five common or abundant Seaward Zone fishes (Spotted Ratfish, Longnose Skate, Pygmy Rockfish, Calico Rockfish, Shortspine Combfish) more often occur in waters greater than 100 m (Appendices 11 & 12). There is substantial overlap in species composition with the corresponding Central California assemblage (60 common species), but only 35 species also are shared with the Pacific Northwest assemblage (Appendices 8, 10, & 12). Several elasmobranchs (n = 19) and rockfishes (n = 17) are common in the Seaward Zone of the Southern California Bight, but a diverse group of perciforms also frequent this ecoregion (Appendices 11 & 12). Some large, upper trophic level sharks are included in the common and abundant Seaward Zone ichthyofauna (e.g., Bluntnose Sixgill Shark, Shortfin Mako Shark, White Shark).

Southern California Bight Fish Assemblages: Habitat Associations

Common and abundant soft-bottom-associated fishes are extremely diverse in the Southern California Bight (Table 33). The soft bottom intertidal assemblage contains 20 species. Half of these fishes are found in the Central California assemblage, whereas only three (Brown Smoothhound, Pacific Pompano, Speckled Sanddab) also are found in the Pacific Northwest assemblage (Tables 15, 24, & 33). Unique species from the Southern California Bight intertidal assemblage include sharks and rays (e.g., Pacific Angel Shark, Shovelnose Guitarfish) and benthic species that either swim over (e.g., California Corbina, Striped Mullet) or rest on (e.g., Lavender Sculpin, Fantail Sole) the benthos (Table 33). The soft bottom subtidal assemblage contains all the corresponding intertidal fishes and five fishes that are strongly associated with the seafloor (e.g., Bluebanded Ronquil, California

Table 33. Southern California Bight soft bottom and soft bottom biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Brown Smoothhound	*Mustelus henlei*	A	X	X	A
Soft Bottom	Spotted Cusk-eel	*Chilara taylori*	A	X	X	A
Soft Bottom	White Croaker	*Genyonemus lineatus*	A	X	X	A
Soft Bottom	California Corbina	*Menticirrhus undulatus*	A	X	X	
Soft Bottom	Queenfish	*Seriphus politus*	A	X	X	C
Soft Bottom	Pacific Pompano	*Peprilus simillimus*	A	X	X	A
Soft Bottom	Gray Smoothhound	*Mustelus californicus*	C	X	X	C
Soft Bottom	Pacific Angel Shark	*Squatina californica*	C	X	X	C
Soft Bottom	Shovelnose Guitarfish	*Pseudobatos productus*	C	X	X	R
Soft Bottom	Big Skate	*Beringraja binoculata*	C		X	C
Soft Bottom	Thornback Ray	*Platyrhinoidis triseriata*	C	X	X	R
Soft Bottom	Bat Ray	*Myliobatis californica*	C	X	X	C
Soft Bottom	Pacific Snake Eel	*Ophichthus triserialis*	C	X	X	C
Soft Bottom	California Lizardfish	*Synodus lucioceps*	C		X	C
Soft Bottom	Plainfin Midshipman	*Porichthys notatus*	C	X	X	C
Soft Bottom	Striped Mullet	*Mugil cephalus*	C	X	X	C
Soft Bottom	Longspine Combfish	*Zaniolepis latipinnis*	C		X	A

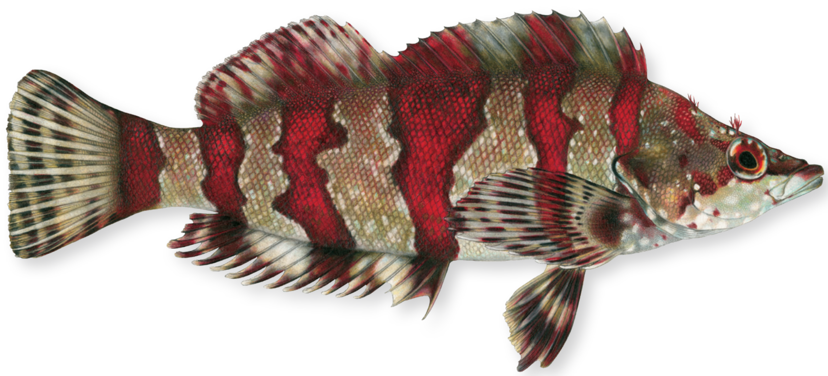
Table 33. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Soft Bottom	Lavender Sculpin	*Leiocottus hirundo*	C	X	X	R
Soft Bottom	Pygmy Poacher	*Odontopyxis trispinosa*	C		X	C
Soft Bottom	Yellowfin Croaker	*Umbrina roncador*	C	X	X	R
Soft Bottom	Bluebanded Ronquil	*Rathbunella hypoplecta*	C		X	C
Soft Bottom	Longjaw Mudsucker	*Gillichthys mirabilis*	C	X	X	
Soft Bottom	Speckled Sanddab	*Citharichthys stigmaeus*	C	X	X	C
Soft Bottom	California Halibut	*Paralichthys californicus*	C	X	X	C
Soft Bottom	Fantail Sole	*Xystreurys liolepis*	C	X	X	C
Soft Bottom	Spotted Turbot	*Pleuronichthys ritteri*	C		X	R
Soft Bottom	Hornyhead Turbot	*Pleuronichthys verticalis*	C		X	C
Soft Bottom	Pacific Hagfish	*Eptatretus stoutii*	R		X	C
Soft Bottom	Longnose Skate	*Beringraja rhina*	R		X	C
Soft Bottom	Roughback Sculpin	*Chitonotus pugetensis*	R	X	X	C
Soft Bottom	Spotfin Sculpin	*Icelinus tenuis*	R		X	C
Soft Bottom	Blackbelly Eelpout	*Lycodes pacificus*	R		X	C
Soft Bottom	Pacific Sanddab	*Citharichthys sordidus*	R	X	X	A
Soft Bottom	Bigmouth Sole	*Hippoglossina stomata*	R		X	A
Soft Bottom Biotic	Curlfin Sole	*Pleuronichthys decurrens*	R	X	X	C
Soft Bottom Biotic	Bay Pipefish	*Syngnathus leptorhynchus*	A	X	X	
Soft Bottom Biotic	Shiner Perch	*Cymatogaster aggregata*	A	X	X	A
Soft Bottom Biotic	Pacific Staghorn Sculpin	*Leptocottus armatus*	C	X	X	R
Soft Bottom Biotic	Barred Surfperch	*Amphistichus argenteus*	C	X	X	R
Soft Bottom Biotic	Arrow Goby	*Clevelandia ios*	C	X	X	R
Soft Bottom Biotic	Bay Goby	*Lepidogobius lepidus*	C	X	X	C
Soft Bottom Biotic	English Sole	*Parophrys vetulus*	C	X	X	C
Soft Bottom Biotic	Diamond Turbot	*Pleuronichthys guttulatus*	C	X	X	R
Soft Bottom Biotic	California Tonguefish	*Symphurus atricauda*	C	X	X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Lizardfish, Pygmy Poacher; Table 33). This assemblage exhibits limited similarity to the Central California assemblage (13 common species) and is nearly distinct from that of the Pacific Northwest (two common species; Tables 15, 24, & 33).

Among unique fishes in the soft bottom subtidal assemblage, most primarily use a combination of sand and mud (e.g., Pacific Snake Eel, Queenfish) or purely sand (e.g., California Corbina, Bluebanded Ronquil), with the exception of the Spotted Turbot, which is largely found on mud (Appendix 12). Although primarily a pelagic species, the California Grunion is abundant in this ecoregion and relies on soft bottom beach habitats for spawning. Soft bottom biotic intertidal and subtidal assemblages are identical, consisting of nine species that commonly use seagrass habitats, with eight represented in the Pacific Northwest assemblage (Tables 24 & 33).



Painted Greenling (*Oxylebius pictus*). (J. Tomelleri)

Twenty-seven species are included in the soft bottom Seaward Zone assemblage of the Southern California Bight (Table 33). They include seven novel species rarely encountered in the Core Zone (e.g., Pacific Hagfish, Pacific Sanddab; Appendix 12). Five soft-bottom-associated species common in subtidal waters of the Core Zone (e.g., Thornback Ray, Spotted Turbot) rarely venture into deeper waters and are not included in the corresponding Seaward Zone assemblage (Table 33). The soft bottom biotic assemblage of the Seaward Zone consists of four species also included in corresponding Core Zone assemblages, as well as one unique species (Curlfin Sole; Table 33).

In the Southern California Bight, the hard bottom biotic assemblages are substantially more species rich than those that do not associate strongly with biota (Table 34). Nine species, including seven scorpionfishes (e.g., California Scorpionfish, Brown Rockfish, Roughcheek Sculpin), the California Moray, and the Rockpool Blenny constitute the intertidal hard bottom assemblages. In subtidal Core Zone waters, common and abundant species include all those of the intertidal plus Honeycomb Rockfish. Only four of 10 species of the Southern California Bight hard bottom subtidal assemblage, all scorpionfishes, also are found in the Central California assemblage. Three such

Table 34. Southern California Bight hard bottom and hard bottom biotic fish assemblages—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom	California Scorpionfish	*Scorpaena guttata*	A	X	X	A
Hard Bottom	Olive Rockfish	*Sebastes serranoides*	A	X	X	A
Hard Bottom	Roughcheek Sculpin	*Ruscarius creaseri*	A	X	X	R
Hard Bottom	California Moray	*Gymnothorax mordax*	C	X	X	R
Hard Bottom	Brown Rockfish	*Sebastes auriculatus*	C	X	X	C
Hard Bottom	Copper Rockfish	*Sebastes caurinus*	C	X	X	C
Hard Bottom	Honeycomb Rockfish	*Sebastes umbrosus*	C		X	A
Hard Bottom	Painted Greenling	*Oxylebius pictus*	C	X	X	C
Hard Bottom	Cabezon	*Scorpaenichthys marmoratus*	C	X	X	C

Table 34. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom	Rockpool Blenny	*Hypsoblennius gilberti*	C	X	X	
Hard Bottom	Starry Rockfish	*Sebastes constellatus*	R		X	C
Hard Bottom	Calico Rockfish	*Sebastes dallii*	R		X	C
Hard Bottom	Squarespot Rockfish	*Sebastes hopkinsi*	R		X	C
Hard Bottom	Speckled Rockfish	*Sebastes ovalis*	R		X	C
Hard Bottom	Rosy Rockfish	*Sebastes rosaceus*	R		X	C
Hard Bottom Biotic	Swell Shark	*Cephaloscyllium ventriosum*	A		X	C
Hard Bottom Biotic	Blue Rockfish	*Sebastes mystinus*	A	X	X	A
Hard Bottom Biotic	Sargo	*Anisotremus davidsonii*	A	X	X	A
Hard Bottom Biotic	Salema	*Brachygenys californiensis*	A		X	A
Hard Bottom Biotic	Rockweed Gunnel	*Apodichthys fucorum*	A	X	X	
Hard Bottom Biotic	Spotted Kelpfish	*Gibbonsia elegans*	A	X	X	R
Hard Bottom Biotic	Kelp Pipefish	*Syngnathus californiensis*	C	X	X	
Hard Bottom Biotic	Kelp Rockfish	*Sebastes atrovirens*	C		X	R
Hard Bottom Biotic	Gopher Rockfish	*Sebastes carnatus*	C	X	X	C
Hard Bottom Biotic	Black-and-Yellow Rockfish	*Sebastes chrysomelas*	C	X	X	R
Hard Bottom Biotic	Treefish	*Sebastes serriceps*	C	X	X	C
Hard Bottom Biotic	Snubnose Sculpin	*Orthonopias triacis*	C	X	X	
Hard Bottom Biotic	Slimy Snailfish	*Liparis mucosus*	C	X	X	
Hard Bottom Biotic	Giant Sea Bass	*Stereolepis gigas*	C		X	C
Hard Bottom Biotic	White Seabass	*Atractoscion nobilis*	C	X	X	C
Hard Bottom Biotic	Opaleye	*Girella nigricans*	C	X	X	R
Hard Bottom Biotic	Zebraperch	*Kyphosus azureus*	C	X	X	
Hard Bottom Biotic	Halfmoon	*Medialuna californiensis*	C	X	X	R
Hard Bottom Biotic	Kelp Perch	*Brachyistius frenatus*	C	X	X	R
Hard Bottom Biotic	Reef Perch	*Micrometrus aurora*	C	X	X	
Hard Bottom Biotic	Dwarf Perch	*Micrometrus minimus*	C	X	X	R
Hard Bottom Biotic	Pile Perch	*Phanerodon vacca*	C	X	X	C
Hard Bottom Biotic	Rubberlip Seaperch	*Rhacochilus toxotes*	C	X	X	C
Hard Bottom Biotic	Blacksmith	*Chromis punctipinnis*	C		X	C

Table 34. Continued.

Assemblage	Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Hard Bottom Biotic	Garibaldi	*Hypsypops rubicundus*	C	X	X	R
Hard Bottom Biotic	California Sheephead	*Bodianus pulcher*	C	X	X	C
Hard Bottom Biotic	Señorita	*Halichoeres californicus*	C	X	X	C
Hard Bottom Biotic	Rock Wrasse	*Halichoeres semicinctus*	C	X	X	R
Hard Bottom Biotic	Bay Blenny	*Hypsoblennius gentilis*	C	X	X	
Hard Bottom Biotic	Mussel Blenny	*Hypsoblennius jenkinsi*	C	X	X	
Hard Bottom Biotic	Rock Prickleback	*Xiphister mucosus*	C	X	X	
Hard Bottom Biotic	Spotted Kelpfish	*Gibbonsia elegans*	C	X	X	R
Hard Bottom Biotic	Crevice Kelpfish	*Gibbonsia montereyensis*	C	X	X	R
Hard Bottom Biotic	Giant Kelpfish	*Heterostichus rostratus*	C	X	X	C
Hard Bottom Biotic	Kelp Clingfish	*Rimicola muscarum*	C	X	X	
Hard Bottom Biotic	Broadnose Sevengill Shark	*Notorynchus cepedianus*	R		X	C
Hard Bottom Biotic	Bocaccio	*Sebastes paucispinis*	R		X	C
Hard Bottom Biotic	Flag Rockfish	*Sebastes rubrivinctus*	R		X	C
Hard Bottom Biotic	Yellowtail Rockfish	*Sebastes flavidus*	R	X	X	A

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R= rare, and blank = absent.

members (Copper Rockfish, Painted Greenling, Cabezon) are found in the Pacific Northwest assemblage, too (Tables 25 & 34).

The hard bottom Core Zone biotic subtidal assemblage consists of 35 species, 30 of which also are common and abundant in similar intertidal habitats (Table 34). Twenty of these species are found in the Pacific Northwest assemblage (Tables 25 & 34). Five rockfishes (e.g., Starry Rockfish, Speckled Rockfish) in the hard bottom Seaward Zone assemblage of the Southern California Bight are uncommon in subtidal waters of the Core Zone and not part of the corresponding assemblage (Table 34). Three members of the Core Zone subtidal assemblage are either rare (California Moray, Roughcheek Sculpin) or absent (Rockpool Blenny) in deeper waters (Table 34).

There is even less similarity between the hard bottom biotic subtidal assemblage and that of the Seaward Zone, with only 37% (n = 13) shared species. Four unique species, mainly rockfishes (e.g., Flag Rockfish), are part of this Seaward Zone assemblage. Similarities to assemblages in Central California are strong among scorpionfishes, and especially rockfishes, which constitute many of the species in the Seaward Zones. In contrast, other taxa vary more between the Seaward Zones of Central California and the Southern California Bight (Tables 25 & 34).

Assemblages of soft- and hard-bottom-associated fishes and habitat generalists exhibit a strong similarity between intertidal and subtidal regions of the Southern California Bight but a limited similarity between Core and

Seaward Zones. The soft and hard bottom intertidal assemblage consists of three benthic species (Blackeye Goby, Yellow Snake Eel, Island Kelpfish) and Pacific Electric Ray, an active nocturnal predator that also ranges into midwater regions (Table 35, Appendix 12). The corresponding subtidal assemblage comprises one additional species, Bluntnose Sixgill Shark (Table 35). Two species in this assemblage (Bluntnose Sixgill Shark, Blackeye Goby) are common throughout subtidal waters of all three outer coast ecoregions (Tables 17, 26, & 35), and Bluntnose Sixgill Sharks utilize the Salish Sea Ecoregion for pupping and rearing of juveniles. Yellow Snake Eel and Pacific Electric Ray use mud, sand, and rock, whereas Blackeye Goby also commonly associate with gravel. The Island Kelpfish is found largely on shell hash and rock (Appendix 12).

Intertidal and subtidal Core Zone assemblages of habitat generalists share 16 species, with the subtidal assemblage also including Ocean Whitefish (Table 36). Several species in the subtidal habitat generalist assemblage (n = 11) also are found in the Central California assemblage, whereas similarity with the Pacific Northwest assemblage is limited to four co-occurring species (Tubesnout, Lingcod, White Seaperch, C-O Sole; Tables 18, 27, & 36).

Leopard Shark (*Triakis semifasciata*). (J. Tomelleri)

The soft and hard bottom assemblage of the Southern California Bight Seaward Zone is more than twice as species rich as the analogous subtidal Core Zone assemblage (Table 35). It contains all the fishes of the subtidal assemblage and six additional taxonomically diverse species (e.g., Starry Skate, Halfbanded Rockfish, Deepwater Blenny) that are rare in the subtidal and largely absent in the intertidal (Table 35). By contrast, the number of habitat generalists in the Seaward Zone assemblage is somewhat less diverse than the corresponding subtidal Core Zone assemblage, with two additional species (Pacific Spiny Dogfish, Pygmy Rockfish) and eight spe-

Table 35. Southern California Bight soft-hard bottom fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Blackeye Goby	*Rhinogobiops nicholsii*	A	X	X	A
Bluntnose Sixgill Shark	*Hexanchus griseus*	C		X	C
Pacific Electric Ray	*Tetronarce californica*	C	X	X	C
Yellow Snake Eel	*Ophichthus zophochir*	C	X	X	C
Vermilion Rockfish	*Sebastes miniatus*	C		X	A
Island Kelpfish	*Alloclinus holderi*	C	X	X	C
Spotted Ratfish	*Hydrolagus colliei*	R	X	X	C
Starry Skate	*Beringraja stellulata*	R		X	C
Halfbanded Rockfish	*Sebastes semicinctus*	R		X	A
Shortspine Combfish	*Zaniolepis frenata*	R		X	C
Pink Seaperch	*Zalembius rosaceus*	R	X	X	C
Deepwater Blenny	*Cryptotrema corallinum*	R		X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Table 36. Southern California Bight habitat generalist fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Scientific Name	Core	Intertidal	Subtidal	Seaward
Leopard Shark	*Triakis semifasciata*	A	X	X	C
Tubesnout	*Aulorhynchus flavidus*	A	X	X	R
Woolly Sculpin	*Clinocottus analis*	A	X	X	
Rainbow Seaperch	*Embiotoca caryi*	A	X	X	A
Yellowfin Fringehead	*Neoclinus stephensae*	A	X	X	
Horn Shark	*Heterodontus francisci*	C	X	X	C
Round Stingray	*Urobatis helleri*	C	X	X	R
Lingcod	*Ophiodon elongatus*	C	X	X	C
Barred Sand Bass	*Paralabrax nebulifer*	C	X	X	C
Ocean Whitefish	*Caulolatilus princeps*	C		X	C
Black Perch	*Embiotoca jacksoni*	C	X	X	R
Walleye Surfperch	*Hyperprosopon argenteum*	C	X	X	R
White Seaperch	*Phanerodon furcatus*	C	X	X	C
Onespot Fringehead	*Neoclinus uninotatus*	C	X	X	R
Bluebanded Goby	*Lythrypnus dalli*	C	X	X	C
Zebra Goby	*Lythrypnus zebra*	C	X	X	C
C-O Sole	*Pleuronichthys coenosus*	C	X	X	R
Pacific Spiny Dogfish	*Squalus suckleyi*	R	X	X	C
Pygmy Rockfish	*Sebastes wilsoni*	R		X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent. Generalist = similar use of soft, hard, and biotic habitats.

cies excluded (Table 36). Eight of 11 members of the soft and hard bottom Seaward Zone assemblage of the Southern California Bight are included in the Central California assemblage, and three of these (Spotted Ratfish, Bluntnose Sixgill Shark, Blackeye Goby) extend to the Pacific Northwest assemblage (Tables 17, 26, & 35). All members of the Seaward Zone's smaller Central California habitat generalist assemblage are contained in the Southern California Bight assemblage; only two species (Pacific Spiny Dogfish, Lingcod) also are included in the Pacific Northwest assemblage (Tables 18, 27, & 36).

Pelagic fish assemblages in the Southern California Bight exhibit strong similarities among depth zones, but species composition differs considerably from assemblages in other ecoregions (Table 37). The intertidal assemblage consists of 11 species, including forage fishes (e.g., Pacific Sardine, Northern Anchovy, Topsmelt, Pacific Saury), mackerels (Chub Mackerel, Pacific Jack Mackerel), and relatively large, predatory species (California Needlefish, Pacific Barracuda). Species composition of the Core Zone subtidal pelagic assemblage contains four additional species, three of which are fast, schooling mesopredators (Dolphinfish, Yellowtail, Pacific Bonito; Table 37). Only four of the 15 species in the pelagic subtidal assemblage of the Southern California Bight also occur in the corresponding Central California assemblage (Tables 28 & 37). Salmonids, which are present in the pelagic subtidal fauna of each other ecoregion, rarely occur in the pelagic subtidal assemblage of the Southern California Bight. The pelagic assemblage of the Seaward Zone shares 11 species with the associated Core Zone subtidal assemblage. Three large shark species are included (Common Thresher, Shortfin Mako, Blue Shark) and mainly represented by juveniles (Love 2011), whereas four species with shallow, coastal distributions are omitted (e.g., Jacksmelt, Deepbody Anchovy).

Selected Invertebrates

The selected invertebrate fauna of the Southern California Bight Ecoregion consists of 16 species, nine of which are molluscs (Table 38). Five species are unique to the Southern California Bight; however, the other 11 species are included among the Central California fauna, and eight of these species also were found in the Pacific Northwest Ecoregion. These findings indicate a similarity in the composition of commercially and ecologically important nearshore invertebrates among outer coast ecoregions. The warmer temperatures of the Southern California Bight relative to more northern parts of the U.S. West Coast influenced the selection of invertebrates, as most of the newly selected species have warm-temperate and subtropical distributions. These species include the Spiny Lobster (*Panulirus interruptus*), Warty Sea Cucumber (*Apostichopus parvimensis*), and three abalone species: Green Abalone (*Haliotis fulgens*), Pink Abalone (*H. corrugata*), and White Abalone (*H. sorenseni*). Additionally, the geographic orientation of the Southern California Bight buffers the mainland coast from northwest-derived wave energy, creating quiescent conditions ideal for the Green Abalone and Warty Sea Cucumber compared to the Central California and Pacific Northwest coasts. Most of the selected invertebrates are primarily distributed at intertidal and subtidal depths of the Core Zone (Table 38); however, White Abalone and California Market Squid mainly occur in the Seaward Zone, and Spiny Lobster and Red Rock Crab are commonly distributed from MLLW to the mid–continental shelf. Biological characteristics of abalone (e.g., episodic recruitment, extreme longevity) make them vulnerable to overexploitation and climate change and have resulted in population declines for all the selected species in the Southern California Bight. White Abalone was the first marine invertebrate to be federally listed endangered by NOAA Fisheries in 2001. Subsequently, NOAA Fisheries listed Black Abalone as endangered in 2009 (CDFW 2021b).

In the Southern California Bight, populations of formerly abundant gastropod species have declined substantially from a combination of overharvesting, disease, and climate change. The Pink Abalone (maximum shell length = 250 mm; Gotshall 2005) was once a dominant member of the subtidal benthic community in the Southern California Bight and the most important species in the regional abalone fishery. It is still the most common abalone species in Southern California and (along with Green Abalone) recruits well during warm-water years (Kawana et al. 2019). However, it has declined to a fraction of its former abundance because of overharvesting, Withering Syndrome, and elevated temperatures associated with climate change (Button and Rogers-Bennett 2011). Larger Black Abalone are associated with warmer temperature regimes in the Southern California Bight. Such temperatures lead to Withering Syndrome and population reductions for Red Abalone (Vilchis et al. 2005, Haas et al. 2018, Kawana et al. 2019). White Abalone was targeted for harvesting after the earlier depletion of shallower-dwelling abalone species, and after approximately 30 years of intense harvesting, the entire U.S. population consisted of more than 3,000 individuals (Butler et al. 2006). Populations at Tanner Bank, an area of historically high abundance, have continued to decline (Stierhoff et al. 2012).

Pacific Barracuda (*Sphyraena argentea*). (J. Tomelleri)

Table 37. Southern California Bight pelagic fish assemblage—Core and Seaward relative abundance and intertidal, subtidal, and seaward compositions.

Common Name	Taxon	Core	Intertidal	Subtidal	Seaward
Northern Anchovy	*Engraulis mordax*	A	X	X	A
Pacific Sardine	*Sardinops sagax*	A	X	X	A
Topsmelt	*Atherinops affinis*	A	X	X	
Jacksmelt	*Atherinopsis californiensis*	A	X	X	
Pacific Barracuda	*Sphyraena argentea*	A	X	X	A
Deepbody Anchovy	*Anchoa compressa*	C	X	X	
Slough Anchovy	*Anchoa delicatissima*	C	X	X	
California Needlefish	*Strongylura exilis*	C	X	X	C
Pacific Saury	*Cololabis saira*	C	X	X	C
Jack Mackerel	*Trachurus symmetricus*	C	X	X	C
Pacific Chub Mackerel	*Scomber japonicus*	C	X	X	C
Smallhead Flyingfish	*Cheilopogon pinnatibarbatus*	C		X	C
Yellowtail	*Seriola dorsalis*	C		X	C
Dolphinfish	*Coryphaena hippurus*	C		X	C
Pacific Bonito	*Sarda chiliensis*	C		X	C
Common Thresher Shark	*Alopias vulpinus*	R		X	C
Shortfin Mako	*Isurus oxyrinchus*	R		X	C
Blue Shark	*Prionace glauca*	R		X	C

Note. This table includes the relative abundance of constituent species in Core and Seaward Zones and assemblage composition among Intertidal, Subtidal, and Seaward regions (X). Species selected for inclusion in the assemblage were either abundant or common in at least one zone. A = abundant, C = common, R = rare, and blank = absent.

Recommended restoration strategies include stocking large adult individuals to reduce Allee effects and mitigating the negative effects of ocean warming and poaching on remnant populations (Li and Rogers-Bennett 2017). A White Abalone restoration program is underway in California. It involves a partnership of federal, state, academic, and private institutions and includes population surveys, captive breeding, health monitoring, recovery site development, and recovery modeling (Rogers-Bennett et al. 2016b). The recovery of the Owl Limpet has been hampered in Southern California by human impacts, which were determined to be greater than the effects of oystercatcher predation or habitat variability (Sagarin et al. 2007). Greater sizes and higher frequencies of large Owl Limpets have been documented at locations with low human visitation (Kido and Murray 2003; Sagarin et al. 2007).

Market Squid are common in the Southern California Bight and are genetically similar throughout California (Cheng et al. 2021); however, differences in hydrology result in behavioral changes between populations. Eggs are deposited in deeper locations (to 93 m) and at higher temperatures (to 14.4 °C) in Southern California compared to Monterey Bay (61 m, 12.0 °C; Zeidberg et al. 2011). Habitat compression, caused by low oxygen and pH levels, also drives the deposition of Market Squid eggs in dense aggregations instead of smaller, cryptic aggregations in Southern California (Navarro et al. 2018). These aggregations may be more susceptible to predators and may alter the population dynamics and ecological interactions of Southern California Market Squid populations.

The selected crustacean fauna of the Southern California Bight has received recent scientific attention. The Spiny Lobster supports productive commercial and recreational fisheries in the Southern California Bight (Dunn et al. 2017; Samhouri et al. 2019). Spiny Lobsters occur in association with rock habitat from the low intertidal to a depth of 100 m (Lindberg 1955). Off La Jolla, Spiny Lobsters exhibit high site fidelity and rather small home ranges (95% usage = 5912 m2 per week; Withy-Allen and Hovel 2013). Patterns of Pacific Sand Crab recruitment differ for populations north and south of Point Conception, and recruitment dynamics in the Southern California Bight are poorly understood (Diehl et al. 2007). Declines in size and catch were reported for the Red Rock Crab fishery off the Channel Islands and attributed to overharvesting and changing environmental conditions; however, evidence of decline was highly variable among locations and between sexes (Fitzgerald et al. 2019).

California Tonguefish (*Symphurus atricauda*). (J. Tomelleri)

A commercial fishery for Warty Sea Cucumbers began in the mid-1990s and is centered in the Channel Islands and off Santa Barbara, California. A population assessment based on the catch per unit effort determined the stock to be healthy, but declines of up to 83% were reported based on population monitoring at fished and unfished sites (Schroeter et al. 2001). More recent commercial landings data and independent monitoring data suggest that Warty Sea Cucumber populations have reached levels of concern (Mireles 2020).

The combined impacts of overexploitation and ocean warming on ecological interactions of Red Sea Urchin and Purple Sea Urchin populations have recently been investigated in the Southern California Bight. These urchin species co-occur along the U.S. West Coast and exhibit two main foraging modes. They shelter and graze locally when food is abundant but emerge and overgraze when food is scarce, creating urchin barrens (Parnell et al. 2007). Sheltering behavior and diel movement patterns differ between species (Parnell et al. 2007). Furthermore, these species have different gut microbes that may play an important role in resource use and trophic separation (Miller et al. 2021). Sea Otters, the most influential urchin predator in Central California and the Pacific Northwest, have been extirpated from the Southern California Bight. The two main contemporary predators in this region, California Sheephead and Spiny Lobster, appear to exert much weaker top-down control than Sea Otters (Dunn and Hovel 2019). The Sunflower Sea Star can exert strong top-down effects on Purple Sea Urchin, but these effects are mediated by temperature. At mean annual temperatures of less than 14 °C in the northern Channel Islands, Sunflower Sea Stars were common, Purple Sea Urchins were rare, and kelp was persistent. At temperatures greater than 14 °C, Sunflower Sea Stars and kelp were rare and Purple Sea Urchins were abundant (Bonvari et al. 2017). The combined impacts of Sea Star Wasting Disease and rising ocean temperatures are affecting this top-down control of Purple Sea Urchins by Sunflower Sea Stars, posing significant risks to the persistence of kelp forests (Bonvari et al. 2017).

MPA effects in Southern California appear to vary for Purple Sea Urchins and Red Sea Urchins. Purple Sea Urchins were less dense and more cryptic inside an MPA off San Diego than in nearby fished sites, whereas Red Sea Urchins rarely were found outside the MPA (Nichols et al. 2015). An MPA effect for Red Sea Urchins also was found off the Channel Islands, where size and adult density were greater in MPAs, especially in association with kelp (Teck et al. 2017). Ocean warming, however, is likely to reduce the population size of Red Sea Urchins in the Southern California Bight, mitigating MPAs' positive effects (Kawana et al. 2019).

Pacific Bonito (*Sarda chiliensis*). (J. Tomelleri)

Table 38. Occurrence of selected invertebrates in the Southern California Bight ecoregion among nearshore zones and established coastal regions.

Higher Taxon/Species	Core		
	Intertidal	Subtidal	Seaward
MOLLUSCA			
Owl Limpet (*Lottia gigantea*)	Black		
Black Abalone (*Haliotis cracherodii*)	Black	Dark gray (vertical hatch)	
Green Abalone (*Haliotis fulgens*)	Black	Black	
Pink Abalone (*Haliotis corrugata*)	Dark gray (vertical hatch)	Black	Light gray (diagonal hatch)
Red Abalone (*Haliotis rufescens*)	Light gray (diagonal hatch)	Black	Dark gray (vertical hatch)
White Abalone (*Haliotis sorenseni*)		Dark gray (vertical hatch)	Black
Pismo Clam (*Tivela stultorm*)	Black	Dark gray (vertical hatch)	
California Market Squid (*Doryteuthis opalescens*)		Dark gray (vertical hatch)	Black
Red Octopus (*Octopus rubescens*)	Black	Dark gray (vertical hatch)	Light gray (diagonal hatch)
CRUSTACEA			
Spiny Lobster (*Panulirus interruptus*)	Dark gray (vertical hatch)	Black	Black
Pacific Sand Crab (*Emerita analoga*)	Black	Black	Black
Red Rock Crab (*Cancer productus*)	Black	Black	Black
ECHINODERMATA			
Ochre Sea Star (*Pisaster ochraceus*)	Black	Black	
Warty Sea Cucumber (*Apostichopus parvimensis*)	Black	Black	Dark gray (vertical hatch)
Purple Sea Urchin (*Strongylocentrotus purpuratus*)	Black	Black	Dark gray (vertical hatch)
Red Sea Urchin (*Mesocentrotus franciscanus*)	Light gray (diagonal hatch)	Black	Dark gray (vertical hatch)

Note. When possible, regional depth distributions were used. Intertidal = Splash Zone to MLLW, Subtidal = MLLW to 30 m, Inner Shelf = 30–100 m. Black = primary depth range, dark gray with vertical hatch marks = secondary depth range, light gray with diagonal hatch marks = tertiary depth range, and white = absent. All utilized citations are provided in the text.

Pacific Eletric Ray (*Tetronarce californica*). (J. Tomelleri)

Otter Rock intertidal, Oregon, collecting sea star data, 06/15/2022. (ODFW)

DATA GAPS AND CONSIDERATIONS

DATA GAPS AND CONSIDERATIONS

Distribution and Abundance of CMECS Habitat Types Among Nearshore Zones

Nearshore Zones

Some habitats shoreward of the MHW may have been excluded. – Bathymetry data were available from regional sources across the West Coast and were merged together; source spatial resolutions range from 30–200m (Table 1). The national bathymetry dataset available through NOAA was not used because the spatial resolution was too coarse for this project's purposes. For this reason, regional-based sources were identified.

Data defining the upper limit of the splash zone (the landward boundary of the Core Zone) were not consistently available at a West Coast or regional scale for all regions, and consequently, shoreline datasets defined by MHW were used as a proxy for this boundary (Table 1). The MHW cutoff will limit the information summarized within the Core Zone; it may exclude habitats found shoreward of the line but should still be considered part of the Core Zone.

Habitat Spatial Data

Using CMECS biotopes would enhance habitat classifications. – This is a first step in classifying habitats in the U.S. West Coast nearshore using the CMECS Biotic and Substrate Components, where data were available. This effort did not explicitly classify biotopes across CMECS components, which can help data users understand how abiotic and biotic elements interact in nature. However, the classification of biotic and substrate ecological units within nearshore zones is a first step in describing biotopes in the region. Fish and invertebrate habitat associations reference utilization across abiotic and biotic elements; therefore, classifying data as CMECS biotopes would result in a more advanced understanding of the habitat availability for species.

Future research could consider adding CMECS's Geoform and Water Column Components to the spatial data system. – This project completed mapping products for two out of four CMECS components: the Biotic and Substrate Components. A data gap remains concerning information related to the CMECS Geoform and Water Column Components. Future efforts can classify the physiographic unit for the Geoform Component based on available data with relatively minimal effort. However, more extensive data mining and classification need to be conducted to classify at the geoform level. Water Column Component data are much more limited, and there is a significant data gap in the ability to complete the fourth CMECS component.

A lack of quality data should not be interpreted to mean that a given habitat is absent from a given location; future data collection efforts could yield higher-quality data that indicates the habitat's presence. – The biotic and substrate habitat maps and data summaries are results of available spatial data. Datasets varied by resolution, data collection methods, and data interpretation methods, as well as regionally and by habitat type (Appendix 4). Map scales ranged from less than 1:10,000 (high resolution) to greater than 1:1,000,000 (low resolution), indicating a wide range in the source data's quality (Appendix 4). Data collection methods ranged from digitized versions of reports or expert opinion to multibeam sonar and aerial imagery interpretation and ground-truthed remote-sensing datasets. The footprint of habitat surveys varied by habitat and data source. Therefore, data gaps or lack of data for a particular habitat type do not necessarily indicate the absence of a habitat, particularly for biotic features, and may indicate that there are no available data for that location.

All datasets that were not already classified using CMECS were crosswalked into CMECS using source habitat data definitions. Some datasets had specific habitat types that could not be crosswalked to CMECS; these were added as proposed or as provisional units into CMECS. There were 21 biotic communities and eight substrate subgroups added as proposed units into CMECS. See Appendix 13 for proposed CMECS updates. To view the CMECS crosswalks for each source dataset, see metadata for the biotic and substrate habitat datasets.

These data are based on a snapshot in time, and the PMEP Nearshore dataset should be only one among many decision-making inputs. – The CMECS substrate and biotic datasets can be used as baseline information to understand potential habitats for management, conservation, and restoration efforts. The information contained in the database should not be used in place of consultations with environmental, natural resource, and cultural resource agencies or in place of field surveys.

CMECS Substrate Component

Most of the needed substrate data were available for the entire West Coast, but data for shallow areas (less than 10 m depth) proved challenging. – Substrate data exist across much of the West Coast. Consequently, more than 99% of PMEP's Scope Boundary is classified for its substrate types. Most of the unclassified areas are in the intertidal zone, generally less than 10 m to the shoreline boundary of the Core Zone. This area is challenging to map in many places; vessel-based efforts are more challenging in shallow areas, and waves crashing in the shallow intertidal zone present challenges when using aerial imagery interpretation. Much of the data in these shallow areas of the Core Zone came from Intertidal Habitat Inventories in the Salish Sea or from Ocean Imaging in California, both of which used aerial imagery interpretation and ground-truthing to map these shallow areas. In California, source datasets classified much of the area as a white zone. In areas where predicted substrate data did not exist, modeled datasets were used when available. Otherwise, the area was categorized as "unclassified."

When necessary, we found it useful to use modeled datasets even though they generally were of lower quality. – Modeled datasets used in this effort generally are lower data quality than the high-resolution predicted substrate maps that have been ground-truthed. Modeled datasets were incorporated in the Salish Sea, along the Oregon Coast, and in California. In the Salish Sea, this included the modeled Bloch Marine Substrate dataset from WADNR, making it a cross between a modeled and direct-observation dataset and improving its reliability. In California, UCSC created an interpolated white-zone map for the whole state using the Environmental Sensitivity Index line data describing shoreline habitat. These data filled data gaps but may not be the best estimate of area for habitats. An exception is the modeled dataset along the Oregon coast. These data were developed using ShoreZone data and machine learning of rocky substrate data provided by aerial imagery. All outputs were manually reviewed for accuracy. Despite the data-quality differences, modeled datasets are beneficial as baseline information when other ground-truthed data are unavailable.

The data sources' varying quality may account for the variability in findings concerning the U.S. West Coast's substrate classifications (i.e., rock to unconsolidated mineral substrates). – Rock substrate is much less abundant than unconsolidated mineral substrate across the West Coast; rock substrate accounts for between 7% and 20% of the Core Zone and 3% and 5% of the Seaward Zone. Central California has the highest proportion of rock substrate in the Core Zone and Seaward Zone of all regions along the West Coast.

Coarse unconsolidated mineral substrate is much less common than fine unconsolidated substrate across the outer coast Core Zone, accounting for 1%–2%. However, it is more common in the Salish Sea, where it accounts for 13% of the Core Zone. These differences may be due to the quality of the data inputs. Coarse, unconsolidated substrate is more common in the Seaward Zone, but it varies along the outer coast. In areas north of Fort Bragg (i.e., the Washington, Oregon, and Northern California coast), this category accounts for approximately 15% of the zone and 30% in the Salish Sea. In Central and Southern California, it accounts for approximately 1% of the zone. These findings are most likely due to the quality of source datasets; in California, substrate habitat has generally been classified into two categories (either hard or soft and/or rock or sediment) and, therefore, would not be at a resolution to account for coarse unconsolidated substrate.

The CMECS definition for the substrate type *boulder* is "a median gravel size of 256 millimeters to < 4,096 millimeters." This is a wide range in size, and some source datasets classify boulders, particularly those on the larger end of this definition's range, as rock substrate. In addition, boulders are generally considered *hard* substrate in other datasets, such as the SGH dataset from Oregon State University (Goldfinger et al. 2014), which would crosswalk into the CMECS *rock substrate* category. In literature discussing fish habitat associations, *boulders* are referenced as *hard* substrate. For this effort, all source data classified as *boulder* followed the CMECS definition and crosswalked to *boulder* in the *coarse unconsolidated mineral substrate* subclass in CMECS. However, as a reference to fish habitat, *boulder* is better suited in the CMECS *rock substrate* ecological unit, as opposed to *coarse unconsolidated mineral substrate*.

Much of the Core Zone in California is unclassified *unconsolidated mineral substrate*. Data within state waters with this classification came from data compiled by UCSC for CDFW as part of the marine reserves planning process. These high-resolution data (source data resolution ranged from 2–10m) were categorized into either *rock* or *sediment* categories. The *rock* category did not distinguish between bedrock and boulders, so boulders in this dataset are included as *rock substrate* as opposed to the CMECS definition of *coarse unconsolidated substrate*. The *sediment* category includes both fine and other coarse unconsolidated sediments, such as cobble. They were crosswalked into the *unconsolidated mineral substrate category*. As a result of this simplified classification, California's state waters are categorized at the CMECS class level, as opposed to a more detailed ecological unit, such as subclass, group, or subgroup as used in the Salish Sea, Washington, Oregon, and habitat outside of California's state-waters boundary.

The exception to this simple classification along the California Coast came from data in the California State Waters Map Series managed by USGS. These data were used in California state waters, when available, to crosswalk substrate habitats into CMECS to allow for more detailed classifications and to replace the CMECS Class-level substrate habitat from the CDFW data. The PMEP Nearshore dataset includes 38 unique datasets with potential benthic habitats mapped from the California State Waters Map Series. Data collected from Offshore of Punta Gorda to Offshore of Point Arena and Offshore of Lafler Rock to Offshore of Point Arguello had no habitat interpretations; therefore, potential benthic habitat maps for that region were not included in this effort.

Seaward Zone areas south of Fort Bragg included datasets with very low resolutions. For example, the California Continental Margin Geologic Map Series, a dataset that was incorporated into the EFH SGH dataset, includes very coarse, low-resolution expert interpretations of substrate habitats. These data depict large areas of rock substrate around San Clemente Island and Santa Catalina Island, which is currently the best available data. However, these coarse interpretations are lower quality than the fine-resolution, ground-truthed data available in other areas. The data limitations for these area summaries should be kept in mind.

Future research should better distinguish anthropogenic features and rock substrate. – The CMECS Substrate Component includes classifications of the anthropogenic substrate, but it is limited. Information on anthropogenic features is available only if the source substrate datasets specifically included them in their data classifications. The compilation of anthropogenic-specific datasets was beyond the scope of this project. In California, the CDFW mapping effort simplified substrate into two categories (rock or substrate). As a result, many anthropogenic features were categorized as *rock substrate* in this report's accompanying Nearshore dataset. From a more detailed examination, it is clear that some anthropogenic features, such as underwater cables, outfalls, and oil platform structures, were captured in the *rock substrate* category, which is made obvious by their linear or rectangular shapes. To resolve this issue, future updates to PMEP's Nearshore CMECS Substrate dataset can incorporate anthropogenic-specific information. In addition, completion of the CMECS Geoform Component for the U.S. West Coast nearshore would include anthropogenic features.

CMECS Biotic Component

Much of the needed data concerning the biotic spatial extent was unavailable. – Many data gaps exist in the spatial extent of biotic habitats across the nearshore of the U.S. West Coast. Biotic habitat extent data are predominately in the Core Zone, with very limited extent data in the Seaward Zone. The majority of biotic habitat datasets were generated for aquatic vegetation beds, such as seagrass and canopy-forming macroalgae (i.e., kelp) and, to a lesser extent, for other types of macroalgae, such as coralline or leafy algal beds. Data depicting the extent of faunal beds were limited, particularly on the outer coast of Washington, Oregon, and California. The majority of data were for the benthic/attached biota CMECS setting. Very little to no data were available for the extent of planktonic biota. Microbial and moss or lichen community classes in CMECS had no data across all four ecoregions.

Enough data were available for seagrasses and canopy-forming algal beds to develop basic estimates. – Two of the biotic habitat categories had enough quality spatial-extent data to represent a coarse estimate of coverage of the habitat: seagrass in the Salish Sea and canopy-forming algal beds (i.e., kelp) along the three outer coast ecoregions. Other biotic habitat types, including faunal beds and other categories of macroalgae, had incomplete spatial-extent data across all four ecoregions. The Pacific Northwest Ecoregion had the most data gaps in biotic habitat, with 98.2% of the Core Zone categorized as *unclassified*.

For the three ecoregions on the outer coast, spatial data for canopy-forming algal beds (i.e., kelp) are a result of long-term data collection efforts, providing good estimates for habitat coverage. For example, in Washington, WADNR has monitored the aerial extent of kelp along the Washington Coast and Strait of Juan de Fuca since 1989. In Oregon, ODFW monitored kelp intermittently from 1990 to 2010. In California, CDFW has monitored kelp since 1989. In addition to these state-wide monitoring programs, other kelp mapping efforts have been conducted within these regions and contributed to a West Coast Canopy-Forming Kelp dataset that was incorporated into the CMECS Biotic Component for this effort.

Future data collection should focus on faunal beds to fill a significant gap in biotic habitat data. – Faunal beds have limited or incomplete mapping throughout all four ecoregions, which represents a large data gap in biotic habitat data. Polygon data that do exist are of relatively low quality and generally represent digitized areas from expert opinion instead of field sampling. Many monitoring datasets document faunal beds across the West Coast; however, they do not include a polygon-based spatial extent of observations. Along the Pacific Northwest coast, the Partnership for Interdisciplinary Studies of Coasts and Oceans (PISCO) manages a long-term biotic community survey program to monitor the biodiversity and abundance of all invertebrates (faunal beds) and algal species at their monitoring sites along the shoreline of the U.S. West Coast. The ShoreZone datasets for Oregon and Washington provide observations of faunal beds that exist within the intertidal zone. However, for both of these datasets, the polygon-based spatial extent is not mapped.

In Oregon, barnacles (a CMECS group under the Class *faunal bed*) are documented by ShoreZone to be present across 48% of the shoreline (ODFW 2014). In addition, NOAA's 2014 Groundfish EFH report identified coral, sponge, and pennatulid (sea pen) observations on the continental shelf off the coast of Washington, Oregon, and California, as well as a few observations in the Salish Sea (NMFS 2013). NOAA's Environmental Sensitivity Index identified potential faunal beds for the Pacific Northwest region based on expert opinion and therefore did not meet the requirements for inclusion. However, it identified a wide variety of faunal beds that potentially exist throughout the nearshore of Washington and Oregon. Based on the aforementioned datasets, some notable biotic data gaps on the spatial extent of faunal beds in the nearshore include the following CMECS groups: attached anemones, basket stars, corals, sponges, tunicates, sea stars, pennatulid beds, and sand dollar beds. Even though the data and information sources do not provide information on the habitat extent, they are good sources of biotic community information on the West Coast and can be used as a proxy for understanding the distribution of faunal habitats in the nearshore, particularly in the area of the Core Zone closest to the shore (i.e., the intertidal zone).

Future data collection should also focus on non-canopy-forming kelps and other macroalgae. – Another significant biotic data gap is for other kelps (non-canopy-forming) and other types of macroalgae. Much of this mapping focus has been on canopy-forming kelps, specifically Bull Kelp (*Nereocystis luetkeana*) and Giant Kelp (*Macrocystis pyrifera*), because they can be observed on the surface of the water and have traditionally been monitored and mapped using aerial and satellite imagery. However, other prostrate and stipitate kelp species (i.e., non-floating kelp or understory kelp) exist across the West Coast and constitute significant understory habitat for fish and invertebrates across their life history. Along the Oregon coast, ShoreZone identified red and green algae across 54% and 32% of the mapped intertidal shoreline, respectively (ODFW 2014). Even though ShoreZone is not polygon based, it does give a general sense of the abundance of biotic habitats along the shoreline. The PMEP CMECS biotic dataset for other benthic macroalgae was mapped across only 0.1% of the Core Zone, illustrating a major data gap for this habitat type. Data gaps in the PMEP Nearshore dataset include the following CMECS groups of benthic macroalgae: calcareous, coralline/crustose, filamentous, leathery/leafy, mesh/bubble, sheet, and turf algal beds.

There is also a disconnect between the way many of the habitat datasets classify macroalgae data and the CMECS classification. Most West Coast datasets showing the macroalgae extent have classified them based on color, such as red, green, or brown algae, but these color designations have not always been consistent. For example, WADNR conducts kelp monitoring efforts in the Salish Sea, specifically in Central and Southern Puget Sound. They categorize macroalgae by color, including green algae and red/brown algae. Ocean Imaging used similar categorization in California. These categories do not crosswalk to CMECS in more detail than the subclass level (i.e., benthic macroalgae), since CMECS uses species and a physiographic category to group macroalgae, not color.

Some CMECS biotic habitats classified as aquatic vegetation beds represent biotic features that lacked detailed information from the source data. These habitat classifications in CMECS may include macroalgae and seagrass; therefore, although macroalgae and seagrass may be underestimated in certain regions, a higher level CMECS category of aquatic vegetation beds may also include unclassified seagrass or macroalgae that were not further distinguished to the more detailed ecological unit. Aquatic vegetation beds are mapped across the West Coast, in particular in Central California, where surfgrass is known to exist, such as off the coast of Point Reyes and along the Channel Islands (Fig. 18). Surfgrass along the Oregon and Washington coasts was documented more often in ShoreZone data than in polygon-based data sources. Data were compiled as part of this effort to estimate the maximum observed extent of the biotic habitat type, which represents all spatial extent observations across all years and datasets. These data should not be used to represent the current extent of habitats, and it should be noted that the extent of some biotic habitats (such as seagrasses and eelgrasses) naturally expand and contract over time.

Selected Invertebrates

Nearshore macroinvertebrates are not as well documented as ichthyofauna. – In contrast to the nearshore ichthyofauna, the nearshore marine macroinvertebrates of the U.S. West Coast are relatively poorly documented (e.g., Pietsch and Orr 2019), except in rocky intertidal habitats. Shallow-water surveys are frequent and widespread throughout the region but generally target a subset of relatively abundant, well-described benthic species instead of a complete species inventory (e.g., by PISCO or the Reef Environmental Education Foundation [REEF]) Additionally, many benthic macroinvertebrate species appear identical but are genetically distinct. Genetic analyses often are necessary to distinguish macroinvertebrate species with similar morphologies (Ereskovsky et al. 2017). Benthic macroinvertebrates in the Seaward Zone are largely beyond the depths of scuba surveys and collections. These regions may be effectively surveyed for known species with autonomous underwater vehicles, ROVs, or human-occupied submersibles (Yoklavich and O'Connell 2008). Still, these methods are expensive, have a limited range of visibility, and struggle when exploring under and over complex structures. Additionally, delicate or undescribed invertebrate species are difficult to collect using underwater vehicles and are often too damaged from trawl surveys to facilitate identification. More taxonomic and survey work on the macroinvertebrates of the U.S. West Coast is necessary, combining genetic and morphometric analyses.

Future research should investigate the effects of climate and ocean changes on macroinvertebrates and the consequences of associated population changes. – Although the identifications and assemblage structures of nearshore macroinvertebrates are poorly known, the biology of the selected invertebrates identified in this report is mostly well described. Scientific interest has been generated by the economic or ecological importance of these species, by their ease of study based on their largely sedentary occurrence in nearshore regions, and by the need to address population declines in overexploited species or those that have been negatively impacted by climate change and disease. An exception is the White Abalone, which has limited life history information, possibly because its deeper depth distribution makes it less accessible to collection than other abalones (Lafferty et al. 2004). Additionally, age and growth information is largely unknown for the California Sea Cucumber and Warty Sea Cucumber because reliable aging structures or methods have not yet been developed. Research that replicates the anticipated impacts of climate change (e.g., temperature, pH, dissolved oxygen) on the biology and behaviors of the selected invertebrates is badly needed; many such studies have been published or are in progress (e.g., Crosson and Friedman 2018). Additionally, a better understanding of climate and ocean change impacts on the structure and composition of species assemblages and their demographic associations will be necessary to better understand and perhaps anticipate future population changes (Coates et al. 2013).

Several of the selected invertebrates have undergone severe population declines, either from historical overfishing, environmental dynamics, disease, or a combination of these factors. The combined recent effects of Abalone Withering Syndrome, Sea Star Wasting Disease, and the northeast Pacific marine heatwave have rippled through rocky intertidal and subtidal communities along the U.S. West Coast, altering ecological relationships and resulting in modified species composition and relative abundance (e.g., Bonvari et al. 2017; Rogers-Bennett and Catton 2019). Whereas bottom-up effects often can be reliably tracked, associated top-down effects are more difficult to interpret because they may vary spatially and be influenced by the demographics of predator populations. Major ecological repercussions of Ochre Sea Star and Sunflower Sea Star declines are expected throughout the U.S. West Coast but have not yet been well documented (Menge et al. 2016; Bonvari et al. 2017; Murie and Bordeau 2019). Because sea urchins and abalone are competitors and function as ecosystem engineers (Karpov et al. 2000; Scheibling et al. 2020), modifying the predatory effects of sea stars can alter the relative abundance and behavior of prey populations that drive the distribution and abundance of algal beds (Rogers-Benett and Okamoto 2020). For example, off Oregon and Northern California, ecological restructuring has resulted in a massive increase in Purple Sea Urchins and a shift from Bull Kelp beds to sea urchin barrens in some areas (Rogers-Bennett and Catton 2019). Interactive community studies are needed to better understand and respond to the impacts of a changing climate on rocky intertidal and subtidal communities (Kawana et al. 2019).

Ichthyofaunal Characteristics, Demographics, and Distributions

Common and abundant species within nearshore waters were examined across all four ecoregions of the U.S. West Coast. While habitat associations and preferences, life history data, and predator–prey interactions were included in assessing fish assemblages, as information was available, a range of data gaps persisted. Many individual species data gaps were too extensive to address in the scope of this study, but common or readily identifiable gaps across species types or assemblages are discussed herein.

Future data collection should capitalize on emerging technologies (e.g., fisheries catch reconstruction, remote sensing). – Much of the ecoregion assessments relied on information obtained using current resources and tools available to practitioners. Survey method technology has greatly improved over the past couple of decades. Traditional methods of fisheries-dependent stock assessments, fisheries-independent ecosystem surveys (Essington et al. 2021), and scuba-based transect and habitat surveys have provided baseline contextual information on richness, diversity, and habitat preferences for individuals and species assemblages. Emerging and novel techniques are becoming more commonplace with fisheries catch reconstruction, remote sensing (satellite, aerial, lidar, multibeam bathymetry, environmental DNA [eDNA] analysis, ROVs), and modeling for data-limited species life history (Beaudreau and Essington 2009). New tools can have benefits and limitations (e.g., ROVs improve direct observation of deepwater habitats, but they have a limited range of view). Still, utilizing a combination of these methods while eliciting input from regional experts (Hollarsmith et al. 2022) can address a range of data gaps. These tools are particularly important to resource managers to make informed decisions on the best available science.

Further research on habitat and population connectivity would better explain how assemblages are related across ecoregions. – Comparisons between ecoregion assemblages identified potential similarities and trends for common species, but questions remain for habitat and population connectivity. While identical species might be found across multiple ecoregions, presence alone is not enough to describe the movement of populations, gene flow, or recruitment sources. Marine species have complex life-history dynamics, where larvae, juveniles, and adults may occupy differing habitats, have changing food resource needs, and migrate between depths with size. *Connectivity* refers to the ability of species at these various life-history stages to openly move and exchange individuals within or across regions to populate habitats or contribute to existing local populations (Cowen et al. 2002; Pineda et al. 2007). Barriers to connectivity may result in restricted gene flow (bottleneck or Allee effects), limitations to recruitment success (minimum viable population size), or extirpated local populations. Addressing data gaps related to connectivity would help inform how species assemblages are related across ecoregions and between depth zones.

There are known geographic and oceanographic barriers between the four ecoregions that contribute to connectivity limitations. The Southern California Bight is differentiated from the northern ecoregions by the formation of the Southern California Eddy that circulates between northern waters at Point Conception and southern waters from Baja California. The exchange with warmer southern currents and more sheltered waters results in relatively greater species richness (478 species). There is also less similarity in species to the adjacent Central California Ecoregion assemblages across depth zones compared to species similarities between the Central California and Pacific Northwest assemblages.

The Central California assemblages were more similar to the Pacific Northwest Ecoregion across depth zones, and changes in predominant currents between seasons may increase connectivity across this region (summer coastal California surface currents that predominately flow south, compared to the northern countercurrent flows of the coastal Davidson Current in the winter). In examining the gene flow of the Longfin Smelt (listed as endangered by the state of California in 2009), it has been suggested that the California Current is less likely to assist gene flow than the Davidson Current (Saglam et al. 2021), but overall, these similarities describe potential connectivity between the two ecoregions.

Many of the fish species identified in the Salish Sea Ecoregion assemblage are also present in the Pacific Northwest Ecoregion, but the Pacific Northwest has a higher overall richness. While tidal currents contribute to gene flow into the Salish Sea, bathymetric features (Victoria sill, Hood Canal sill, Tacoma Narrows) may limit connectivity from outer coast populations and between basins or subregions. Genetic evidence on Yelloweye Rockfish identified a separate population in Hood Canal from the

Schooling fish. (A. Obaza, Paua Marine Research Group) rest of the Puget Sound DPS and the outer coast population (NMFS 2017). Continued genetic work within species that cross ecoregions is needed to differentiate connectivity between populations. Recent management and recovery plans have also identified the need to better understand genetic sources and early life-history connectivity to fully describe species assemblages and inform spatial and temporal management considerations (NMFS 2017; CDFW 2019; Calloway 2020).

Research on assemblage connectivity should specifically explore larval mortality. – An important component of connectivity for larval recruitment is mortality, especially for threatened and endangered species. Understanding impacts on larvae from climate change (temperature, pH) and interactions with predator consumption and prey resources can inform species responses to changing environmental conditions. Plankton studies that identify species occurrence, general abundance, prey availability, and seasonal timing in relation to roaming and foraging predators can inform food web dynamics to better define how fish assemblages are spatiotemporally related. Novel modeling techniques using results from plankton tow and diet gut content analyses (Beauchamp et al. 2018) are improving our estimates concerning recruitment potential for data-limited species.

Future research should examine forage fish and their effects on the trophic cascade. – Moving up the food web, forage fish are frequently identified as an important component of fish assemblage structure and sustainability, but data gaps on bottom-up impacts and linkages to predators remain. Workshops and studies have identified the need to better understand forage fish spawning and recruitment dynamics, population abundance, and the impacts of reduced plankton and other prey resources (Selleck et al. 2015; Rivers et al. 2022). Top-down control of ecosystems is well described for invertebrate communities (e.g., kelp and urchin barrens, and the community responses to the loss of controlling predators from Sea Star Wasting Disease and Withering Syndrome), but information on forage fish predator shifts in response to stressors and changing climate conditions is still lacking. In particular to this study, there was a lack of information about trophic cascade impacts on higher-level roaming predators from the loss of forage species abundance (e.g., Bluntnose Sixgill Shark, Shortfin Mako Shark, White Shark, Pacific Halibut).

Future research should explore range shifts resulting from changes in an ecosystem's periphery habitats. – Changing ocean conditions due to climate change have already been identified as a known stressor. Data gaps exist related to what will happen to already-depleted populations that occupy habitats on the edge of their range (Essington et al. 2013; Pietsch and Orr 2019) when connectivity is limited due to temperature barriers or other stressors. The Salish Sea gains some of its species diversity from its proximity to the point where the North Pacific Current splits to flow north and south, providing an input of northern and southern species. As regional temperatures rise, the consequences for species more adapted to the cooler northern temperatures are unknown (Ciannelli et al. 2021). Research in the Bering Sea is already identifying the effects of climate change on range shifts in Pacific Cod (Spies et al. 2019) and shifts in larval timing that also lead to declined survival due to reduced prey resource availability (Laurel et al. 2021). In areas with redundant functional species in the food webs, these changes may lead to regime shifts in ecosystems, where a different species of a similar trophic niche occupies a vacated biological function in response to a population decline. But studies to understand the consequences of regime shifts are still limited (Levin and Mollmann 2015).

Many paths for future research will improve our understanding of the U.S. West Coast's nearshore ecosystems: understanding connectivity between ecoregion fish assemblages, spatiotemporal shifts in populations in response to changing ecological conditions, shifts in species abundance and function, and utilizing emerging technologies and novel techniques in data collection and interpretation.

A herd of urchins, Otter Rock Marine Reserve, Oregon, 07/2019. (ODFW)

STRESSORS

STRESSORS TO U.S. WEST COAST NEARSHORE FISH, INVERTEBRATES, AND FISH HABITATS

This report details the state of the knowledge of the spatial extent of fish assemblages and select invertebrates, as well as the substrate and biotic fish habitats in the U.S. West Coast nearshore. Animals move and habitats expand and contract in response to many factors, including environmental stressors and human actions. In this section, we provide a brief overview of the many stressors affecting nearshore fish, invertebrates, and their habitats. The stressors identified include direct human action, such as commercial fish harvesting, and the indirect effects of human action, such as ocean acidification. Many of these stressors also have natural, environmental components that are not human-induced, such as water temperature variations associated with normal climate variability and the dynamics of water circulation patterns on an ocean-wide scale. These stressors may influence the spatial extent of nearshore fish habitats and the ranges of fish and invertebrates in the future. See Table 39 for a list of stressors described in this report and their sources.

A full review of all stressors and their trends is beyond the scope of this report. We direct readers to a more thorough investigation of anthropogenic stressors in the California Current by Andrews et al. (2015). For an in-depth description of integrating stressors and responses in the management of a single nearshore foundational species (kelp), we direct readers to Hollarsmith et al. (2022). Broad-scale assessments of the impacts of various stressors on particular fish and invertebrate species during status evaluation processes at both the state and federal levels for the U.S. West Coast are also readily available (e.g., Palsson et al. 2009; Drake et al. 2010; Gustafson et al. 2010). For listed species, regularly timed status updates also incorporate emerging science and new data pertinent to stressors that directly affect population status.

Of particular importance are the impacts of climate and ocean change on non-climate-related stressors to fish and invertebrates and biotic habitats. Since the onset of the industrial revolution, increased carbon dioxide in the atmosphere and in the ocean has caused a cascade of indirect stressors to fish and invertebrates and to biotic habitats. These stressors include ocean acidification and ocean warming, which in turn are linked to species shifts, disease, habitat contraction, hypoxia, and HABs. Modeling of climate and ocean change impacts on the Salish Sea suggests that by 2095, the Salish Sea average temperature will rise (1.51 °C) and pH and dissolved oxygen will fall (−0.18 units and −0.77 mg/L, respectively), causing algal biomass to increase by 23% and recurring hypoxia to increase by 16% (Khangaonkar et al. 2019). In the California Current, models have projected a −0.2 unit change in pH during summers from 2013–2063, resulting in a wide range of impacts (Marshall et al. 2017). It is important to acknowledge how climate and ocean changes may affect the distribution of fish and invertebrates and biotic habitats not just through lethal impacts but by altering trophic interactions and causing species shifts (Low and Micheli 2018; Khangaonkar et al. 2019; Rose et al. 2020).

Ocean acidification has far-reaching effects through a complex series of direct and indirect effects on both habitats and food webs (Feely et al. 2009; Chan et al. 2016). Of particular concern along the U.S. West Coast is its impacts on commercially important bivalves and on species that form the food web's base, such as pteropods, which are consumed by a wide array of fish and invertebrate species (Gazeau et al. 2013). Depressed pH levels have been implicated in reduced larval success, abnormal shell development, and reduced adult survival in various species, including abalones, Dungeness Crab, and numerous bivalves (Crim et al. 2011; Bednaršek et al. 2020). Impacts on biotic habitats and important forage species, such as Market Squid and intertidal mussels, have also been documented (Navarro et al. 2016; Rose et al. 2020). Models of ecosystem effects from ocean acidification along the West Coast predict dramatic declines in species biomass in the Central California and Southern California Bight Ecoregions. However, more economic impacts are predicted in the Pacific Northwest Ecoregion due to declines in the Dungeness Crab fishery, mainly from the loss of prey (Hodgson et al. 2018). As for other large-scale stressors, ocean acidification will have differing impacts on different species. Some, such as eelgrass

Table 39. Identified stressors to nearshore fish habitats coast-wide, their causes, and impacts.

Stressors	Direct human action	Indirect human action	Environ-mental and human actions	Infra-structure	Land use	Resource use	Species impacts	Biotic habitat impacts	Substrate habitat impacts
Ocean Acidification*		X		X			X	X	
Ocean Warming*		X	X	X			X	X	
Harmful Algal Blooms*		X	X	X	X		X		
Hypoxia*		X	X	X	X		X		
Eutrophication*		X	X		X		X	X	
Disease*		X	X	X			X		
Invasive Species*	X	X	X			X	X	X	
Shoreline Hardening/ Development	X				X		X	X	X
Aquaculture	X					X	X	X	X
Oil Spills	X			X	X	X	X	X	X
Pollutant Discharges	X			X	X		X	X	
Power Plant Impacts	X			X			X	X	
Oil Rig Decom-missioning	X			X				X	X
Energy Development	X			X				X	X
Fiber-Optic Cables	X			X				X	X
Underwater Noise	X			X		X	X		

* Indicates stressors caused by or exacerbated by climate and ocean change.

(Zostera spp.), may be more successful than others in lower pH environments (Zimmerman et al. 2017; Rose et al. 2020).

Likewise, warming ocean temperatures induce dramatic impacts all along the U. S. West Coast. Higher water temperatures are known to negatively impact the distribution of floating kelp and the recruitment of native Olympia Oysters, but these same temperatures may also be an advantage for other species, such as abalone, some urchin species, and Pacific Oysters (Magallana gigas); Puget Sound Ecosystem Monitoring Program [PSEMP] Marine Waters Workgroup 2012; Valdez and Ruesink 2017; Kawana et al. 2019; Rogers-Bennett and Catton, 2019).

Between 2013 and 2015, the Northeast Pacific experienced the most extreme marine heatwave ever recorded, characterized by average temperatures reaching 3 °C above normal, including one 226-day stretch with temperatures consistently 2.5 °C above normal (Hobday et al. 2016; Rogers-Bennett and Catton 2019). This heatwave had far-reaching and long-lasting impacts on the U.S. West Coast's species and biotic habitats that are still being felt today. The marine heatwave devastated kelp forests in the Pacific Northwest and Central California Ecoregions, triggering a massive decline in Red Abalone (*Haliotis rufescens*). The heat wave was coupled with a loss of predatory sea stars, including the Ochre Star and Sunflower Sea Star, due to Sea Star Wasting Disease. This combination of stressors resulted in a population explosion among Purple Sea Urchin, resulting in urchin barrens. The recreational Red Abalone fishery in Northern California was closed in 2018 due to the dwindling population, and much of the commercial Red Sea Urchin fisheries collapsed due to starvation conditions, leading to unmarketable sea urchins (Rogers-Bennett and Catton 2019).

While the 2013-15 marine heatwave was a catastrophic event, and extreme events are expected to increase in frequency, continued overall ocean warming is also expected to influence future species shifts in the nearshore as some species decline and some increase in response to warming temperatures (Kawana et al. 2019). Species responses depend on many variables, including a species' functional group and habitat associations. For example, benthic fish species more associated with the substrate appear to shift less than pelagic species more associated with ocean temperatures (Roberts et al. 2020).

As ocean temperatures warm and sea level rises, the intertidal zone will shift landward. Areas will be disproportionately affected where there is a lack of available space or correct elevation to accommodate the landward shift (e.g., cliffs, steep slopes, or human development) as the shallow intertidal rocky substrate becomes more regularly inundated. This shift and its effects will have impacts on vegetated biotic habitats and the species that depend on them, as well as species that occupy intertidal rocky areas. Remote sensing and terrestrial laser scanning have been used to estimate the loss of intertidal habitat due to sea level rise in all of the ecoregions. Depending on the sea level rise scenario, losses are predicted to range from 13% to greater than 50% (Lee II et al. 2017). Researchers also estimate future declines of submerged aquatic vegetation and biotic habitats in Southern California, with a parallel decline in sessile and mobile invertebrates (Hollenbeck et al. 2014; Kaplanis et al. 2020). Sea level rise will also exacerbate problems associated with *coastal squeeze*, or the loss of intertidal habitat due to a fixed structure (such as shoreline armoring) that prohibits the landward migration of organisms and habitats. This squeeze will particularly affect species relying on beach and shallow intertidal areas for spawning, such as Surf Smelt and Pacific Sand Lance in the Salish Sea Ecoregion (Penttila 2007; Quinn et al. 2012).

Disease is another species stressor exasperated by climate change impacts (Raimondi et al. 2002). The combined recent effects of Abalone Withering Syndrome, Sea Star Wasting Disease, and the marine heatwave have rippled through rocky intertidal communities throughout the U.S. West Coast, altering ecological relationships and resulting in modified species composition and relative abundance (Bonavari et al. 2017; Rogers-Bennett and Catton 2019). Whereas bottom-up effects often can be reliably tracked, associated top-down effects are more difficult to interpret because they may vary spatially and be influenced by the demographics of predator populations (Moritsch and Raimondi 2018). Major ecological repercussions of Ochre Sea Star and Sunflower Sea Star declines are expected throughout the U.S. West Coast. To date, they have been documented only on a localized basis (Menge et al. 1994; Schultz et al. 2016; Bonaviri et al. 2017; Burt et al. 2018; Murie and Bourdeau, 2019). Because sea urchins and abalones are competitors and function to alter ecosystems, modifying the predatory effects of sea stars can alter the relative abundance and behavior of prey populations that drive the distribution and abundance of algal beds (Rogers-Bennett and Okamoto 2020).

Direct Actions Affecting Nearshore Species and Habitats

Eutrophication, hypoxia, and HABs are interrelated stressors on nearshore species and habitats. They occur to some degree throughout the nearshore but are exacerbated by human actions, particularly the introduction of nutrients and warming temperatures (Scavia and Bricker 2006; Lewitus et al. 2012). The 2013-16 marine heatwave caused a massive HAB of *Pseudo-nitzschia*-producing domoic acid that delayed the opening of the West Coast Dungeness Crab fishery and closed the recreational

Razor Clam fishery (Ekstrom et al. 2020). While some HAB toxic impacts are related to human health, blooms of some types of raphidophyte algae, such as *Haterosigma akashiwo*, have caused multiple fish kills along the U.S. West Coast (Lewitus et al. 2012). Climate change and ocean change are expected to indirectly increase HAB and hypoxia frequency and intensity (Wells et al. 2015; Khangaonkar et al. 2019).

In recent years, nearshore waters in Oregon and Washington have exhibited seasonal hypoxia. Waters with oxygen levels below 1.4 mg/L are generally defined to be hypoxic (Chan et al. 2019). Many marine organisms will experience behavior, metabolism, or survival impacts when oxygen levels are below this threshold. Hypoxia has occurred on parts of the Oregon and Washington continental shelf in the summer months during most years since it was first documented in Oregon in 2002 (Grantham et al. 2004; Chan et al. 2019). The spatial extent, intensity, and duration vary from year to year. In some years, hypoxic waters have covered up to 62% of the Oregon and Washington shelf (Chan et al. 2019) and have resulted in documented marine life die-offs (Chan et al. 2008). Unlike other parts of the world where coastal hypoxia results from polluted land run-off, hypoxia off Oregon and Washington results from the upwelling of nutrient-rich, oxygen-poor waters into the nearshore. The high nutrients drive increased phytoplankton production, and the decomposing plankton decreases oxygen in the already oxygen-poor waters, leading to hypoxic conditions. Climate change has caused a reduction in oxygen in the upwelling source waters and an intensification of upwelling, both contributing to the recent emergence of hypoxia in the Pacific Northwest Ecoregion (Chan et al. 2019).

Effluent discharges into the nearshore and marine environments introduce toxins, nutrients, and warm water from point and nonpoint sources. These discharges cause impacts such as dead zones, HABs, and eutrophication that affect the ability of fish and invertebrates to thrive and alter biotic habitats (Malone and Newton 2020). Long-term studies of nutrient concentrations in San Francisco Bay revealed the role of increased nutrients in invasions of macrophytes, molluscs, and harmful bacteria, illustrating the complex and persistent influence nutrients play in food web dynamics (Glibert et al. 2011). Even in areas such as the Santa Barbara Channel, where upwelling is the major source of nutrients in the nearshore, increased nutrient loading from anthropogenic discharges can have local impacts, including HABs (Lewitus et al. 2012; Malone and Newton 2020). Documented impacts from power-plant warm-water discharges (generally more prevalent in Central California and the Southern California Bight Ecoregions) include shifts in species and biotic habitat distribution (Ehrler et al. 2002; Steinbeck et al. 2005; Bolorinos et al. 2018).

Development and construction are extensive in some areas of the nearshore and marine environments along the U.S. West Coast. Development transforms marine fish habitats both during construction and after structures are in place. This extensive development has been dubbed "ocean sprawl," and emerging energy infrastructure development (tide, wave, and wind energy) will increase its footprint (Heery et al. 2017; Perry and Heyman 2020; Chowdhury et al. 2021). With strong wind resources off the U.S. West Coast, the area is attractive to potential wind energy projects. Though most studies around impacts from wind energy have focused on birds and cetaceans (Best and Halpin 2019), known wind farm impacts to fish and fish habitats include cable disturbances, electromagnetic field effects, turbulence, and placement of hard substrate that can act as artificial reefs, altering settlement/recruitment patterns and fish behaviors (Boyd et al. 2018; Hutchison et al. 2020; Perry and Heyman 2020). The potential impacts of floating wind turbines include entanglement (Maxwell et al. 2022). The development of large wind farms could also displace fisheries, shifting effort toward other fishing grounds and possibly resulting in the localized depletion of fishery resources at these secondary locations. Secondary fishing grounds may also be less productive, resulting in increased costs for vessels as they work harder and travel farther to obtain the same harvest. For fisheries operating on the financial edge, such displacement could result in total closure.

Likewise, strong wave resources, especially off of Washington and Oregon (Yang et al. 2020), could promote the development of wave energy facilities. Potential impacts to fish and habitats associated with these facilities include alteration of seabed morphology and benthic habitats, electromagnetic effects and noise, toxicity of paints, alterations to animal movements and migrations, direct impacts to species due to moving parts, and even large-scale changes in ocean stratification. Note that many of these impacts are presumed based on similar impacts from existing infrastructure like wind farms (Polagye et al. 2011; Christiansen et al. 2022).

Submarine cables are important for global communications, require significant investment to place and maintain, and will become increasingly common for power delivery to offshore energy developments (Coffen-Snout and Herbert 2000; Clark 2016; Taormina et al. 2018). Though impacts from their installation, maintenance, and operations are not considered severe, they may increase as more cables are laid. The impacts of communication cables seem most pronounced during construction, but lingering impacts can include toxic chemical leaching, scour and habitat alteration, and sediment transport disruptions (Jurdana et al. 2014). Known impacts of submarine power cables are similar to the assumed impacts of offshore energy facilities: habitat loss or alteration (more pronounced during construction), noise, toxins, electromagnetic impacts, direct injury caused by equipment, and the alteration of species behaviors (Taormina et al. 2018; Vasilescu and Dinu 2021).

In addition to impacts associated with the construction and maintenance of ocean-built infrastructure, impacts associated with decommissioning facilities could affect fish and invertebrate distributions considering the tremendous diversity of fish found on oil and gas platforms off Southern California (Claisse et al. 2014; Love et al. 2019; Meyer-Gutbrod et al. 2019a). Though most of these facilities occur in deeper water (the Seaward Zone), there is a handful in California state waters and at the depth range of the nearshore Core Zone. Decommissioning these facilities may disrupt the spatial extent of some fish assemblages and invertebrates (Claisse et al. 2014; Meyer-Gutbrod et al. 2019b) and has the potential to introduce a broad array of toxic chemicals into the environment.

The nearshore and shoreline areas of the U.S. West Coast have been highly modified to accommodate development and commerce. Modifications include dredging and the construction of alongshore armoring and bulwarks, jetties, groins, breakwaters, and other coastal-defense and wave-attenuating structures (Dugan et al. 2012; Ruggiero et al. 2013). In 2002, in the Southern California Bight Ecoregion, over 30% of the shoreline was armored, with cities like Long Beach more than 70% armored (Dugan et al. 2012). In the Salish Sea in 2021, 29% of the shoreline was armored (Small 2021). Shoreline armoring steepens slopes, alters sediment transport and detritus deposition, eliminates intertidal and shallow-water nursery fish habitats, reduces invertebrate densities, and influences fish assemblages, with some fish avoiding modified shorelines altogether (Toft et al. 2007; Dugan et al. 2012; Morley et al. 2012; Heery and Sebens 2018). In the Southern California Bight Ecoregion, beach nourishment is a common strategy to mitigate shoreline erosion (Ludka et al. 2018). Beach nourishment has short-term impacts on species and habitats (crushing, burying, clogging feeding tubes) and longer-term impacts, including interference with foraging, spawning, and nesting habitats for nearshore species. Water quality impacts also persist after nourishment and can affect reefs and biotic habitats several kilometers from the nourishment site (Ludka et al. 2018; De Schipper et al. 2021).

The impacts of underwater anthropogenic sound on marine mammals have been highly publicized, especially in the Salish Sea, where it has been identified as one of three major stressors on the population of Southern Resident Killer Whales federally listed as endangered (NMFS 2008; Best and Halpin 2019). Underwater sound is known to negatively affect fish and invertebrates. Sounds such as vessel engine noise and pile driving can cause physical harm to fish (cochlear damage and metabolic disruption) and disrupt social and feeding behavior (Peng et al. 2015). Underwater sound has also been shown to impact physiological processes in invertebrates, such as defensive behavior and color change (camouflage; Carter et al. 2019). The understanding of underwater sound on marine fish and invertebrates is limited by the sheer variety of taxa, their unique responses, and the varied sound sources (Williams et al. 2015). Even methods to assess how far sound travels underwater are limited, especially in the shallow nearshore Core Zone (Hawkins and Popper 2017). Propagation distance can be dramatically affected by water temperature, water column stratification, the density of planktonic algae, and other highly dynamic factors difficult to accurately assess or predict.

Aquatic invasive species are a pervasive stressor on nearshore fish, invertebrates, and biotic habitats. Researchers have documented hundreds of species (fish, invertebrates, algae, and plants) introduced to the Northeast Pacific Ocean, including 76 species established in the

Salish Sea (Wonham and Carlton 2005) and 240 species established in San Francisco Bay. The latter is considered one of the most invaded estuaries in the world (Cohen et al. 1995; Briggs 2016). Whether an introduced species is invasive is subjective, but introduced species generally are considered invasive if they threaten the ecosystem or economy of their new habitats (Environment Canada 2010). Invasive species can be introduced through direct human action, such as the release of European Green Crab (Carcinus maenas) into San Francisco Bay in live oyster packaging (Cohen et al. 1995). Alternatively, they can be introduced through indirect impacts from human actions, such as the European Green Crab's subsequent range expansion through larval transport (Jensen et al. 2002; Behrens Yamada et al. 2015; Behrens Yamada et al., 2017). The European Green Crab is a voracious predator known to destroy eelgrass beds and shellfish beds and outcompete native crabs for food. Its recent spread in the Salish Sea prompted the governor of Washington to declare a state of emergency to secure funding to prevent its permanent establishment ("Emergency Proclamation. 22-02. Green Crab Infestation. January 19 2022" n.d.).

The invasive algae *Caulerpa* spp. can disrupt fisheries and native seagrass communities (Williams and Grosholz 2002). In the Southern California Bight Ecoregion, the recent indication of *Caulerpa prolifera*, which can live as deep as 50 m in low-light conditions, triggered an emergency eradication response (NOAA Fisheries n.d.). The threat of major introductions of invasive species carried on debris from the Great Tohoku Earthquake and Tsunami of 2011 seems to have been averted by prompt emergency debris removal programs (Hansen et al. 2018).

Aquaculture is a substantial and growing industry along the U.S. West Coast and a major economic engine, especially for rural counties (Northern Economics 2013; Andrews et al. 2015). Unfortunately, aquaculture also stresses nearshore fish and their habitats along the U.S. West Coast. Impacts of aquaculture involving bivalves, abalones, salmonids, and other finfish include habitat destruction and conversion, water pollution, disease, and eutrophication (Ahmed and Thompson 2019). Disease transmission is also a concern, with Abalone Withering Syndrome known to be transmitted to wild populations through the transport of cultured abalone (Crosson et al. 2014).

Finally, catastrophic or major oil spills have huge and lasting impacts on nearshore fish and their habitats. Most oil spills do not make the news, though, and the amount of oil spilled by freight ships, fishing vessels, and other vessels combined can be significant, even compared to spills from tankers and tank barges (Dalton and Jin 2010). Facilities and pipelines contribute more spills along the U.S. West Coast than vessels. In Orange County in the Southern California Bight Ecoregion, 25,000 gallons (94,635 L) of oil spilled from an offshore pipeline leak in October 2021, prompting fisheries closures and remediation (Taxin 2021). From 2002–2020, 13.6 million gallons (51.5 million L) of crude and non-crude oil were released along the West Coast, including Alaska and British Columbia. A quarter of that volume was released in just two incidents, including 54,000 gallons (204,412 L) of bunker fuel released in 2008 from the *Cosco Busan* in the Central California Ecoregion. And trends in oil releases are steady if not increasing in the region (Pacific States/British Columbia Oil Spill Task Force 2021), making oil spills a persistent risk to West Coast ecosystems.

Impacts from oil spills are dependent on a variety of conditions, including the type of oil spilled, the environment where it is released, the substrate, wave exposure, and the response process. How species are impacted varies also, but in general, intertidal species that must survive in the air/water interface are more highly impacted by oil spills, and their recovery is related to their life history, with short-lived species recovering more quickly than long-lived species (Chang et al. 2014). Short-term impacts of oil spills like the *Cosco Busan* spill include acute toxic effects from ingestion, inhalation, and smothering, as well as changes in algal composition in the intertidal. Decades after the *Exxon Valdez* spill in Prince William Sound, long-term impacts include the continued mortality of fish embryos incubating in the intertidal and persistent sub-surface oil remaining on beaches (Lindeberg et al. 2018; Barron et al. 2020). Indeed, herring embryo mortality was still being detected in San Francisco Bay years after the *Cosco Busan* spill (Incardona et al. 2012).

Seagrasses. (A. Obaza, Paua Marine Research Group)

DISCUSSION

DISCUSSION

In 2018, PMEP convened the nearshore working group to develop a state-of-the-knowledge report to identify, catalog, and map U.S. West Coast nearshore fish and invertebrate habitats and to describe how biotic assemblages use these habitats. Through a process guided by experts on the nearshore we gathered datasets and literature to describe benthic substrate type, biotic habitat distribution, all known species distributions for common fish and select invertebrates, and habitat associations for the same. These descriptions span three depth zones (landward to −100 m in depth) and four ecoregions (south from the Salish Sea and the northern Washington border down to the southern California border). This work resulted in an extensive online spatial geodatabase and helped to inform the review of data gaps and identified stressors already discussed.

Our first two goals were to define and map boundaries for nearshore zones and to compile and standardize spatial data on habitats coast-wide. Products stemming from the first goals are available as online resources and attached appendices. The specific objectives addressed in this report were to describe the spatial extent for identified typical fish assemblages and selected invertebrate species and habitats and to define similarities between depth zones and among nearshore regions. The results form a baseline of available information describing the spatial extent of fish habitats for the U.S. West Coast, which we can use to direct conservation efforts and projects to restore species and habitats.

While there were many similarities in fish assemblages between adjacent ecoregions, and some also between more distant ecoregions, spatial data gaps remain concerning the connectivity of larval life histories and stressors related to species distributions. The unique current patterns and basin bathymetries contribute to each ecoregion's assemblages and available habitats. Overlapping physical and habitat features can describe some similarities, but each region has uniquely contributing watersheds and environmental conditions that drive species assemblages. Going forward, efforts to further define habitat structure, identify the spatial arrangement and connectivity of habitats, and detail the habitat associations of marine fishes and invertebrates are needed to inform effective long-term monitoring, conservation, and management.

This project was a first step in classifying U.S. West Coast fish habitats using CMECS, completing two of four the CMECS components: the CMECS Biotic Component and Substrate Component datasets. Completing the remaining two CMECS components, Geoform and Water Column, will provide more information on the physical and chemical-forcing functions of habitat in the region. Future efforts can classify the physiographic unit for the Geoform Component based on available data with relatively minimal effort. However, more extensive data mining and classification need to be conducted to classify at the geoform level. Additional investigation into the data availability for the Water Column Component needs to be done to see if completing it is possible with available data at the West Coast–wide scale and to identify specific data needs. As a part of the California Current Ecosystem, the units underlying these components have a major influence on fish habitats in the region.

The MHW shoreline currently represents the shoreward boundary of the PMEP Nearshore dataset since it was the best data readily available for use. However, CMECS defines the upper extent of the nearshore zone as the splash zone. Using the best available topo-bathymetry data across the West Coast, a new line feature better defining the upper edge of the intertidal zone should be developed. Concurrently, using the same source data, a line defining MLLW across the U.S. West Coast can represent the seaward edge of the intertidal zone. This report classified fishes' habitat usage within intertidal and subtidal areas of the Core Zone. Having a clearer definition of the upper and lower boundaries of the intertidal zone will more explicitly align with the habitat use information for fish and invertebrates summarized in this report.

The habitat data developed as part of this project was limited to source datasets depicting the spatial extent of habitats as polygon features. Other available datasets, such as ShoreZone, the Environmental Sensitivity Index, PISCO, and NOAA's observation of corals and other habitat-forming invertebrates, are mapped as line and point features. To be more inclusive of the variety of existing data available, researchers can create a web application to integrate PMEP's Nearshore dataset with other publicly available habitat data services. To have consistency of classification across datasets, discussions with data providers can be initiated to explore the possibility of crosswalking data into CMECS.

Fishes' and invertebrates' habitat use, as summarized in this report, align with the habitats in the biotic and substrate datasets. NOAA currently hosts and manages a Habitat Use Database (HUD), which was used in this report's fish and invertebrates summaries. This report can be used to update the HUD, which can then be used to visualize the habitat use of invertebrates and species in association with the Biotic and Substrate Components datasets created as part of this project. As additional components, such as the Geoform and Water Column Components, are created, additional visualizations can be developed.

Certain biotic habitats are mapped throughout the West Coast. However, some habitat types have significantly fewer mapping efforts associated with them. Specifically, information about the extent of faunal beds, macroalgae, and other kelps (non-canopy-forming) is limited across the whole West Coast (see the Data Gaps and Considerations section for specific habitat types). Additional efforts to inventory these habitat types, or efforts to interpolate areal extent from the points or lines of these habitats, would fill a significant data gap in biotic features.

The novel efforts made in this report to describe U.S. West Coast habitats, fish, and invertebrates were monumental. The report and accompanying PMEP Nearshore dataset give researchers, restoration practitioners, decision-makers, and other stakeholders a searchable repository of the best available science. They are tools to better understand what we know now about these fish and invertebrate habitats and what more we can learn. Still, our efforts thus far have been only an initial approach to compiling and synthesizing existing data sources. More work remains.

Through this process, some remaining key data and knowledge gaps emerged that have implications for all stakeholders.

- First, developing a West Coast-wide *intertidal zone* dataset within the PMEP Nearshore dataset would help to align connectivity more clearly with this study's data on fish and invertebrate habitat use.
- Second, the geodatabases and species assemblages compiled herein will help inform our understanding of ecosystem processes and drivers.
- Third, the physical orientation of the Southern California Bight shoreline creates coastal habitat characteristics that distinguish it from the other outer coast ecoregions, highlighting a unique ecosystem of fish assemblages, particularly its use as a nursery among species in the upper trophic level.
- Fourth, among unique assemblages, Core and Seaward Zone assemblages are more dissimilar, and hard bottom assemblages are relatively more diverse in the Pacific Northwest than in the Salish Sea.
- Fifth, connectivity between the Salish Sea and Pacific Northwest Ecoregions for some species is poorly understood.
- Sixth, as climate conditions change, approximately 15% of Salish Sea fishes are at the terminus of their range (Pietsch and Orr 2019), attributed to where the North Pacific Current splits to flow north and south. Monitoring focal species at risk in this ecoregion will be important to quantify the impacts of changing environmental baselines.

Ongoing work to understand and quantify regional differences will inform future conservation projects for the PMEP. We wish to thank the members of the PMEP Nearshore Working Group, PMEP Science & Data Committee, PMEP Steering Committee, and PMEP staff for their input and dedication to creating this report.

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APPENDIX 1

Contact Information

For general questions or comments about this report or the underlying datasets, please contact the Pacific Marine and Estuarine Fish Habitat Partnership (PMEP) at info@pacificfishhabitat.org. Or visit PMEP's website at www.pacificfishhabitat.org for more information about our work.

If you would like to request the new crosswalks developed for this report or merely have questions about them, please contact the GIS team (gis@psmfc.org) at the Pacific States Marine Fisheries Commission.

APPENDIX 2

Locations and Types of Estuaries Among the Four Designated U.S. West Coast Ecoregions, from North to South

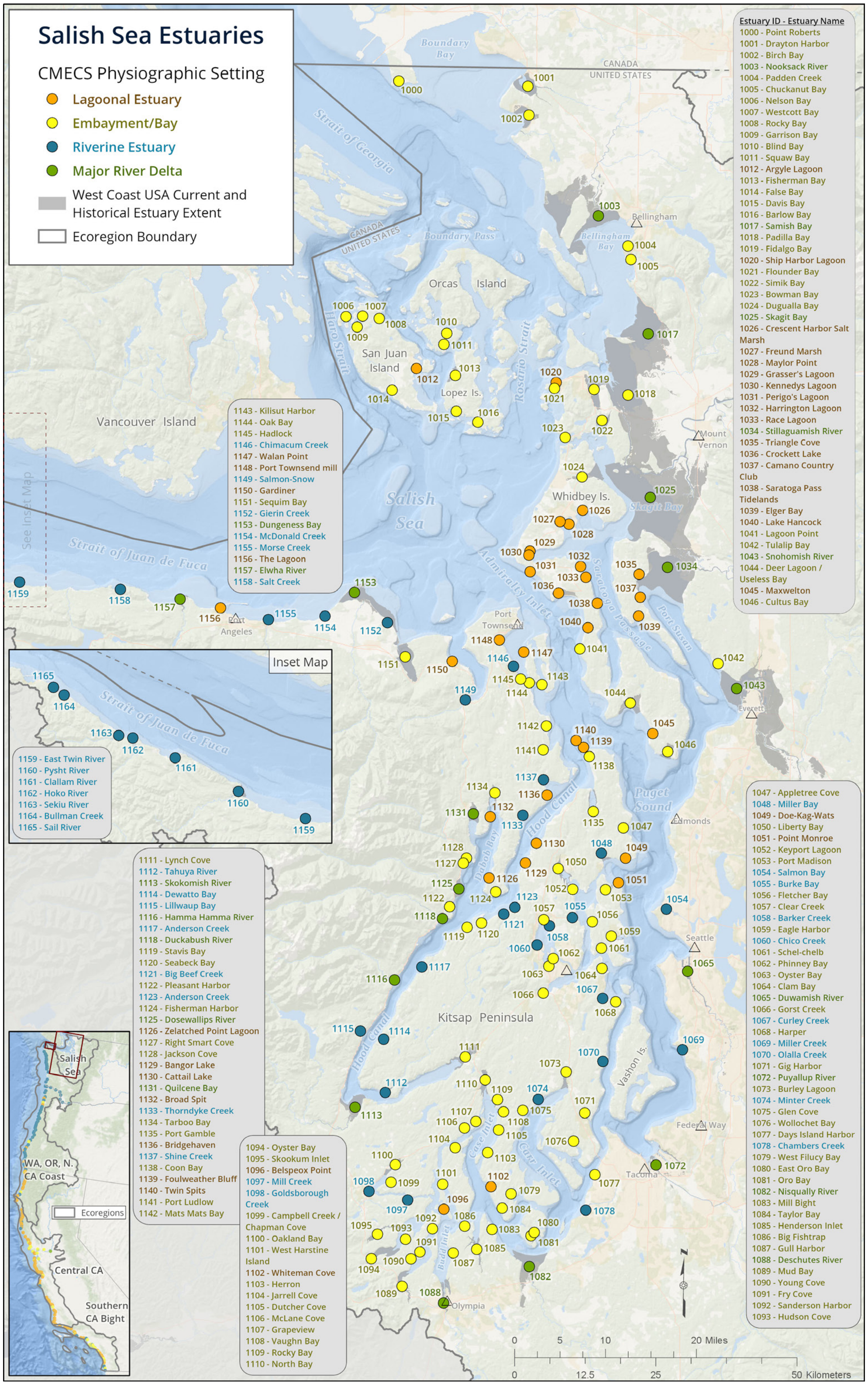

Figure A2.1. Locations and types of Salish Sea estuaries.

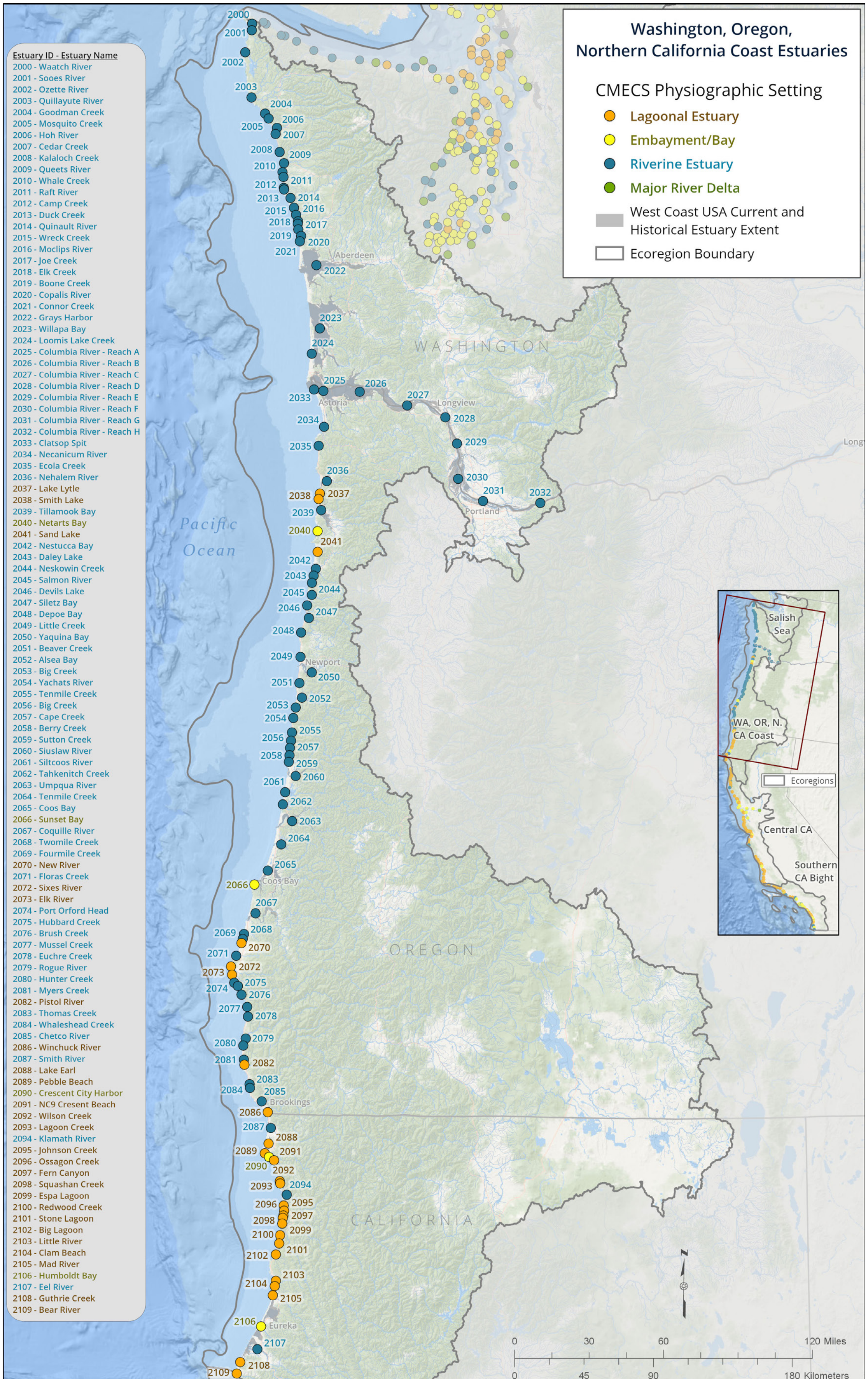

Figure A2.2. Locations and types of Pacific Northwest estuaries.

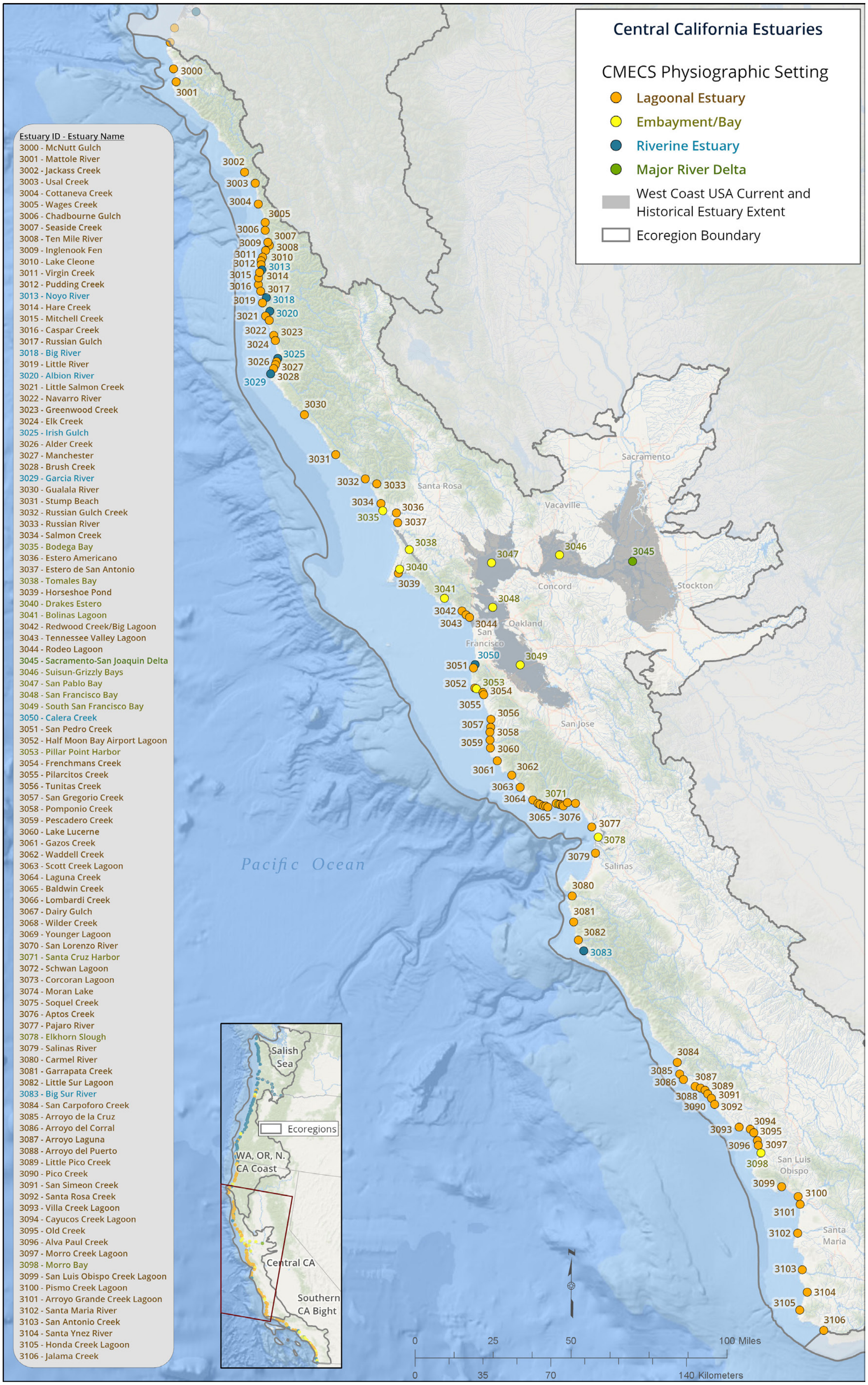

Figure A2.3. Locations and types of Central California estuaries.

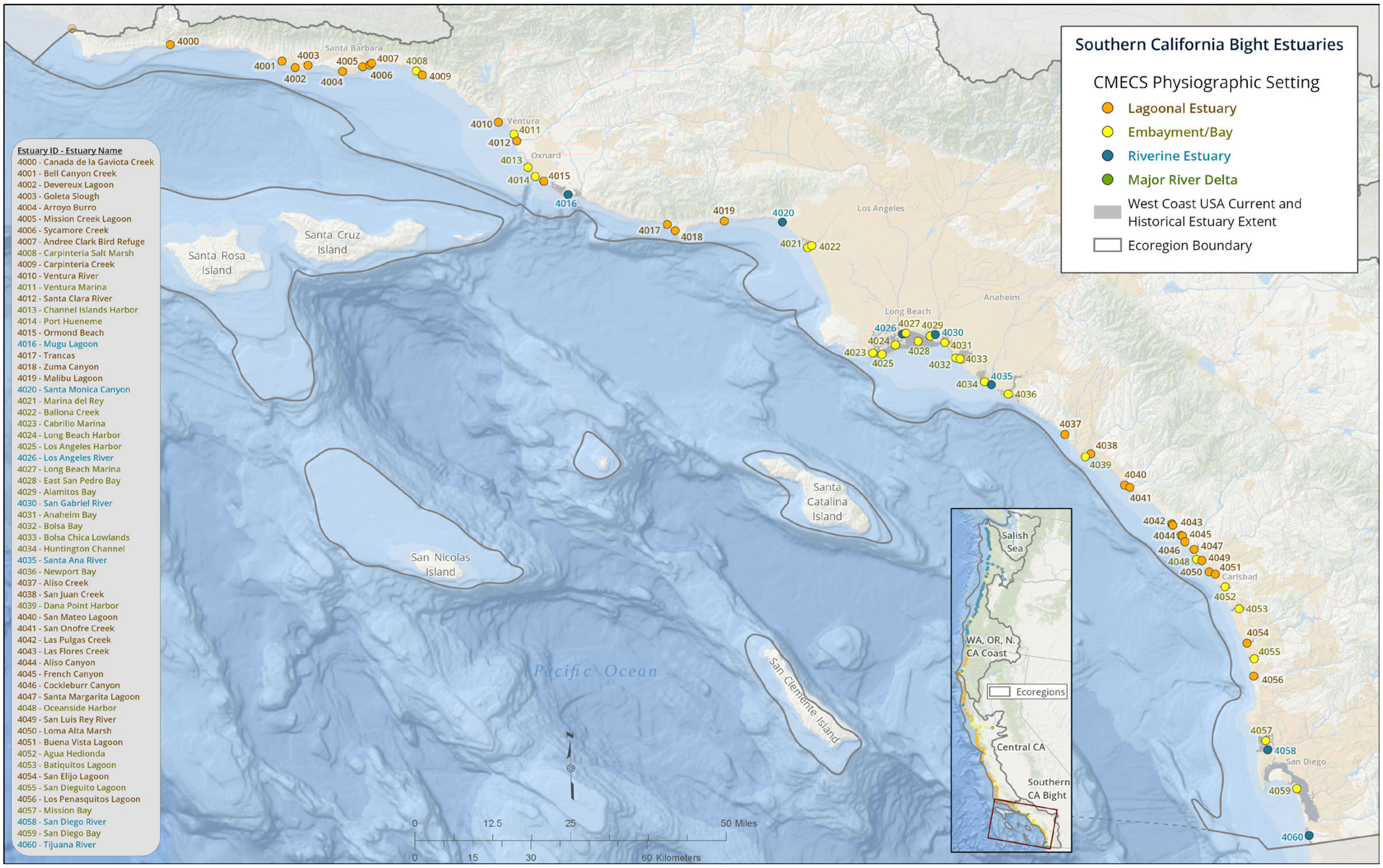

Figure A2.4. Locations and types of Southern California Bight estuaries.

APPENDIX 3

CMECS Classifications Used in Unit Definitions and Information Sources Used to Make Classifications

CMECS Setting/ Component	Unit	Source	Unit Names Present in PMEP Nearshore Data
Biogeographic Setting	Realm	MEOW	Temperate Northern Pacific
	Province	MEOW	Cold Temperate Northeast Pacific, Warm Temperate Northeast Pacific
	Ecoregion	Modified MEOW	Salish Sea, Washington, Oregon, Northern California Coast, Central California, Southern California Bight
Aquatic Setting	System	"NOAA water level models + LIDAR DEM, Bathymetry"	Marine, Estuarine
	Subsystem	Bathymetry	Marine Nearshore

Water Column Component	Unit	Source	Unit Names Present in PMEP Nearshore Data
Geoform Component	Physiographic Setting	various, PMEP	Sound, Contiental/Island Shelf, Bight
Substrate Component	Substrate Origin	(see Appendix 4 data sources)	Geologic Substrate
	Substrate Class		Rock Substrate, Unconsolidated Mineral Substrate, Organic Substrate, Shell Substrate, Anthropogenic Rock, Anthropogenic Wood, Construction Materials, Metal
	Substrate Subclass		Anthropogenic Rock Rubble, Anthropogenic Rock Reef, Anthropogenic Rock Rubble, Metal Reef, Construction Reef, Shell Hash, Coarse Unconsolidated Substrate, Fine Unconsolidated Substrate, Bedrock
	Substrate Group		Gravel, Gravel Mixes, Gravelly, Slightly Gravelly, Sand, Sandy Mud, Mud, Woody Debris
	Substrate Subgroup		Boulder, Cobble, Pebble, Granule, Sandy Gravel, Muddy Sandy Gravel, Muddy Gravel, Sandy Cobble, Sandy Muddy Cobble, Cobble Mix, Muddy Sandy Cobble Mix, Gravelly Sand, Gravelly Muddy Sand, Gravelly Mud, Cobbley Sand, Cobbley Sandy Mud, Cobbley, Slightly Gravelly Sand, Slightly Gravelly Muddy Sand, Slightly Gravelly Mud, Slightly Cobbley Sand, Sandy Silt, Silt, Silt-Clay, Clay

CMECS Setting/ Component	Unit	Source	Unit Names Present in PMEP Nearshore Data
Biotic Component	Biotic Setting	(see Appendix 4 data sources)	Benthic/Attached Biota, Planktonic Biota
	Biotic Class		Floating/Suspended Plants and Macroalgae, Faunal Bed, Aquatic Vegetation Bed, Emergent Wetland, Scrub-Shrub Wetland, Forested Wetland
	Biotic Subclass		Attached Fauna, Soft Sediment Fauna, Benthic Macroalgae, Aquatic Vascular Vegetation, Emergent Tidal Marsh, Tidal Scrub-Shrub Wetland, Tidal Forest/Woodland
	Biotic Group		Attached Oysters, Attached Sea Urchins, Tunneling Megafauna, Clam Bed, Mussel Bed, Scallop Bed, Canopy-Forming Algal Bed, Seagrass Bed, Brackish Marsh
	Bioitic Community		Attached Crassostrea, Attached Strongylocentrotus franciscanus, Attached Haliotis, Attached Mytilus, Macoma Bed, Mya Bed, Clinocardium Bed, Cryptomya Bed, Leukoma Bed, Nuttallia Bed, Saxidomus Bed, Tresus Bed, Venerupis Bed, Crassodoma Bed, Chlamys Bed, Protothaca Bed, Tivela Bed, Chione Bed, Panopea Bed, Siliqua Bed, Macrocystis Communities, Mixed Kelp Communities, Nereocystis Communities, Zostera marina, Zostera japonica, Eelgrass bed, Zostera pacifica, Surfgrass (Phyllospadix spp.), Spartina alterniflora

APPENDIX 4

Source Datasets Used to Develop Nearshore Zones and CMECS Biotic and Substrate Component Datasets

PMEP Region Key: SS = Salish Sea; PNW = Pacific Northwest; CC = Central California; SCB = Southern California Bight

Data Quality Ranking Key:

- Low = Resolution >1:100,000 map scale/100m resolution, data digitized from expert input/reports, no ground-truthing
- Moderate = Resolution >12-100 m gridded or >1:24,000-100,000 scale, high resolution with no ground-truthing, low resolution with ground-truthing, data compilation with varying resolution data, volunteer field data collection with ground-truthing
- High = Resolution <1:24,000 or 12m resolution, ground-truthing
- Modeled = Modeled dataset, not from remote sensing or ground-truthed information

Note. The following datasets numbers do not appear in this appendix: 24, 47, 48, 49, 71, and 74. They are missing because the associated datasets were ultimately not used in this project.

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
1	Habitat	Historical Floating Kelp	Washington Department of Natural Resources (WA DNR)	SS	N/A	Low	Digitized historical interpretations	1912	Biotic
2	Habitat	Regional Surveys of Bull Kelp	The Northwest Straits Commission (NWSC) and Marine Resources Committees (MRCs)	SS	~5m	Moderate	Digitized perimeter of ground-truthed habitat by volunteers	2015-2019	Biotic
3	Habitat	Essential Fish Habitat Mapping (SGH V5)	Oregon State University, Active Tectonics & Seafloor Mapping Lab (AT&SML), NOAA Fisheries Northwest Fisheries Science Center, and the Bureau of Ocean Energy Management	SS; PNW; CC; SCB	25m	Moderate	Data compilation	2021	Substrate

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
4	Habitat	Canopy-forming Kelp Inventory in the Western San Juan Archipelago	Washington Department of Natural Resources (WA DNR)	SS	~3m	Moderate	Imagery classification	2004-2006	Biotic
5	Habitat	Skagit County Intertidal Habitat Inventory	Washington Department of Natural Resources (WA DNR)	SS	1:12,000	High	Imagery interpretation and classification; ground-truth	1996	Substrate, Biotic
6	Habitat	Whatcom County Intertidal Habitat Inventory	Washington Department of Natural Resources (WA DNR)	SS	1:12,000	High	Imagery interpretation and classification; ground-truth	1995	Substrate, Biotic
7	Habitat	Tulalip Intertidal Habitat Inventory (North Puget Sound, Possession Sound, and Port Susan)	Tulalip and Stillaguamish Tribes	SS	1:12,000	High	Imagery interpretation and classification; ground-truth	2001	Substrate, Biotic
8	Habitat	Bloch Marine Substrate	Washington Department of Natural Resources (WA DNR)	SS	N/A	Modeled	Modeled (ShoreZone	2005	Substrate
9	Habitat	Salish Sea Benthic Habitat Maps	The Nature Conservancy (TNC)	SS	1:50,000-1:100,000	Moderate	Data compilation	2014	Substrate
10	Habitat	Puget Sound Environmental Atlas	Washington Department of Fish and Wildlife (WDFW)	SS	Unknown	Low	Digitized interpretations	1992	Biotic
11	Habitat	Oregon's Shore Substrate Habitats (CMECS)	Oregon Coastal Management Program (DLCD)	PNW	20m	Modeled	Modeled (imagery, DEM, Oregon ShoreZone)	2020	Substrate

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
12	Habitat	California Substrate Habitat	Institute of Marine Science (UCSC), California Department of Fish and Wildlife (CDFW)	PNW; CC; SCB	2m	High	Rugosity analysis	2020	Substrate
13	Habitat	California Substrate Habitat (modeled white zone)	Institute of Marine Science (UCSC)	PNW; CC; SCB	30m	Modeled	Modeled (Environmental Sensitivity Index)	2020	Substrate
14	Habitat	Seafloor Habitat Mapping Nearshore San Diego County	San Diego Association of Governments (SANDAG)	SCB	~1:24,000	Moderate	Remote sensing interpretations; ground-truth	2005	Substrate
15	Habitat	PMEP Biotic Estuary Extent	Pacific Marine & Estuarine Fish Habitat Partnership	SS	Various	Moderate	Data compilation	2018	Biotic
16	Habitat	Nearshore Substrate Mapping Change Analysis using Multispectral Imagery, California South Coast MPA Baseline Study	Ocean Imaging	SCB	1m	Moderate	Imagery classification	2011	Substrate, Biotic
17	Habitat	Nearshore Habitat Mapping - North Central Coast	Ocean Imaging	CC	1m	Moderate	Imagery classification	2010	Substrate, Biotic
18	Habitat	Long-Term Monitoring of Floating Kelp Along the Outer Coast and Strait of Juan de Fuca	Washington Department of Natural Resources (WA DNR)	SS; PNW	4m	High	Imagery interpretation	2015-2016	Biotic
19	Habitat	California Kelp Persistence	California Department of Fish & Wildlife	PNW; CC; SCB	2m	High	Remote sensing	2015-2016	Biotic

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
20	Habitat	Maximum Observed Extent of Eelgrass on the West Coast, USA	Pacific Marine & Estuarine Fish Habitat Partnership (PMEP)	SS; PNW; SCB	Various	Moderate	Data compilation	2020	Biotic
21	Habitat	National Wetlands Inventory	U.S. Fish and Wildlife Service (USFWS)	SS; PNW; CC; SCB	1:24,000	Moderate	Imagery interpretation and classification; ground-truth	2016	Substrate, Biotic
22	Habitat	NOAA Seagrass	Office for Coastal Management (NOAA)	SS; PNW; CC; SCB	Various	Moderate	Data compilation	2015	Biotic
23	Habitat	West Coast Canopy Forming Kelp	Bureau of Ocean Energy Management	SS; PNW; CC; SCB	Various	Moderate	Data compilation	1989-2014	Biotic
25	Habitat	Olympic Coast Sanctuary Seafloor Mapping Data	Olympic Coast National Marine Sanctuary (NOAA)	SS; PNW	1:24,000	High	Data compilation	2015	Substrate
26	Habitat	Drakes Bay and Vicinity (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2014	Substrate
27	Habitat	Fanny Shoal Habitat (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2006	Substrate
28	Habitat	Monterey Canyon and Vicinity (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2016	Substrate
29	Habitat	North Anacapa Island (nanahab) (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2002	Substrate

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
30	Habitat	Offshore Aptos (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2016	Substrate
31	Habitat	Offshore Bodega Head (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2014	Substrate
32	Habitat	Offshore Bolinas (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate
33	Habitat	Offshore Coal Oil Point (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2014	Substrate
34	Habitat	Offshore Fort Ross (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate
35	Habitat	Offshore of Half Moon Bay, California (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2014	Substrate
36	Habitat	Offshore Pacifica (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2014	Substrate
37	Habitat	Offshore Pigeon Point (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate
38	Habitat	Offshore Point Reyes (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
39	Habitat	Offshore Salt Point (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate
40	Habitat	Offshore Santa Cruz (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2016	Substrate
41	Habitat	Offshore Scott Creek (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate
42	Habitat	Offshore Point Conception (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2018	Substrate
43	Habitat	Offshore of Monterey, California (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2016	Substrate
44	Habitat	Offshore Tomales Point (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate
45	Habitat	Offshore Ventura (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2013	Substrate
46	Habitat	San Miguel Island Habitat (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2003	Substrate
50	Habitat	Offshore of San Gregorio (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2014	Substrate

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
51	Habitat	North Anacapa Island Habitat (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2003	Substrate
52	Habitat	Offshore Ventura (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2013	Substrate
53	Habitat	Hueneme Canyon (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2012	Substrate
54	Habitat	Offshore Carpinteria (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2013	Substrate
55	Habitat	Offshore Gaviota (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2018	Substrate
56	Habitat	Offshore Refugio Beach (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2015	Substrate
57	Habitat	Offshore Santa Barbara (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2013	Substrate
58	Habitat	South Anacapa Island (sanahab) (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2005	Substrate
59	Habitat	South Anacapa Passage (sanphab) (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2005	Substrate

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
60	Habitat	South East Santa Cruz Island (secruhab) (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2005	Substrate
61	Habitat	Big Sycamore Reserve Area (bsychab) (CSMP)	United States Geological Survey (USGS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2002	Substrate
62	Habitat	North Anacapa Passage (nanphab) (CSMP)	United States Geological Survey (USGS)	SCB	1:24,000	High	Remote sensing interpretations; ground-truth	2005	Substrate
63	Habitat	Channel Islands National Park Habitats	U.S. National Park Service (NPS)	SCB	1:24,000	High	Remote sensing interpretations, modeled	2015	Substrate
64	Habitat	Channel Islands National Park Habitats (including White Zone)	U.S. National Park Service (NPS)	SCB	1:24,000	Modeled	Modeled	2015	Substrate
65	Habitat	Golden Gate National Recreation Area (GGNRA) Habitats	U.S. National Park Service (NPS)	CC	1:24,000	High	Remote sensing interpretations; ground-truth	2009	Substrate
66	Habitat	Golden Gate National Recreation Area (GGNRA) Habitats (White Zone)	U.S. National Park Service (NPS)	CC	1:24,000	Modeled	Modeled	2009	Substrate
67	Habitat	Point Reyes National Seashore Habitats	U.S. National Park Service (NPS)	CC	1:24,000	High	Remote sensing interpretations,	2011	Substrate

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
68	Habitat	Point Reyes National Seashore Habitats (White Zone)	U.S. National Park Service (NPS)	CC	1:24,000	Modeled	Modeled	2011	Substrate
69	Habitat	Environmental Sensitivity Index - Invertebrates (Central California)	Office of Response and Restoration (NOAA)	CC	1:24,000 (fuzzy)	Low	Data compilation (mainly digitized index polygons with expert interpretations)	2006	Biotic
70	Habitat	Environmental Sensitivity Index - Invertebrates (Southern California)	Office of Response and Restoration (NOAA)	CC: SCB	1:24,000 (fuzzy)	Low	Data compilation (mainly digitized index polygons with expert interpretations)	2014	Biotic
72	Habitat	Environmental Sensitivity Index - Invertebrates (Northern California)	Office of Response and Restoration (NOAA)	PNW; CC	1:24,000 (fuzzy)	Low	Data compilation (mainly digitized index polygons with expert interpretations)	2010	Biotic
73	Habitat	Environmental Sensitivity Index - Benthic Habitat (Southern California)	Office of Response and Restoration (NOAA)	SCB	1:24,000 (fuzzy)	Low	Data compilation (mainly digitized index polygons with expert interpretations)	2014	Biotic
75	Shoreline	Continually Updated Shoreline Product (CUSP)	NOAA National Geodetic Survey (NOAA)	SS; PNW; CC; SCB	"1:1,000–1:24,000"	High	Imagery interpretations (MHW)	2016	Nearshore Zones

Dataset Number	Data Category	Dataset	Source	PMEP Region	Resolution or Scale	Data Quality	Type	Publication Year	Input Into
76	Shoreline	Oregon Continually Updated Shoreline Product	"Oregon Coastal Management Program (DLCD)"	PNW	"1:1,000–1:24,000"	High	Imagery interpretations (MHW)	2015	Nearshore Zones
77	Shoreline	Shoreline dervied from Watershed Boundary Dataset (NHDPlus HR)	United States Geological Survey (USGS)	SS	1:24,000	High	Aggregated data based on topographic and hydrologic features	2013	Nearshore Zones
78	Bathym-etry	Bathymetry Mosaic for the WA Salish Sea (10m contours)	Northwest Fisheries Science Center (NOAA)	SS	30m	Moderate	Data compilation of best available bathymetry	2009	Nearshore Zones
79	Bathym-etry	Washington, Oregon, Northern California 100m DEM (10m contours)	Active Tectonics Mapping Lab, Oregon State University	PNW	100m	Moderate	Contours developed from Digitial Elevation Model (DEM)	2014	Nearshore Zones
80	Bathym-etry	High Resolution Bathymetry Interpolations (5 m contours)	University of California Santa Cruz	CC; SCB	30m	High	Data compilation of high resolution bathymetry	2019	Nearshore Zones
81	Bathym-etry	Bathymetry for Marine Life Protection Act Initiative	California Department of Fish and Wildlife	SCB	200m	Moderate	Contours developed from Digitial Elevation Model (DEM)	2019	Nearshore Zones

APPENDIX 5

Qualitative Assessment of Relative Abundance Among Documented Fishes in U.S. Waters of the Salish Sea

This assessment is based on Pietsch and Orr's (2019) synthesis and augmented with additional relevant literature. Included in the following table are the taxon (order, family, genus, species), common name, and abundance estimates throughout the ecoregion (Overall), in the Core and Seaward Zones, and among the seven Salish Sea subregions. Only fishes with several documented records in the ecoregion are included. Blank entries indicate that the species has not been documented in a particular subregion.

Key: SJI = San Juan Islands Archipelago, WB = Whidbey Basin, SCPSB = South Central Puget Sound Basin, SPSB = South Puget Sound Basin, HC = Hood Canal, NCPSB = North Central Puget Sound Basin, and SJDFB = Strait of Juan de Fuca Basin. A = abundant, C = common, and R = rare.

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
PETROMYZONTIFORMES	LAMPREYS										
Petromyzontidae	Lampreys										
Entosphenus tridentatus	Pacific Lamprey	C	R	C	C	C	C	C	C	C	C
Lampetra ayresii	Western River Lamprey	R	R	R	R	R	R				
CHIMAERIFORMES	CHIMAERAS										
Chimaeridae	Shortnose Chimaeras										
Hydrolagus colliei	Spotted Ratfish	A	C	A	A	A	A	A	C	A	C
LAMNIFORMES	MACKEREL SHARKS										
Lamnidae	Mackerel Sharks										
Lamna ditropis	Salmon Shark	C	R	C	C		R				C
CARCHARHINIFORMES	GROUND SHARKS										
Scyliorhinidae	Cat Sharks										
Apristurus brunneus	Brown Cat Shark	C	R	R	C	C	C	C	C	C	
HEXANCHIFORMES	SIX-GILL SHARKS										
Hexanchidae	Cow Sharks										
Hexanchus griseus	Bluntnose Sixgill Shark	C	C	C	C	C	C	C	C	C	C
SQUALIFORMES	DOGFISH SHARKS										
Squalidae	Dogfish Sharks										
Squalus suckleyi	Pacific Spiny Dogfish	A	C	A	A	A	A	A	A	A	A
TORPEDINIFORMES	ELECTRIC RAYS										

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Torpedinidae	Electric Rays										
Tetronarce californica	Pacific Electric Ray	R	R	R	R	R	R	R	R	R	R
RAJIFORMES	SKATES										
Rajidae	Hardnose Skates										
Bathyraja kincaidii	Sandpaper Skate	R	R	R	R						R
Beringraja binoculata	Big Skate	A	A	A	A	A	A	A	A	A	A
Beringraja rhina	Longnose Skate	C	R	C	C	C	C	C	C	C	C
ACIPENSERIFORMES	STURGEONS										
Acipenseridae	Sturgeons										
Acipenser medirostris	Green Sturgeon	R	R	R	R	R	R	R	R	R	R
Acipenser transmontanus	White Sturgeon	C	C	C	C	R	R	R	R		C
CLUPEIFORMES	ANCHOVIES AND HERRINGS										
Engraulidae	Anchovies										
Engraulis mordax	Northern Anchovy	C	C	C	C	C	C	C	C	C	C
Clupeidae	Herrings										
Alosa sapidissima	American Shad	R	R	R	R	R	R	R	R	R	R
Clupea pallasii	Pacific Herring	A	A	A	A	A	A	A	A	A	A
OSMERIFORMES	FRESHWATER SMELTS										
Osmeridae	Smelts										
Allosmerus elongatus	Whitebait Smelt	R	R	R	R						R
Hypomesus pretiosus	Surf Smelt	C	C	C	C	C	C	C	C	C	C
Spirinchus thaleichthys	Longfin Smelt	C	C	C	C	C	C	C	C	C	C
Thaleichthys pacificus	Eulachon	C	C	C	C	C	C	C		C	C
SALMONIFORMES	SALMON AND TROUTS										
Salmonidae	Salmon and Trouts										
Oncorhynchus clarkii	Cutthroat Trout	C	C	C	C	C	C	C	C	C	C
Oncorhynchus gorbuscha	Pink Salmon	C	C	C	C	C	C	C	C	C	C
Oncorhynchus keta	Chum Salmon	C	C	C	C	C	C	C	C	C	C
Oncorhynchus kisutch	Coho Salmon	C	C	C	C	C	C	C	C	C	C
Oncorhynchus mykiss	Steelhead	C	C	C	C	C	C	C	C	C	C
Oncorhynchus nerka	Sockeye Salmon	C	C	C	C	C	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Oncorhynchus tshawytscha	Chinook Salmon	C	C	C	C	C	C	C	C	C	C
Salmo salar	Atlantic Salmon	R	R	R	R	R	R	R	R	R	R
Salvelinus confluentus	Bull Trout	C	C	C	C	C	C	C	C	C	C
Salvelinus malma	Dolly Varden	C	C		C	C	C	C	C	C	C
AULOPIFORMES	LIZARDFISHES										
Alepisauridae	Lancetfishes										
Alepisaurus ferox	Longnose Lancetfish	R	R	R	R	R	R	R		R	R
GADIFORMES	CODS										
Merlucciidae	Hakes										
Merluccius productus	Pacific Hake	C	R	C	C	C	C	C	C	C	C
Gadidae	Cods										
Gadus chalcogrammus	Walleye Pollock	C	C	C	C	C	C	C	C	C	C
Gadus macrocephalus	Pacific Cod	C	R	C	C	C	C	C	C	C	C
Microgadus proximus	Pacific Tomcod	C	C	C	C	C	C	C	C	C	C
Bythitidae	Viviparous Brotulas										
Brosmophycis marginata	Red Brotula	R	R	R	R	R	R	R	R	R	
BATRACHOIDIFORMES	TOADFISHES										
Batrachoididae	Toadfishes										
Porichthys notatus	Plainfin Midshipman	A	A	A	A	A	A	A	A	A	A
GASTEROSTEIFORMES	STICKLEBACKS										
Aulorhynchidae	Tubesnouts										
Aulorhynchus flavidus	Tubesnout	C	C	C	C	C	C	C	C	C	C
Gasterosteidae	Sticklebacks										
Gasterosteus aculeatus	Threespine Stickleback	A	A		A	A	A	A	A	A	A
Syngnathidae	Pipefishes										
Syngnathus leptorhynchus	Bay Pipefish	C	C		C	C	C	C	C	C	C
SCORPAENIFORMES	SCORPIONFISHES										
Scorpaenidae	Rockfishes and Thornyheads										
Sebastes aleutianus	Rougheye Rockfish	R		R		R	R				R
Sebastes alutus	Pacific Ocean Perch	R		R							R
Sebastes auriculatus	Brown Rockfish	C	C	C	C	C	A	A	C	C	C

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Sebastes caurinus	Copper Rockfish	A	A	A	A	C	A	A	C	C	C
Sebastes diaconus	Deacon Rockfish	R	R	R	R						R
Sebastes diploproa	Splitnose Rockfish	R		R	R		R		R	R	R
Sebastes elongatus	Greenstriped Rockfish	C	R	C	C	C	C	R	C	C	C
Sebastes emphaeus	Puget Sound Rockfish	C	C	C	C	C	C	C	C	C	C
Sebastes flavidus	Yellowtail Rockfish	R	R	R	R	R	R		R	R	R
Sebastes maliger	Quillback Rockfish	A	A	A	A	A	A	A	A	A	C
Sebastes melanops	Black Rockfish	C	C	C	A	A	A	C	R	A	C
Sebastes miniatus	Vermillion Rockfish	R	R	R	R	R	R		R	R	R
Sebastes nebulosus	China Rockfish	R	R	R	R					R	R
Sebastes nigrocinctus	Tiger Rockfish	R	R	R	C		R				R
Sebastes paucisipinis	Bocaccio	R	R	R	R	R	R		R	R	R
Sebastes pinniger	Canary Rockfish	C	C	C	C	C	C		C	C	C
Sebastes proriger	Redstripe Rockfish	C	R	C	C	C	C	C	C	C	C
Sebastes ruberrimus	Yelloweye Rockfish	C	R	C	C	C	C	C	C	C	C
Sebastes saxicola	Stripetail Rockfish	R	R	R		R	R	R	R		R
Sebastes zacentrus	Sharpchin Rockfish	R	R	R	R	R	R			R	R
Sebastolobus alascanus	Shortspine Thornyhead	R	R	R	R		R		R	R	R
Anoplopomatidae	Sablefishes										
Anoplopoma fimbria	Sablefish	A	R	C	A	A	A	A	A	A	A
Zaniolepididae	Combfishes										
Oxylebius pictus	Painted Greenling	R	R	R	R	R	R	R	R		
Zanlolepis latipinnis	Longspine Combfish	R	R	R	R	R	R	R	R		R
Hexagrammidae	Greenlings										
Hexagrammos decagrammus	Kelp Greenling	C	C	C	C		C			C	C
Hexagrammos logocephalus	Rock Greenling	R	R	R	R	R	R			R	R
Hexagrammos stelleri	Whitespotted Greenling	C	C	C	C	C	C	C	C	C	C
Ophiodon elongatus	Lingcod	A	A	A	A	A	A	A	A	A	A
Jordaniidae	Longfin Sculpins										
Jordania zonope	Longfin Sculpin	C	C	C	C	C	C			C	C
Scorpaenichthyidae	Cabezon										

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Scorpaenichthys marmoratus	Cabezon	C	C	C	C	C	C	C	C	C	C
Rhamphocottidae	Grunt Sculpins										
Rhamphocottus richardsonii	Grunt Sculpin	C	C	R	C		C	C	C	C	C
Cottidae	Freshwater Sculpins										
Cottus aleuticus	Coastrange Sculpin	R	R	R	R	R	R	R	R	R	R
Cottus asper	Prickly Sculpin	R	R	R	R	R	R	R	R	R	R
Leptocottus armatus	Pacific Staghorn Sculpin	A	A	C	A	A	A	A	A	A	A
Psychrolutidae	Marine Sculpins										
Artedius fenestralis	Padded Sculpin	C	C	C	C	C	C	C	C	C	C
Artedius harringtoni	Scalyhead Sculpin	C	C	C	C	C	C	C	C	C	C
Artedius lateralis	Smoothhead Sculpin	C	C	C	C	C	C	C	C	C	C
Ascelichthys rhodorus	Rosylip Sculpin	R	R		R	R	R			R	R
Asemichthys taylori	Spinynose Sculpin	R	R		C					R	
Chitonotus pugetensis	Roughback Sculpin	C	C	C	C	C	C	C	C	C	R
Clinocottus acuticeps	Sharpnose Sculpin	C	C		C	C	C	C	C	C	C
Dasycottus setiger	Spiny Sculpin	C	R	C	C	C	C	C	C	C	R
Enophrys bison	Buffalo Sculpin	C	C	C	C	C	C	C	C	C	R
Icelinus borealis	Northern Sculpin	C	C	C	A	C	C	C	C	C	C
Icelinus filamentosus	Threadfin Sculpin	R	R	R	R	R	R		R	R	R
Icelinus tenuis	Spotfin Sculpin	R	R	R		R	R		R	R	
Malacocottus kincaidii	Blackfin Sculpin	R		R					R		
Myoxocephalus polyacanthocephalus	Great Sculpin	A	A	A	A	A	A	A	A	A	A
Oligocottus maculosus	Tidepool Sculpin	A	A		A	A	A	A	A	A	A
Oligocottus rimensis	Saddleback Sculpin	R	R		C		R			R	R
Psychrolutes paradoxus	Tadpole Sculpin	C	C	C	C	C	C	C	C	C	C
Psychrolutes sigalutes	Soft Sculpin	R	R	R	R	R	R	R	R	R	R
Radulinus asprellus	Slim Sculpin	C	C	C	C	C	C	C	C	C	C
Synchirus gilli	Manacled Sculpin	R	R		R		R		R	R	R
Triglops macellus	Roughspine Sculpin	R	R	R	R	R	R	R	R	R	R
Triglops pingelii	Ribbed Sculpin	R	R	R	R	R	R			R	R

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Agonidae	Poachers										
Agonopsis vulsa	Northern Spearnose Poacher	C	C	C	A	C	C	C	C	C	R
Anoplagonus inermis	Smooth Alligatorfish	C	C	C	C		R		R	R	R
Bathyagonus alascanus	Gray Starsnout	R	R	R	R		R			R	R
Bathyagonus infraspinatus	Spinycheek Starsnout	R	R	R	R	R	R		R		R
Bathyagonus nigripinnis	Blackfin Poacher	R	R	R	R	C	R		R		
Bathyagonus pentacanthus	Bigeye Poacher	R		R	R		R			R	R
Blepsias cirrhosus	Silverspotted Sculpin	C	C	C	A	C	C		C	C	C
Bothragonus swanii	Rockhead	R	R		C					R	
Hemilepidotus hemilepidotus	Red Irish Lord	C	C	C	C	C	C	C	C	C	C
Hypsagonus quadricornis	Fourhorn Poacher	C	C	C	C	R				R	R
Nautichthys oculofasciatus	Sailfin Sculpin	C	C	C	C	C	C	C	C	C	C
Odontopyxis trispinosa	Pygmy Poacher	C	C	C	C	C	C	C	C	C	R
Pallasina barbata	Tubenose Poacher	R	R	R	C		R			R	R
Podothecus accipenserinus	Sturgeon Poacher	C	C	C	C	R	C	C	C	C	C
Xeneretmus latifrons	Blacktip Poacher	A	A	A	R	A	A	A	A	A	R
Xeneretmus triacanthus	Bluespotted Poacher	C	R	C	R	C	C	C	C	C	
Cyclopteridae	Lumpsuckers										
Eumicrotremus orbis	Pacific Spiny Lumpsucker	C	C	C	C	C	C	C		C	C
Liparidae	Snailfishes										
Liparis callyodon	Spotted Snailfish	C	C	C	C	R				R	R
Liparis cyclopus	Ribbon Snailfish	C	C	C	C	C	C	C		C	R
Liparis dennyi	Marbled Snailfish	C	C	C	C	C	C	C		C	R
Liparis florae	Tidepool Snailfish	C	C		A	R	R				A
Liparis fucensis	Slipskin Snailfish	C	C	C	C	R	R			R	C
Liparis greeni	Lobefin Snailfish	R	R		R					R	R
Liparis pulchellus	Showy Snailfish	C	C	C	C	C	C	C	C	C	R
Nectoliparis pelagicus	Tadpole Snailfish	R	R	R		R	R	R	R	R	
PERCIFORMES	PERCHES										
Embiotocidae	Surfperches										
Brachyistius frenatus	Kelp Perch	R	R	R	R	R	R		R	R	

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Cymatogaster aggregata	Shiner Perch	A	A	C	A	A	A	A	A	A	A
Embiotoca lateralis	Striped Surfperch	A	A	A	A	A	A	A	A	A	A
Phanerodon furcatus	White Surfperch	R	R	R	R		R		R		R
Phanerodon vacca	Pile Perch	A	A	A	A	A	A	A	A	A	A
Bathymasteridae	Ronquils										
Ronquilius jordani	Northern Ronquil	C	C	C	C	C	C	C	C	C	C
Zoarcidae	Eelpouts										
Lycodes beringi	Bering Eelpout	R		R	R		R		R		
Lycodes brevipes	Shortfin Eelpout	C	R	C	C	R	R	C		R	
Lycodes pacificus	Blackbelly Eelpout	A	C	A	A	A	A	A	A	A	R
Lycodes palearis	Wattled Eelpout	R	R	R	C		R		R		R
Stichaeidae	Pricklebacks										
Anoplarchus purpurescens	High Cockscomb	C	C	R	C	C	C	C	C	C	C
Chirolophis decoratus	Decorated Warbonnet	R	R	R	R	R	R				
Chirolophis nugator	Mosshead Warbonnet	R	R	R	R		R			R	
Leptoclinus maculatus	Daubed Shanny	R	R	R	R		R				R
Lumpenus sagitta	Snake Prickleback	A	A	A	A	A	A	A	A	A	C
Phytichthys chirus	Ribbon Prickleback	R	R		C		R			R	
Plectobranchius evides	Bluebarred Prickleback	R		R		C	C	R	R	C	
Poroclinus rothrocki	Whitebarred Prickleback	C		C	R	C	C	R	R	C	
Xiphister atropurpureus	Black Prickleback	C	C		A		R			R	C
Xiphister mucosus	Rock Prickleback	C	C		A	R	R			R	C
Cryptacanthodidae	Wrymouths										
Cryptacanthodes aleutensis	Dwarf Wrymouth	C	C	C	C		R	R	R	R	
Cryptacanthodes giganteus	Giant Wrymouth	R	R	R	R	R	R				R
Pholidae	Gunnels										
Apodichthys flavidus	Penpoint Gunnel	C	C		A	C	C	C	C	C	C
Pholis laeta	Crescent Gunnel	C	C	C	C	C	C	C	C	C	C
Pholis ornata	Saddleback Gunnel	C	C	C	C	C	C	C	C	C	C
Anarhichadidae	Wolffishes										
Anarrhichthys ocellatus	Wolf-Eel	R	R	R	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Ptilichthyidae	Quillfishes										
Ptilichthys goodei	Quillfish	R	R	R	C		R		R	R	
Scytalinidae	Graveldiggers										
Scytalina cerdale	Graveldiver	R	R		C						C
Trichodontidae	Sandfishes										
Trichodon trichodon	Pacific Sandfish	R	R	R	C	R	R				R
Ammodytidae	Sand Lances										
Ammodytes personatus	Pacific Sand Lance	C	C	C	C	C	C	C	C	C	C
Icosteidae	Ragfishes										
Icosteus aenigmaticus	Ragfish	R	R	R	R		R	R		R	
Gobiesocidae	Clingfishes										
Gobiesox maeandricus	Northern Clingfish	C	C	R	C		C			C	R
Gobiidae	Gobies										
Clevelandia ios	Arrow Goby	R	R	R	R	R	R	R	R	R	R
Lepidogobius lepidus	Bay Goby	C	C	C	C	C	C	C	C	C	
Rhinogobiops nicholsii	Blackeye Goby	C	C	C	C		C	C	C	C	C
Stromateidae	Butterfish										
Peprilus simillimus	Pacific Pompano	R	R	R	R	R	R		R	R	
PLEURONECTIFORMES	FLATFISHES										
Paralichthyidae	Sand Flounders										
Citharichthys sordidus	Pacific Sanddab	A	A	A	A	A	A	A	A	A	A
Citharichthys stigmaeus	Speckled Sanddab	A	A	A	A	A	A	A	A	A	A
Pleuronectidae	Righteye Flounders										
Atheresthes stomias	Arrowtooth Flounder	C	R	C	C	C	C	C	C	C	C
Eopsetta jordani	Petrale Sole	R	R	R	R	R	R	R	R	R	C
Glyptocephalus zachirus	Rex Sole	C	R	C	C	C	C	C	C	C	C
Hippoglossoides elassodon	Flathead Sole	C	R	C	C	C	C	C	C	C	C
Hippoglossus stenolepis	Pacific Halibut	C	C	C	C	C	R	R	R	C	C
Isopsetta isolepis	Butter Sole	C	C	C	C	C	C	C	C	C	R
Lepidopsetta bilineata	Southern Rock Sole	C	C	C	C	C	C	C	C	C	C
Lepidopsetta polyxystra	Northern Rock Sole	C	C	C	C	C	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	SJI	WB	SCPSB	SPSB	HC	NCPSB	SJDFB
Lyopsetta exilis	Slender Sole	A	C	A	A	A	A	A	A	A	A
Microstomus pacificus	Dover Sole	C	C	C	C	C	C	C	C	C	C
Parophrys vetulus	English Sole	A	A	C	A	A	A	A	A	A	A
Platichthys stellatus	Starry Flounder	C	C	C	C	C	C	C	C	C	C
Pleuronichthys coenosus	C-O Sole	C	C	C	C	C	C	C	C	C	R
Psettichthys melanostictus	Sand Sole	A	A	A	A	A	A	A	A	A	A

APPENDIX 6

Depth and Habitat Associations of Documented Fishes in U.S. Waters of the Salish Sea

These associations are based on Ebert (2002), Love et al. (2005), Love (2011), Butler et al. (2012), Pietsch and Orr (2019), and a review of primary literature, fishery-independent survey catches, and museum records. Included in the following table is the vertical zonation, which is classified as Benthic (benthic and demersal), Midwater, Pelagic, and WC (meaning, found throughout the water column). The table also lists the depth range in meters (i.e., the minimum [Min] and maximum [Max]) and the common depth in meters. For each seafloor habitat (mud, sand, gravel, shell, etc.) a numeral indicates whether it is a primary or secondary habitat: 1 = primary habitat or similar utilization of habitat types for generalist species. 2 = secondary habitat. Habitat associations are for combined juvenile and adult life stages. Gravel includes pebbles. SFMI stands for structure-forming marine invertebrates.

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
PETROMYZONTIFORMES	LAMPREYS																
Petromyzontidae	Lampreys																
Entosphenus tridentatus	Pacific Lamprey		A	WC	16–1508	< 250											
Lampetra ayresii	Western River Lamprey		A	Pelagic	S–119												
CHIMAERIFORMES	CHIMAERAS																
Chimaeridae	Shortnose Chimaeras																
Hydrolagus colliei	Spotted Ratfish			Benthic	0–1593	30–300	1	1	1		1	1	1				
LAMNIFORMES	MACKEREL SHARKS																
Lamnidae	Mackerel Sharks																
Lamna ditropis	Salmon Shark			Pelagic	S–1864												
CARCHARHINIFORMES	GROUND SHARKS																
Scyliorhinidae	Cat Sharks																
Apristurus brunneus	Brown Cat Shark			Benthic, Midwater	24–1401	33-360	1	1					2				
HEXANCHIFORMES	SIX-GILL SHARKS																
Hexanchidae	Cow Sharks																
Hexanchus griseus	Bluntnose Sixgill Shark			Benthic, WC	10–2490		1	1	1		1	1	1				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
SQUALIFORMES	DOGFISH SHARKS																
Squalidae	Dogfish Sharks																
Squalus suckleyi	Pacific Spiny Dogfish			WC, Benthic	0–1460	10-250	1	1	1		1	1	1			1	
TORPEDINIFORMES	ELECTRIC RAYS																
Torpedinidae	Electric Rays																
Tetronarce californica	Pacific Electric Ray			Benthic, Midwa-ter	0–406	60-200	1	1				2	1		2		
RAJIFORMES	SKATES																
Rajidae	Hardnose Skates																
Bathyraja kincaidii	Sandpaper Skate			Benthic	18–1372	200–500	1	2			2	2	2				
Beringraja binoculata	Big Skate			Benthic	2–501	< 100	1	1	2	2							
Beringraja rhina	Longnose Skate			Benthic	9–1294	200–400	1	1	1		2		2				
ACIPENSERIFORMES	STURGEONS																
Acipenseridae	Sturgeons																
Acipenser medirostris	Green Sturgeon		A	Benthic	168		1	1	1		1	1	1				
Acipenser transmon-tanus	White Sturgeon		A	Benthic	122	< 50	1	1	1		1	1	1				
CLUPEIFORMES	ANCHOVIES AND HERRINGS																
Engraulidae	Anchovies																
Engraulis mordax	Northern Anchovy			Pelagic	S/0–528												
Clupeidae	Herrings																
Alosa sapidissima	American Shad	X	A	Pelagic	S–250												
Clupea pallasii	Pacific Herring			Pelagic	S–250												
OSMERIFORMES	FRESHWATER SMELTS																
Osmeridae	Smelts																
Allosmerus elongatus	Whitebait Smelt			Pelagic	S–495												
Hypomesus pretiosus	Surf Smelt			Benthic, Pelagic	0–185	< 50									1	1	
Spirinchus thaleichthys	Longfin Smelt		A	Pelagic	S/0–137												

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Thaleichthys pacificus	Eulachon		A	WC, Benthic	10–400	20–150	1	1	2		2						
SALMONIFORMES	SALMON AND TROUTS																
Salmonidae	Salmon and Trouts																
Oncorhynchus clarkii	Cutthroat Trout		A	WC	S												
Oncorhynchus gorbus-cha	Pink Salmon		A	Pelagic	S–74	< 10											
Oncorhynchus keta	Chum Salmon		A	Pelagic	S–253	< 10											
Oncorhynchus kisutch	Coho Salmon		A	Pelagic	S–97	< 10											
Oncorhynchus mykiss	Steelhead		A, FW	Pelagic	S	< 20											
Oncorhynchus nerka	Sockeye Salmon		A	Pelagic	S–83	< 10											
Oncorhynchus tshawytscha	Chinook Salmon		A	Pelagic, WC	S–538	< 150											
Salmo salar	Atlantic Salmon	X	A	Pelagic	S												
Salvelinus confluentus	Bull Trout		A, FW	Pelagic	S												
Salvelinus malma	Dolly Varden		A, FW	Pelagic	S–8	3–4											
AULOPIFORMES	LIZARDFISHES																
Alepisauridae	Lancetfishes																
Alepisaurus ferox	Longnose Lan-cetfish			Pelagic, Midwa-ter	5–1830												
GADIFORMES	CODS																
Merlucciidae	Hakes																
Merluccius productus	Pacific Hake			Pelagic, Benthic	12–1437	50–420											
Gadidae	Cods																
Gadus chalcogrammus	Walleye Pollock			Benthic, Pelagic	0–1280	30–400	1	1	2		2	2	2				
Gadus macrocephalus	Pacific Cod			Benthic, Pelagic	0–1280	< 300	1	1	2		1	2	2		1	1	1

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Microgadus proximus	Pacific Tomcod			Benthic, Pelagic	0–310	< 100	1	1							2	2	
Bythitidae	Viviparous Brotulas																
Brosmophycis marginata	Red Brotula			Benthic	3–256								1				
BATRACHOIDIFORMES	TOADFISHES																
Batrachoididae	Toadfishes																
Porichthys notatus	Plainfin Midshipman			Benthic, Pelagic	0–464	< 250	1	1								2	
GASTEROSTEIFORMES	STICKLEBACKS																
Aulorhynchidae	Tubesnouts																
Aulorhynchus flavidus	Tubesnout			WC	0–40	< 20		1					1		1	1	
Gasterosteidae	Sticklebacks																
Gasterosteus aculeatus	Threespine Stickleback		A, FW	WC, Benthic	0–27		1	1					2		2	2	
Syngnathidae	Pipefishes																
Syngnathus leptorhynchus	Bay Pipefish			WC, Benthic	0–18	< 3	2	2	2					2	2	1	
SCORPAENIFORMES	SCORPIONFISHES																
Scorpaenidae	Rockfishes and Thornyheads																
Sebastes aleutianus	Rougheye Rockfish			Benthic	45–765	200–420						1	1				
Sebastes alutus	Pacific Ocean Perch			Benthic, WC	70–1125	100–400	1	1			1	1	1				1
Sebastes auriculatus	Brown Rockfish			Benthic	0–287		2	2		2			1	2		2	
Sebastes caurinus	Copper Rockfish			Benthic	0–408	5–70	2	2				1	1				
Sebastes diaconus	Deacon Rockfish			WC	8–72	< 50							1				
Sebastes diploproa	Splitnose Rockfish			Benthic	50–1050	150–450	1			2			2				
Sebastes elongatus	Greenstriped Rockfish			Benthic	12–1151	100–300	1	1		1	1	1	1				
Sebastes emphaeus	Puget Sound Rockfish			Benthic	3–470	10–366						1	1		1		

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Sebastes flavidus	Yellowtail Rockfish			WC	0–549	90–180						1	1	2	1	2	
Sebastes maliger	Quillback Rockfish			Benthic	0–398	10-140							1		1	1	1
Sebastes melanops	Black Rockfish			WC	0–366	< 75							1	2	1	2	
Sebastes miniatus	Vermillion Rockfish			Benthic	12–478	< 100	2	2			1	1	1				
Sebastes nebulosus	China Rockfish			Benthic	3–177	10–100		2			2	1	1		1	2	2
Sebastes nigrocinctus	Tiger Rockfish			Benthic	2–298	> 30						1	1				
Sebastes paucisipinis	Bocaccio			Benthic, WC	20–475							1	1		1		
Sebastes pinniger	Canary Rockfish			Benthic, WC	18–458	< 200	2				2	1	1				
Sebastes proriger	Redstripe Rockfish			Benthic	4–550	100–300	2	2	1		1	1	1				
Sebastes ruberrimus	Yelloweye Rockfish			Benthic	11–732	90–180						1	1				
Sebastes saxicola	Stripetail Rockfish			Benthic	25–547	100–300	1	1		1	1		1				1
Sebastes zacentrus	Sharpchin Rockfish			Benthic	25–660	200–300	1			1	1	1	1				1
Sebastolobus alascanus	Shortspine Thornyhead			Benthic	17–1524	200–420	1		2		2		2				2
Anoplopomatidae	Sablefishes																
Anoplopoma fimbria	Sablefish			Benthic, Pelagic	12–2740	300–420	1				2	2					
Zaniolepididae	Combfishes																
Oxylebius pictus	Painted Greenling			Benthic	0–249	< 50	2	2				1	1				2
Zanlolepis latipinnis	Longspine Combfish			Benthic, Midwater	16–421		1	2					2				
Hexagrammidae	Greenlings																
Hexagrammos decagrammus	Kelp Greenling			Benthic	0–303	0-100							1	1	1	1	
Hexagrammos logocephalus	Rock Greenling			Benthic	0–80	0-20					1		1	1	1	1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Hexagrammos stelleri	Whitespotted Greenling			Benthic	0–305	< 100		1					1	1	1	1	
Ophiodon elongatus	Lingcod			Benthic	0–750	< 300	1	1		1		1	1		1	1	1
Jordaniidae	Longfin Sculpins																
Jordania zonope	Longfin Sculpin			Benthic	0–497	10–40							1		1		1
Scorpaenichthyidae	Cabezon																
Scorpaenichthys marmoratus	Cabezon			Benthic	0–226	< 73	2				2		1		2	2	
Rhamphocottidae	Grunt Sculpins																
Rhamphocottus richardsonii	Grunt Sculpin			Benthic	0–258	< 10		2		2			1	2			
Cottidae	Freshwater Sculpins																
Cottus aleuticus	Coastrange Sculpin		FW	Benthic				1	1		1						
Cottus asper	Prickly Sculpin		FW	Benthic	< 92	< 10		1	1		1	1					
Leptocottus armatus	Pacific Staghorn Sculpin		FW	Benthic	0–335	< 10	1	1		1						1	
Psychrolutidae	Marine Sculpins																
Artedius fenestralis	Padded Sculpin			Benthic	0–122	< 20	2	2	2		2	2	1		2	2	
Artedius harringtoni	Scalyhead Sculpin			Benthic	0–40	< 20					1		1	1		1	1
Artedius lateralis	Smoothhead Sculpin			Benthic	0–70	< 14		1	1		1		1	1		1	
Ascelichthys rhodorus	Rosylip Sculpin			Benthic	0–15	< 10	1	1	1				1	1	1	1	
Asemichthys taylori	Spinynose Sculpin			Benthic	0–212	5–18		1		1			2				
Chitonotus pugetensis	Roughback Sculpin			Benthic	0–329	8–73	1	1	2				2			2	
Clinocottus acuticeps	Sharpnose Sculpin		FW	Benthic	0–114	< 1		1	1		1	1	1	1		1	
Dasycottus setiger	Spiny Sculpin			Benthic	15–1205	50–300	1	1					2				
Enophrys bison	Buffalo Sculpin			Benthic	0–194	< 45		1	1		1		1	1	1	1	1
Icelinus borealis	Northern Sculpin			Benthic	5–453		1	1	1	1			1			1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Icelinus filamentosus	Threadfin Sculpin			Benthic	18–482		1	1	1								
Icelinus tenuis	Spotfin Sculpin			Benthic	7–375	60–100	1	1		1			2				
Malacocottus kincaidii	Blackfin Sculpin			Benthic	97–119		1			1							
Myoxocephalus polyacanthocephalus	Great Sculpin			Benthic	0–825	< 300	1	1			1		1	1	1	1	
Oligocottus maculosus	Tidepool Sculpin			Benthic	0–9			1			1		1	1		1	1
Oligocottus rimensis	Saddleback Sculpin			Benthic	0–21				1				1	1	1	1	
Psychrolutes paradoxus	Tadpole Sculpin			Benthic	3–419		1	1					1		2	1	
Psychrolutes sigalutes	Soft Sculpin			Benthic	3–500		2	2					1	1			1
Radulinus asprellus	Slim Sculpin			Benthic	9–699		1										
Synchirus gilli	Manacled Sculpin			Benthic	0–21								1	1	1	1	
Triglops macellus	Roughspine Sculpin			Benthic	18–350		1	1									
Triglops pingellii	Ribbed Sculpin			Benthic	4–930	20–150	1	1					2				
Agonidae	Poachers																
Agonopsis vulsa	Northern Spearnose Poacher			Benthic	0–581	10–180	1	1									
Anoplagonus inermis	Smooth Alligatorfish			Benthic	2–465			1	1				1				
Bathyagonus alascanus	Gray Starsnout			Benthic	18–332		1	1									
Bathyagonus infraspinatus	Spinycheek Starsnout			Benthic	6–415		1	1									
Bathyagonus nigripinnis	Blackfin Poacher			Benthic	18–1596	50–420	1	1									
Bathyagonus pentacanthus	Bigeye Poacher			Benthic	50–1197	100–375	1	1									
Blepsias cirrhosus	Silverspotted Sculpin			Benthic	0–97	< 10					1		1		1	1	
Bothragonus swanii	Rockhead			Benthic	0–21				1			1	1		1		1
Hemilepidotus hemilepidotus	Red Irish Lord			Benthic	0–235	< 10		1	1	1	1		1	1	1	1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Hypsagonus quadricornis	Fourhorn Poacher			Benthic	0–452	< 200		1	1	1	1		1				1
Nautichthys oculofasciatus	Sailfin Sculpin			Benthic	0–208	2-30							1		1	1	
Odontopyxis trispinosa	Pygmy Poacher			Benthic	5–373	< 70	1	1									
Pallasina barbata	Tubenose Poacher			Benthic, Pelagic	0–128	< 60		1	1					1		1	
Podothecus accipenserinus	Sturgeon Poacher			Benthic	0–570	< 30	1	1							1	1	
Xeneretmus latifrons	Blacktip Poacher			Benthic	2–1291	18–400	1	1									
Xeneretmus triacanthus	Bluespotted Poacher			Benthic	15–624		1	1									
Cyclopteridae	Lumpsuckers																
Eumicrotremus orbis	Pacific Spiny Lumpsucker			Benthic	2–447	< 200		1	1				1		1	1	
Liparidae	Snailfishes																
Liparis callyodon	Spotted Snailfish			Benthic	0–49					1			1	1	1	1	
Liparis cyclopus	Ribbon Snailfish			Benthic	0–183					1			1	1	1	1	
Liparis dennyi	Marbled Snailfish			Benthic	0–225		1	1		1			1				
Liparis florae	Tidepool Snailfish			Benthic	0–15					1	1	1	1	1	1	1	
Liparis fucensis	Slipskin Snailfish			Benthic	0–388					1			1				
Liparis greeni	Lobefin Snailfish			Benthic	0–21									1	1		
Liparis pulchellus	Showy Snailfish			Benthic	0–191		1	1								2	
Nectoliparis pelagicus	Tadpole Snailfish			Benthic, Midwater	2–3383	45–439	1										
PERCIFORMES	PERCHES																
Embiotocidae	Surfperches																
Brachyistius frenatus	Kelp Perch			WC	0–76			2				2	2	1	1	2	
Cymatogaster aggregata	Shiner Perch		FW	Benthic	0–310	< 10		2					2			1	
Embiotoca lateralis	Striped Surfperch			Benthic, Pelagic	0–111	< 50		2					1	1	1	1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Phanerodon furcatus	White Surfperch			Benthic, WC	0–104	< 43		1					1		1	1	
Phanerodon vacca	Pile Perch			Benthic, WC	0–132	2–55		2					1		1	1	
Bathymasteridae	Ronquils																
Ronquilius jordani	Northern Ronquil			Benthic	3–337	< 150		1					1				
Zoarcidae	Eelpouts																
Lycodes beringi	Bering Eelpout			Benthic	76–1091	> 200	1										
Lycodes brevipes	Shortfin Eelpout			Benthic	2–973		1	1									
Lycodes pacificus	Blackbelly Eelpout			Benthic	7–1036	50–400	1										
Lycodes palearis	Wattled Eelpout			Benthic	2–925	< 200	1	1									
Stichaeidae	Pricklebacks																
Anoplarchus purpurescens	High Cockscomb			Benthic	0–35					1	1		1	1	1	1	
Chirolophis decoratus	Decorated Warbonnet			Benthic	5–297								1	1			1
Chirolophis nugator	Mosshead Warbonnet			Benthic	0–80	1-30				1			1		2		
Leptoclinus maculatus	Daubed Shanny			Benthic	2–773	< 170	1	1	1								
Lumpenus sagitta	Snake Prickleback			Benthic, WC	0–425	0-200	1	1	1		1					1	
Phytichthys chirus	Ribbon Prickleback			Benthic	0–12								1	1	1	1	1
Plectobranchius evides	Bluebarred Prickleback			Benthic	57–368		1	1									
Poroclinus rothrocki	Whitebarred Prickleback			Benthic	35–350		2	2		1			1				
Xiphister atropurpureus	Black Prickleback			Benthic	0–27				1		1	1	1	1			
Xiphister mucosus	Rock Prickleback			Benthic	0–18						1	1	1	1			
Cryptacanthodidae	Wrymouths																
Cryptacanthodes aleutensis	Dwarf Wrymouth			Benthic	18–964		1										

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Cryptacanthodes giganteus	Giant Wrymouth			Benthic	6–331	< 20	1										
Pholidae	Gunnels																
Apodichthys flavidus	Penpoint Gunnel			Benthic	0–11		1	1	1		1	1	1	1		1	
Pholis laeta	Crescent Gunnel			Benthic	0–99						1		1	1	1	1	
Pholis ornata	Saddleback Gunnel			Benthic	0–60		1	1					1	1		1	
Anarhichadidae	Wolffishes																
Anarrhichthys ocellatus	Wolf-Eel			Benthic, Pelagic	0–417								1	2	2		
Ptilichthyidae	Quillfishes																
Ptilichthys goodei	Quillfish			Benthic, WC	5–360		1	1									
Scytalinidae	Graveldiggers																
Scytalina cerdale	Graveldiver			Benthic	0–8			2	1	1			2				
Trichodontidae	Sandfishes																
Trichodon trichodon	Pacific Sandfish			Benthic, Pelagic	0–375	< 100		1			2		2			2	
Ammodytidae	Sand Lances																
Ammodytes personatus	Pacific Sand Lance			Benthic, WC	0–272	0-100		1	1								
Icosteidae	Ragfishes																
Icosteus aenigmaticus	Ragfish			Pelagic, Benthic	0–1420												
Gobiesocidae	Clingfishes																
Gobiesox maeandricus	Northern Clingfish			Benthic	0–18	< 10					2		1	2	2	2	
Gobiidae	Gobies																
Clevelandia ios	Arrow Goby		FW	Benthic	0–45	0-10	1	1								1	
Lepidogobius lepidus	Bay Goby			Benthic	0–305	< 70	1	1								1	
Rhinogobiops nicholsii	Blackeye Goby			Benthic	0–195	< 80	1	1	1				1		2	2	2
Stromateidae	Butterfish																
Peprilus simillimus	Pacific Pompano			Benthic, Pelagic	0–302	3–70		1									
PLEURONECTIFORMES	FLATFISHES																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Paralichthyidae	Sand Flounders																
Citharichthys sordidus	Pacific Sanddab			Benthic	0–581	10–150	1	1		1						2	
Citharichthys stigmaeus	Speckled Sanddab			Benthic	0–366	< 60	1	1							2	2	
Pleuronectidae	Righteye Flounders																
Atheresthes stomias	Arrowtooth Flounder			Benthic	9–1186	100–420	1	1	2				2				
Eopsetta jordani	Petrale Sole			Benthic	0–640	55-420	1	1	2		2						
Glyptocephalus zachirus	Rex Sole			Benthic	0–1237	100–420	1	2			2		2				
Hippoglossoides elassodon	Flathead Sole			Benthic	0–1050	100–300	1	1									
Hippoglossus stenolepis	Pacific Halibut			Benthic, Midwater	2–2000	27-274	1	1				2	2			2	
Isopsetta isolepis	Butter Sole			Benthic	2–425	18–100	1										
Lepidopsetta bilineata	Southern Rock Sole			Benthic	1–476			1	1								
Lepidopsetta polyxystra	Northern Rock Sole			Benthic	0–700	< 200	1	1		2							
Lyopsetta exilis	Slender Sole			Benthic	9–1258	40–110	1						2				
Microstomus pacificus	Dover Sole			Benthic	2–1400		1	2					2				
Parophrys vetulus	English Sole			Benthic	0–608	< 10	1	1								1	
Platichthys stellatus	Starry Flounder		FW	Benthic, Pelagic	0–660	< 1	1	1	1					2		1	
Pleuronichthys coenosus	C-O Sole			Benthic	0–350	< 20	1	1					1			1	
Psettichthys melanostictus	Sand Sole			Benthic	0–325	< 50		1								2	

APPENDIX 7

Qualitative Assessment of Relative Abundance Among Documented Fishes Off the Pacific Northwest Ecoregion

This assessment is based on a review of relevant field guides (e.g., Love et al. 2002; Ebert 2003; Lamb and Edgell 2010; Love 2011; Butler et al. 2012; Kells et al. 2016), primary literature, and landings or survey data. Included in the following table are the taxon (order, family, genus, species), common name, and abundance estimates throughout the ecoregion (Overall), in the Core and Seaward Zones, and among the Pacific Northwest subregions. Only fishes with multiple documented records in the ecoregion are included. Blank entries indicate that the species has not been documented in a particular subregion.

Key: CAPG = Canadian Border to Point Grenville, PGCL = Point Grenville to Cape Lookout, CLCB = Cape Lookout to Cape Blanco, and CBCM = Cape Blanco to Cape Mendocino. A = abundant, C = common, and R = rare.

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
MYXINIFORMES	HAGFISHES							
Myxinidae	Hagfishes							
Eptatretus deani	Black Hagfish	R		R	R	R	R	R
Eptatretus stoutii	Pacific Hagfish	C	R	C	C	C	C	C
PETROMYZONTIFORMES	LAMPREYS							
Petromyzontidae	Lampreys							
Entosphenus tridentatus	Pacific Lamprey	C	R	C	C	C	C	C
Lampetra ayresii	Western River Lamprey	R	R	R	R	R	R	R
CHIMAERIFORMES	CHIMAERAS							
Chimaeridae	Shortnose Chimaeras							
Hydrolagus colliei	Spotted Ratfish	C	R	C	A	C	C	C
LAMNIFORMES	MACKEREL SHARKS							
Alopiidae	Thresher Sharks							
Alopias vulpinus	Common Thresher Shark	R	R	R	R	R	R	R
Cetorhinidae	Basking Sharks							
Cetorhinus maximus	Basking Shark	R	R	R	R	R	R	R
Lamnidae	Mackerel Sharks							
Carcharodon carcharias	White Shark	C	R	C	C	C	C	C
Isurus oxyrinchus	Shortfin Mako	R	R	R	R	R	R	R
Lamna ditropis	Salmon Shark	C	R	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
CARCHARHINIFORMES	GROUND SHARKS							
Scyliorhinidae	Cat Sharks							
Apristurus brunneus	Brown Cat Shark	R	R	R	R	R	R	R
Parmaturus xaniurus	Filetail Cat Shark	R	R	R			R	R
Triakidae	Hound Sharks							
Galeorhinus galeus	Tope Shark	C	R	C	C	C	C	C
Mustelus henlei	Brown Smoothhound	C	C	C	C	C	C	C
Triakis semifasciata	Leopard Shark	R	R	R	R	R	R	C
Carcharhinidae	Requiem Sharks							
Prionace glauca	Blue Shark	C	R	C	C	C	C	C
HEXANCHIFORMES	SIX-GILL SHARKS							
Hexanchidae	Cow Sharks							
Hexanchus griseus	Bluntnose Sixgill Shark	C	C	C	C	C	C	C
Notorynchus cepedianus	Broadnose Sevengill Shark	R	R	R	R	R	R	R
ECHINORHINIFORMES	BRAMBLE SHARKS							
Echinorhinidae	Bramble Sharks							
Echinorhinus cookei	Prickly Shark	R	R	R	R	R	R	R
SQUALIFORMES	DOGFISH SHARKS							
Squalidae	Dogfish Sharks							
Squalus suckleyi	Pacific Spiny Dogfish	A	C	A	A	A	A	C
Somniosidae	Sleeper Sharks							
Somniosus pacificus	Pacific Sleeper Shark	R	R	R	R	R	R	R
SQUATINIFORMES	ANGEL SHARKS							
Squatinidae	Angel Sharks							
Squatina californica	Pacific Angel Shark	R	R	R	R	R	R	R
TORPEDINIFORMES	ELECTRIC RAYS							
Torpedinidae	Electric Rays							
Tetronarce californica	Pacific Electric Ray	R	R	R	R	R	R	R
RAJIFORMES	SKATES							
Arhynchobatidae	Softnose Skates							
Bathyraja aleutica	Aleutian Skate	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Bathyraja kincaidii	Sandpaper Skate	R	R	R	R	R	R	R
Rajidae	Hardnose Skates							
Beringraja binoculata	Big Skate	C	C	C	C	C	C	C
Beringraja inornata	California Skate	R	R	R	R	R	R	R
Beringraja rhina	Longnose Skate	C	R	C	C	C	C	C
Beringraja stellulata	Starry Skate	R	R	R	R	R	R	R
MYLIOBATIFORMES	STINGRAYS							
Myliobatidae	Eagle Rays							
Myliobatis californica	Bat Ray	R	R	R			R	R
ACIPENSERIFORMES	STURGEONS							
Acipenseridae	Sturgeons							
Acipenser medirostris	Green Sturgeon	C	C	C	C	C	C	C
Acipenser transmontanus	White Sturgeon	C	C	C	C	C	C	C
ANGUILLIFORMES	EELS							
Ophichthidae	Snake Eels							
Ophichthus triserialis	Pacific Snake Eel	R	R	R			R	R
CLUPEIFORMES	ANCHOVIES AND HERRINGS							
Engraulidae	Anchovies							
Engraulis mordax	Northern Anchovy	A	A	A	A	A	A	A
Clupeidae	Herrings							
Alosa sapidissima	American Shad	R	R	R	R	R	R	R
Clupea pallasii	Pacific Herring	A	A	A	A	A	A	A
Dorosoma petenense	Threadfin Shad	R	R				R	R
Sardinops sagax	Pacific Sardine	C	C	C	C	C	C	C
ARGENTINIFORMES	ARGENTINES							
Argentinidae	Argentines							
Argentina sialis	Pacific Argentine	R	R	R	R	R	R	R
OSMERIFORMES	FRESHWATER SMELTS							
Osmeridae	Smelts							
Allosmerus elongatus	Whitebait Smelt	C	C	C	C	C	C	C
Hypomesus pretiosus	Surf Smelt	C	C	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Osmerus dentex	Arctic Smelt	R	R	R	R	R	R	
Spirinchus starksi	Night Smelt	C	C	C	C	C	C	C
Spirinchus thaleichthys	Longfin Smelt	C	C	C	C	C	C	C
Thaleichthys pacificus	Eulachon	C	C	C	C	C	C	C
SALMONIFORMES	SALMON AND TROUTS							
Salmonidae	Salmon and Trouts							
Oncorhynchus clarkii	Cutthroat Trout	R	R		R	R	R	R
Oncorhynchus gorbuscha	Pink Salmon	R	R	R	R	R	R	R
Oncorhynchus keta	Chum Salmon	C	C	C	C	C	C	R
Oncorhynchus kisutch	Coho Salmon	C	C	C	C	C	C	C
Oncorhynchus mykiss	Steelhead	C	C	C	C	C	C	C
Oncorhynchus nerka	Sockeye Salmon	C	C	C	C	C	C	R
Oncorhynchus tshawytscha	Chinook Salmon	C	C	C	C	C	C	C
Salvelinus confluentus	Bull Trout	R	R	R	R	R	R	R
Salvelinus malma	Dolly Varden	R	R		R			
AULOPIFORMES	LIZARDFISHES							
Synodontidae	Lizardfishes							
Synodus lucioceps	California Lizardfish	R	R	R	R	R	R	R
Alepisauridae	Lancetfishes							
Alepisaurus ferox	Longnose Lancetfish	R	R	R	R	R	R	R
GADIFORMES	CODS							
Moridae	Codlings, Deepsea Cods, or Moras							
Physiculus rastrelliger	Hundred-fathom Codling	R	R	R			R	R
Merlucciidae	Hakes							
Merluccius productus	Pacific Hake	C	R	C	C	C	C	C
Gadidae	Cods							
Gadus chalcogrammus	Walleye Pollock	C	C	C	A	C	C	C
Gadus macrocephalus	Pacific Cod	C	C	C	A	C	C	C
Microgadus proximus	Pacific Tomcod	R	R	R	R	R	R	R
Ophidiidae	Cusk-eels							
Chilara taylori	Spotted Cusk-eel	R	R	C	R	R	C	C

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Bythitidae	Livebearing Brotulas							
Brosmophycis marginata	Red Brotula	R	R	R	R	R	R	R
BATRACHOIDIFORMES	TOADFISHES							
Batrachoididae	Toadfishes							
Porichthys notatus	Plainfin Midshipman	R	R	R	R	R	R	R
ATHERINIFORMES	SILVERSIDES							
Atherinopsidae	New World Silversides							
Atherinops affinis	Topsmelt	A	A		C	A	A	A
Atherinopsis californiensis	Jacksmelt	C	C		C	C	C	A
BELONIFORMES	NEEDLEFISHES AND RELATIVES							
Exocoetidae	Flyingfishes							
Cheilopogon pinnatibarbatus	Smallhead Flyingfish	R	R	R		R	R	R
Scomberesocidae	Sauries							
Cololabis saira	Pacific Saury	C	C	C	C	C	C	C
CYPRINODONTIFORMES	KILLIFISHES AND RELATIVES							
Fundulidae	Topminnows							
Lucania parva	Rainwater Killifish	R	R				R	
GASTEROSTEIFORMES	STICKLEBACKS							
Aulorhynchidae	Tubesnouts							
Aulorhynchus flavidus	Tubesnout	A	A	R	A	A	A	A
Gasterosteidae	Sticklebacks							
Gasterosteus aculeatus	Threespine Stickleback	A	A		A	A	A	A
Syngnathidae	Pipefishes							
Syngnathus leptorhynchus	Bay Pipefish	A	A		A	A	A	A
SCORPAENIFORMES	SCORPIONFISHES							
Scorpaenidae	Rockfishes and Thornyheads							
Sebastes aleutianus	Rougheye Rockfish	R		C	R	R	R	R
Sebastes alutus	Pacific Ocean Perch	C		C	C	C	C	C
Sebastes auriculatus	Brown Rockfish	R	R	R	R	R	R	R
Sebastes aurora	Aurora Rockfish	R		R	R	R	R	R
Sebastes babcocki	Redbanded Rockfish	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Sebastes borealis	Shortraker Rockfish	R	R	R	R	R	R	R
Sebastes brevispinis	Silvergray Rockfish	R	R	R	R	R	R	R
Sebastes carnatus	Gopher Rockfish	R	R	R	R	R	R	R
Sebastes caurinus	Copper Rockfish	C	C	C	C	C	C	C
Sebastes chlorostictus	Greenspotted Rockfish	R	R	R	R	R	R	R
Sebastes chrysomelas	Black-and-Yellow Rockfish	R	R	R				R
Sebastes crameri	Darkblotched Rockfish	R	R	R	R	R	R	R
Sebastes diaconus	Deacon Rockfish	C	C	C	R	R	C	C
Sebastes diploproa	Splitnose Rockfish	R		R	R	R	R	R
Sebastes elongatus	Greenstriped Rockfish	R	R	R	R	R	R	R
Sebastes emphaeus	Puget Sound Rockfish	C	C	C	C	C	C	R
Sebastes ensifer	Swordspine Rockfish	R		R			R	R
Sebastes entomelas	Widow Rockfish	C	R	C	R	R	R	R
Sebastes eos	Pink Rockfish	R		R		R	R	R
Sebastes flavidus	Yellowtail Rockfish	C	R	A	C	C	C	C
Sebastes gilli	Bronzespotted Rockfish	R		R	R	R	R	R
Sebastes goodei	Chilipepper	R	R	R	R	R	R	R
Sebastes helvomaculatus	Rosethorn Rockfish	R	R	R	R	R	R	R
Sebastes hopkinsi	Squarespot Rockfish	R	R	R	R	R	R	R
Sebastes jordani	Shortbelly Rockfish	R	R	R	R	R	R	R
Sebastes levis	Cowcod	R		R		R	R	R
Sebastes maliger	Quillback Rockfish	C	C	C	C	C	C	C
Sebastes melanops	Black Rockfish	C	C	C	C	C	C	C
Sebastes melanostictus	Blackspotted Rockfish	R	R	R	R	R	R	R
Sebastes melanostomus	Blackgill Rockfish	R		R	R	R	R	R
Sebastes miniatus	Vermilion Rockfish	C	C	C	R	C	C	C
Sebastes mystinus	Blue Rockfish	R	R	R			R	R
Sebastes nebulosus	China Rockfish	C	C	C	C	C	C	C
Sebastes nigrocinctus	Tiger Rockfish	C	R	C	C	C	C	C
Sebastes ovalis	Speckled Rockfish	R	R	R	R	R	R	R
Sebastes paucispinis	Bocaccio	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Sebastes pinniger	Canary Rockfish	C	R	C	C	C	C	C
Sebastes proriger	Redstripe Rockfish	R	R	R	C	R	R	R
Sebastes rastrelliger	Grass Rockfish	R	R	R	R	R	R	R
Sebastes reedi	Yellowmouth Rockfish	R		R	R	R	R	R
Sebastes rosaceus	Rosy Rockfish	R	R	R	R	R	R	R
Sebastes ruberrimus	Yelloweye Rockfish	C	R	C	C	C	C	C
Sebastes rubrivinctus	Flag Rockfish	R	R	R	R	R	R	R
Sebastes rufus	Bank Rockfish	R		R	R	R	R	R
Sebastes saxicola	Stripetail Rockfish	R	R	R	R	R	R	R
Sebastes semicinctus	Halfbanded Rockfish	R	R	R	R	R	R	R
Sebastes serranoides	Olive Rockfish	R	R	R				R
Sebastes variegatus	Harlequin Rockfish	R	R	R	R	R	R	
Sebastes wilsoni	Pygmy Rockfish	C	R	A	C	C	C	C
Sebastes zacentrus	Sharpchin Rockfish	R	R	R	R	R	R	R
Sebastolobus alascanus	Shortspine Thornyhead	R	R	R	R	R	R	R
Sebastolobus altivelis	Longspine Thornyhead	R		R	R	R	R	R
Triglidae	Searobins							
Prionotus stephanophrys	Lumptail Searobin	R	R	R		R	R	R
Anoplopomatidae	Sablefishes							
Anoplopoma fimbria	Sablefish	R	R	R	R	R	R	R
Zaniolepididae	Combfishes							
Oxylebius pictus	Painted Greenling	C	C	C	C	C	C	C
Zaniolepis frenata	Shortspine Combfish	R	R	R				R
Zaniolepis latipinnis	Longspine Combfish	R	R	R	R	R	R	R
Hexagrammidae	Greenlings							
Hexagrammos decagrammus	Kelp Greenling	C	C	C	C	C	C	C
Hexagrammos lagocephalus	Rock Greenling	C	C	C	C	C	C	C
Hexagrammos stelleri	Whitespotted Greenling	R	R	R	R	R	R	R
Ophiodon elongatus	Lingcod	C	C	C	C	C	C	C
Pleurogrammus monopterygius	Atka Mackerel	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Jordaniidae	Longfin Sculpins							
Jordania zonope	Longfin Sculpin	C	C	R	C	C	C	C
Paricelinus hopliticus	Thornback Sculpin	R	R	R	R	R	R	R
Scorpaenichthyidae	Cabezon							
Scorpaenichthys marmoratus	Cabezon	C	C	C	C	C	C	C
Rhamphocottidae	Grunt Sculpins							
Rhamphocottus richardsonii	Grunt Sculpin	C	C	C	C	C	C	C
Cottidae	Freshwater Sculpins							
Cottus aleuticus	Coastrange Sculpin	R	R		R	R	R	R
Cottus asper	Prickly Sculpin	R	R	R	R	R	R	R
Leptocottus armatus	Pacific Staghorn Sculpin	C	C	R	C	C	C	C
Psychrolutidae	Marine Sculpins							
Artedius corallinus	Coralline Sculpin	R	R	R	R	R	R	R
Artedius fenestralis	Padded Sculpin	C	C	R	C	C	C	C
Artedius harringtoni	Scalyhead Sculpin	C	C	R	C	C	C	C
Artedius lateralis	Smoothhead Sculpin	C	C	R	C	C	C	C
Artedius notospilotus	Bonyhead Sculpin	R	R	R	R	R	R	R
Ascelichthys rhodorus	Rosylip Sculpin	C	C	R	C	C	C	C
Asemichthys taylori	Spinynose Sculpin	R	R	R	R	R	R	R
Chitonotus pugetensis	Roughback Sculpin	C	C	R	C	C	C	C
Clinocottus acuticeps	Sharpnose Sculpin	C	C	R	C	C	C	C
Clinocottus embryum	Calico Sculpin	C	C		C	C	C	C
Clinocottus globiceps	Mosshead Sculpin	C	C	R	C	C	C	C
Dasycottus setiger	Spiny Sculpin	R	R	R	R			
Enophrys bison	Buffalo Sculpin	C	C	R	C	C	C	C
Icelinus borealis	Northern Sculpin	R	R	R	R			
Icelinus burchami	Dusky Sculpin	R		R	R	R	R	R
Icelinus filamentosus	Threadfin Sculpin	R	R	R	R	R	R	R
Icelinus fimbriatus	Fringed Sculpin	R	R	R	R	R	R	R
Icelinus tenuis	Spotfin Sculpin	C	R	C	C	C	C	C
Malacocottus zonurus	Darkfin Sculpin	R	R	R	R	R	R	

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Myoxocephalus polyacanthocephalus	Great Sculpin	R	R	R	R	R	R	R
Oligocottus maculosus	Tidepool Sculpin	A	A		A	A	A	A
Oligocottus rimensis	Saddleback Sculpin	C	C		C	C	C	C
Oligocottus snyderi	Fluffy Sculpin	C	C		C	C	C	C
Orthonopias triacis	Snubnose Sculpin	R	R		R	R	R	R
Psychrolutes paradoxus	Tadpole Sculpin	R	R	R	R	R	R	
Psychrolutes sigalutes	Soft Sculpin	R	R	R	R			
Radulinus asprellus	Slim Sculpin	R	R	R	R	R	R	R
Radulinus boleoides	Darter Sculpin	R	R	R	R	R	R	R
Ruscarius meanyi	Puget Sound Sculpin	R	R	R	R	R	R	R
Synchirus gilli	Manacled Sculpin	C	C		C	C	C	C
Triglops macellus	Roughspine Sculpin	R	R		R	R	R	
Triglops pingelii	Ribbed Sculpin	R	R	R	R			
Agonidae	Poachers							
Agonomalus mozinoi	Kelp Poacher	R	R		R	R	R	R
Agonopsis vulsa	Northern Spearnose Poacher	C	C	C	C	C	C	C
Anoplagonus inermis	Smooth Alligatorfish	R	R	R	R	R	R	R
Bathyagonus alascanus	Gray Starsnout	R	R	R	R	R	R	R
Bathyagonus infraspinatus	Spinycheek Starsnout	R	R	C	R	R	R	R
Bathyagonus nigripinnis	Blackfin Poacher	R	R	R	R	R	R	R
Bathyagonus pentacanthus	Bigeye Poacher	R		R	R	R	R	R
Blepsias cirrhosus	Silverspotted Sculpin	C	C	C	C	C	C	C
Bothragonus swanii	Rockhead	R	R		R	R	R	R
Chesnonia verrucosa	Warty Poacher	R	R	R	R	R	R	R
Hemilepidotus hemilepidotus	Red Irish Lord	C	C	C	C	C	C	C
Hemilepidotus spinosus	Brown Irish Lord	C	C	C	C	C	C	C
Hemitripterus bolini	Bigmouth Sculpin	R	R	R	R	R	R	R
Hypsagonus quadricornis	Fourhorn Poacher	R	R	R	R			
Nautichthys oculofasciatus	Sailfin Sculpin	C	C	C	C	C	C	C
Nautichthys robustus	Shortmast Sculpin	R	R	R	R			
Odontopyxis trispinosa	Pygmy Poacher	C	C	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Pallasina barbata	Tubenose Poacher	C	C	C	C	C	C	C
Podothecus accipenserinus	Sturgeon Poacher	C	C	C	C	C	R	R
Stellerina xyosterna	Pricklebreast Poacher	R	R	R	R	R	R	R
Xeneretmus latifrons	Blacktip Poacher	R	R	R	R	R	R	R
Xeneretmus leiops	Smootheye Poacher	R	R	R	R	R	R	R
Xeneretmus triacanthus	Bluespotted Poacher	R	R	R	R	R	R	R
Cyclopteridae	Lumpfishes or Lumpsuckers							
Eumicrotremus orbis	Pacific Spiny Lumpsucker	R	R	R	R			
Liparidae	Snailfishes							
Careproctus colletti	Alaska Snailfish	R		R	R	R	R	R
Careproctus cypselurus	Falcate Snailfish	R		R	R	R	R	R
Careproctus gilberti	Smalldisk Snailfish	R		R	R	R	R	R
Careproctus melanurus	Blacktail Snailfish	R		R	R	R	R	R
Liparis adiastolus	Rosybrown Snailfish	R	R		R	R	R	R
Liparis callyodon	Spotted Snailfish	R	R	R	R	R		
Liparis cyclopus	Ribbon Snailfish	C	C	R	C	C		
Liparis dennyi	Marbled Snailfish	R	R	R	R			
Liparis florae	Tidepool Snailfish	C	C		C	C	C	C
Liparis fucensis	Slipskin Snailfish	C	C	C	C	C	C	C
Liparis greeni	Lobefin Snailfish	R	R		C			
Liparis mucosus	Slimy Snailfish	C	C		C	C	C	C
Liparis pulchellus	Showy Snailfish	C	C	C	C	C	C	C
Lipariscus nanus	Pygmy Snailfish	R		R	R	R	R	R
Nectoliparis pelagicus	Tadpole Snailfish	R	R	R	R	R	R	R
Paraliparis deani	Prickly Snailfish	R	R	R	R	R	R	R
Rhinoliparis barbulifer	Longnose Snailfish	R	R	R	R	R	R	R
PERCIFORMES	PERCHES							
Moronidae	Temperate Basses							
Morone saxatilis	Striped Bass	R	R	R	R	R	R	R
Serranidae	Sea Basses							

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Paralabrax clathratus	Kelp Bass	R	R	R		R	R	R
Priacanthidae	Bigeyes							
Pristigenys serrula	Popeye Catalufa	R	R	R			R	R
Malacanthidae	Tilefishes							
Caulolatilus princeps	Ocean Whitefish	R	R	R	R	R	R	R
Carangidae	Jacks							
Seriola dorsalis	Yellowtail	R	R	R	R	R	R	R
Trachurus symmetricus	Jack Mackerel	R	R	R	R	R	R	R
Coryphaenidae	Dolphinfishes							
Coryphaena hippurus	Dolphinfish	R	R	R		R	R	R
Echeneidae	Remoras							
Remora australis	Whalesucker	R	R	R	R	R	R	R
Remora remora	Remora	R	R	R	R	R	R	R
Sciaenidae	Drums and Croakers							
Atractoscion nobilis	White Seabass	R	R	R	R	R	R	R
Genyonemus lineatus	White Croaker	R	R	R	R	R	R	R
Seriphus politus	Queenfish	R	R	R	R	R	R	R
Kyphosidae	Sea Chubs							
Girella nigricans	Opaleye	R	R	R			R	R
Kyphosus azureus	Zebraperch	R	R					R
Medialuna californiensis	Halfmoon	R	R	R	R	R	R	
Oplegnathidae	Knifejaws							
Oplegnathus fasciatus	Barred Knifejaw	R	R		R	R	R	R
Embiotocidae	Surfperches							
Amphistichus koelzi	Calico Surfperch	R	R		R	R	R	C
Amphistichus rhodoterus	Redtail Surfperch	C	C		C	C	C	C
Brachyistius frenatus	Kelp Perch	C	C	R	C	C	C	C
Cymatogaster aggregata	Shiner Perch	A	A	A	A	A	A	A
Embiotoca lateralis	Striped Seaperch	R	R	R	R	R	R	R
Hyperprosopon argenteum	Walleye Surfperch	R	R	R		R	R	R
Hyperprosopon ellipticum	Silver Surfperch	C	C	R	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Hypocritichthys analis	Spotfin Surfperch	C	C	R	C	C	C	C
Phanerodon atripes	Sharpnose Seaperch	R	R	R			R	R
Phanerodon furcatus	White Seaperch	C	C	C	C	C	C	C
Phanerodon vacca	Pile Perch	C	C	C	C	C	C	C
Bathymasteridae	Ronquils							
Ronquilus jordani	Northern Ronquil	R	R	R	C	R	R	R
Zoarcidae	Eelpouts							
Bothrocara pusillum	Alaska Eelpout	R		R	R	R		
Bothrocara molle	Soft Eelpout	R		R	R	R	R	R
Lycenchelys crotalinus	Snakehead Eelpout	R		R	R	R	R	R
Lycodes brevipes	Shortfin Eelpout	R	R	R	R	R	R	R
Lycodes cortezianus	Bigfin Eelpout	R	R	R	R	R	R	R
Lycodes diapterus	Black Eelpout	R	R	R	R	R	R	R
Lycodes pacificus	Blackbelly Eelpout	C	R	C	C	C	C	C
Lycodes palearis	Wattled Eelpout	R	R	R	R	R		
Lyconema barbatum	Bearded Eelpout	R		R		R	R	R
Stichaeidae	Pricklebacks							
Anoplarchus insignis	Slender Cockscomb	R	R	R	R	R	R	R
Anoplarchus purpurescens	High Cockscomb	A	A	R	A	A	A	A
Cebidichthys violaceus	Monkeyface Prickleback	R	R	R		R	R	R
Chirolophis decoratus	Decorated Warbonnet	C	C	C	C	C	C	C
Chirolophis nugator	Mosshead Warbonnet	C	C	C	C	C	C	C
Leptoclinus maculatus	Daubed Shanny	R	R	R	R			
Lumpenus sagitta	Snake Prickleback	C	C	C	C	C	R	R
Plectobranchus evides	Bluebarred Prickleback	R		R	R	R	R	R
Poroclinus rothrocki	Whitebarred Prickleback	R		R	R	R	R	R
Xiphister atropurpureus	Black Prickleback	C	C		C	C	C	C
Xiphister mucosus	Rock Prickleback	C	C		C	C	C	C
Cryptacanthodidae	Wrymouths							
Cryptacanthodes aleutensis	Dwarf Wrymouth	C	R	C	C	C	R	R
Cryptacanthodes giganteus	Giant Wrymouth	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Pholidae	Gunnels							
Apodichthys flavidus	Penpoint Gunnel	A	A		A	A	A	A
Apodichthys fucorum	Rockweed Gunnel	A	A		A	A	A	A
Pholis clemensi	Longfin Gunnel	R	R	R	R	R	R	R
Pholis laeta	Crescent Gunnel	R	R	R	C	R	R	R
Pholis ornata	Saddleback Gunnel	C	C	R	C	C	C	C
Pholis schultzi	Red Gunnel	C	C	R	C	C	C	C
Anarhichadidae	Wolffishes							
Anarrhichthys ocellatus	Wolf-Eel	A	A	A	A	A	A	A
Ptilichthyidae	Quillfishes							
Ptilichthys goodei	Quillfish	R	R	R	R	R	R	
Zaproridae	Prowfishes							
Zaprora silenus	Prowfish	R	R	R	R	R	R	R
Scytalinidae	Graveldivers							
Scytalina cerdale	Graveldiver	R	R		R	R	R	R
Trichodontidae	Sandfishes							
Trichodon trichodon	Pacific Sandfish	R	R	R	C	R	R	R
Ammodytidae	Sand Lances							
Ammodytes personatus	Pacific Sand Lance	A	A	A	A	A	A	A
Clinidae	Kelp Blennies							
Gibbonsia metzi	Striped Kelpfish	R	R		R	R	R	R
Gibbonsia montereyensis	Crevice Kelpfish	C	C	R	C	C	C	C
Heterostichus rostratus	Giant Kelpfish	R	R	R	R	R	R	R
Icosteidae	Ragfishes							
Icosteus aenigmaticus	Ragfish	R	R	R	R	R	R	R
Gobiesocidae	Clingfishes							
Gobiesox maeandricus	Northern Clingfish	C	C		C	C	C	C
Rimicola muscarum	Kelp Clingfish	C	C		C	C	C	C
Gobiidae	Gobies							
Clevelandia ios	Arrow Goby	C	C	R	C	C	C	C

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Eucyclogobius newberryi	Northern Tidewater Goby	R	R		R	R	R	R
Lepidogobius lepidus	Bay Goby	C	C	C	C	C	C	C
Rhinogobiops nicholsii	Blackeye Goby	A	A	A	A	A	A	A
Sphyraenidae	Barracudas							
Sphyraena argentea	Pacific Barracuda	R	R	R	R	R	R	R
Scombridae	Mackerels							
Sarda chiliensis	Pacific Bonito	R	R	R	R	R	R	R
Scomber japonicus	Pacific Chub Mackerel	C	C	C	C	C	C	C
Stromateidae	Butterfishes							
Peprilus simillimus	Pacific Pompano	C	C	C	C	C	C	C
PLEURONECTIFORMES	FLATFISHES							
Paralichthyidae	Sand Flounders							
Citharichthys sordidus	Pacific Sanddab	A	A	A	A	A	A	A
Citharichthys stigmaeus	Speckled Sanddab	C	C	C	C	C	C	C
Paralichthys californicus	California Halibut	R	R	R	R	R	R	R
Pleuronectidae	Righteye Flounders							
Atheresthes evermanni	Kamchatka Flounder	R	R	R	R	R	R	R
Atheresthes stomias	Arrowtooth Flounder	C	R	C	C	C	C	R
Eopsetta jordani	Petrale Sole	R	R	R	R	R	R	R
Glyptocephalus zachirus	Rex Sole	R	R	R	R	R	R	R
Hippoglossoides elassodon	Flathead Sole	R	R	C	C	C	R	R
Hippoglossus stenolepis	Pacific Halibut	C	R	C	C	C	R	R
Isopsetta isolepis	Butter Sole	C	R	C	C	C	C	C
Lepidopsetta bilineata	Southern Rock Sole	R	R	R	C	R	R	R
Lepidopsetta polyxystra	Northern Rock Sole	R	R	R	R			
Limanda aspera	Yellowfin Sole	R	R	R	R			
Lyopsetta exilis	Slender Sole	R	R	R	R	R	R	R
Microstomus bathybius	Deepsea Sole	R		R	R	R	R	R
Microstomus pacificus	Dover Sole	R	R	R	R	R	R	R
Parophrys vetulus	English Sole	C	C	C	C	C	C	C
Platichthys stellatus	Starry Flounder	C	C	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CAPG	PGCL	CLCB	CBCM
Pleuronichthys coenosus	C-O Sole	C	C	R	C	C	C	C
Pleuronichthys decurrens	Curlfin Sole	C	R	C	C	C	C	C
Pleuronichthys verticalis	Hornyhead Turbot	R	R	R			R	R
Psettichthys melanostictus	Sand Sole	C	C	C	C	C	C	C
Reinhardtius hippoglossoides	Greenland Halibut	R	R	R	R	R	R	R
Cynoglossidae	Tonguefishes							
Symphurus atricauda	California Tonguefish	R	R	R	R	R	R	R

APPENDIX 8

Depth and Habitat Associations of Documented Fishes in the Pacific Northwest Ecoregion

These associations are based on Ebert (2002), Love et al. (2005), Lamb and Edgell (2010), Love (2011), Butler et al. (2012), Kells et al. (2016), and a review of primary literature, fishery-independent survey catches, and museum records. Included in the following table is the vertical zonation, which is classified as Benthic (benthic and demersal), Midwater, Pelagic, and WC (meaning, found throughout the water column). The table also lists the depth range in meters (i.e., the minimum [Min] and maximum [Max]) and the common depth in meters. For each seafloor habitat (mud, sand, gravel, shell, etc.) a numeral indicates whether it is a primary or secondary habitat: 1 = primary habitat or similar utilization of habitat types for generalist species. 2 = secondary habitat. Gravel includes pebbles. SFMI stands for structure-forming marine invertebrates.

Habitat associations are for combined juvenile and adult life stages. Only benthic habitat associations are indicated. Fishes are primarily marine with the following exceptions: Exotic = non-native species and FW = freshwater usage (X = yes, A = anadromous). S = surface depth. 0 = bottom depth.

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
MYXINIFORMES	HAGFISHES																
Myxinidae	Hagfishes																
Eptatretus deani	Black Hagfish			Benthic	52–2743	600–1200	1		2								
Eptatretus stoutii	Pacific Hagfish			Benthic	16–1247	91–366	1						2				
PETROMYZONTIFORMES	LAMPREYS																
Petromyzontidae	Lampreys																
Entosphenus tridentatus	Pacific Lamprey		A	WC	16–1508	< 500											
Lampetra ayresii	Western River Lamprey		A	Pelagic	S–119												
CHIMAERIFORMES	CHIMAERAS																
Chimaeridae	Shortnose Chimaeras																
Hydrolagus colliei	Spotted Ratfish			Benthic	0–1593	50–400	1	1	1		1	1	1				
LAMNIFORMES	MACKEREL SHARKS																
Alopiidae	Thresher Sharks																
Alopias vulpinus	Common Thresher Shark			Pelagic	S–650												
Cetorhinidae	Basking Sharks																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Cetorhinus maximus	Basking Shark			Pelagic	S–1501												
Lamnidae	Mackerel Sharks																
Carcharodon carcharias	White Shark			WC	0–1200												
Isurus oxyrinchus	Shortfin Mako			Pelagic	S–888												
Lamna ditropis	Salmon Shark			Pelagic	S–1864												
CARCHARHINIFORMES	GROUND SHARKS																
Scyliorhinidae	Cat Sharks																
Apristurus brunneus	Brown Cat Shark			Benthic, Midwater	24–1401	33-360	1	1					2				
Parmaturus xaniurus	Filetail Cat Shark			Benthic, Midwater	88–1519		1	1					2				
Triakidae	Hound Sharks																
Galeorhinus galeus	Soupfin Shark			WC	0–826												
Mustelus henlei	Brown Smoothhound			Benthic, WC	0–369		1	1									
Triakis semifasciata	Leopard Shark			Benthic	0–156		1	1					1		1	2	
Carcharhinidae	Requiem Sharks																
Prionace glauca	Blue Shark			Pelagic	S–1136												
HEXANCHIFORMES	SIX-GILL SHARKS																
Hexanchidae	Cow Sharks																
Hexanchus griseus	Bluntnose Sixgill Shark			Benthic, WC	10–2490	> 91	1	1	1		1	1	1				
Notorynchus cepedianus	Broadnose Sevengill Shark			Benthic	1–570	< 50	2	2					1	1			
ECHINORHINIFORMES	BRAMBLE SHARKS																
Echinorhinidae	Bramble Sharks																
Echinorhinus cookei	Prickly Shark			Benthic	4–1100	100-650	1	1									
SQUALIFORMES	DOGFISH SHARKS																
Squalidae	Dogfish Sharks																
Squalus suckleyi	Pacific Spiny Dogfish			WC, Benthic	0–1460	10-250	1	1	1		1	1	1			1	
Somniosidae	Sleeper Sharks																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Somniosus pacificus	Pacific Sleeper Shark			Benthic, WC	0–2205		1	2					2				
SQUATINIFORMES	ANGEL SHARKS																
Squatinidae	Angel Sharks																
Squatina californica	Pacific Angel Shark			Benthic, Midwa-ter	0–205		1	1					2		2	2	
TORPEDINIFORMES	ELECTRIC RAYS																
Torpedinidae	Electric Rays																
Tetronarce californica	Pacific Electric Ray			Benthic, Midwa-ter	0–406	60-200	1	1				2	1		2		
RAJIFORMES	SKATES																
Arhynchobatidae	Softnose Skates																
Bathyraja aleutica	Aleutian Skate			Benthic	15–1602		1										
Bathyraja kincaidii	Sandpaper Skate			Benthic	18–1372	200–500	1	2			2	2	2				
Rajidae	Hardnose Skates																
Beringraja binoculata	Big Skate			Benthic	2–501	< 100	1	1	2	2							
Beringraja inornata	California Skate			Benthic	3–300	< 120	1	1									
Beringraja rhina	Longnose Skate			Benthic	9–1294	200–400	1	1	1		2		2				
Beringraja stellulata	Starry Skate			Benthic	2–400	80-140	2	1					1				
MYLIOBATIFORMES	STINGRAYS																
Myliobatidae	Eagle Rays																
Myliobatis californica	Bat Ray			Benthic, WC	0–176	< 50	1	1					2		2	2	
ACIPENSERIFORMES	STURGEONS																
Acipenseridae	Sturgeons																
Acipenser medirostris	Green Sturgeon		A	Benthic	168		1	1	1		1	1	1				
Acipenser transmon-tanus	White Sturgeon		A	Benthic	122	< 50	1	1	1		1	1	1				
ANGUILLIFORMES	EELS																
Ophichthidae	Snake Eels																
Ophichthus triserialis	Pacific Snake Eel			Benthic	0–155		1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
CLUPEIFORMES	ANCHOVIES AND HERRINGS																
Engraulidae	Anchovies																
Engraulis mordax	Northern Anchovy			Pelagic	S/0–528												
Clupeidae	Herrings																
Alosa sapidissima	American Shad	X	A	Pelagic	S–250												
Clupea pallasii	Pacific Herring			Pelagic	S–250	< 150											
Dorosoma petenense	Threadfin Shad	X	FW	Pelagic	S–20												
Sardinops sagax	Pacific Sardine			Pelagic	S/0–383												
ARGENTINIFORMES	ARGENTINES																
Argentinidae	Argentines																
Argentina sialis	Pacific Argentine			Benthic	11–1093	170-220	1	1									
OSMERIFORMES	FRESHWATER SMELTS																
Osmeridae	Smelts																
Allosmerus elongatus	Whitebait Smelt			Pelagic	S–495												
Hypomesus pretiosus	Surf Smelt			Benthic, Pelagic	0–185	< 50									1	1	
Osmerus dentex	Arctic Smelt		A	Pelagic	S–194												
Spirinchus starksi	Night Smelt			Pelagic	S/0–128												
Spirinchus thaleichthys	Longfin Smelt		A	Pelagic	S/0–137												
Thaleichthys pacificus	Eulachon		A	WC, Benthic	10–400	20–150	1	1	2		2						
SALMONIFORMES	SALMON AND TROUTS																
Salmonidae	Salmon and Trouts																
Oncorhynchus clarkii	Cutthroat Trout		A	WC	S												
Oncorhynchus gorbuscha	Pink Salmon		A	Pelagic	S–74	< 10											
Oncorhynchus keta	Chum Salmon		A	Pelagic	S–253	< 10											
Oncorhynchus kisutch	Coho Salmon		A	Pelagic	S–97	< 10											

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Oncorhynchus mykiss	Steelhead		A, FW	Pelagic	S	< 20											
Oncorhynchus nerka	Sockeye Salmon		A	Pelagic	S–83	< 10											
Oncorhynchus tshawytscha	Chinook Salmon		A	Pelagic, WC	S–538	< 150											
Salvelinus confluentus	Bull Trout		A, FW	Pelagic	S												
Salvelinus malma	Dolly Varden		A, FW	Pelagic	S–8	3–4											
AULOPIFORMES	LIZARDFISHES																
Synodontidae	Lizardfishes																
Synodus lucioceps	California Lizard-fish			Benthic	1–250		1	1	2			2	2				
Alepisauridae	Lancetfishes																
Alepisaurus ferox	Longnose Lan-cetfish			Pelagic, Midwa-ter	5–1830												
GADIFORMES	CODS																
Moridae	Codlings, Deep-sea Cods, or Moras																
Physiculus rastrelliger	Hundred-fathom Codling			Benthic	21–1369								1				
Merlucciidae	Hakes																
Merluccius productus	Pacific Hake			Pelagic, Benthic	12–1437	50–450											
Gadidae	Cods																
Gadus chalcogrammus	Walleye Pollock			Benthic, Pelagic	0–1280	30–400	1	1	2		2	2	2				
Gadus macrocephalus	Pacific Cod			Benthic, Pelagic	0–1280	< 300	1	1	2		1	2	2		1	1	
Microgadus proximus	Pacific Tomcod			Benthic, Pelagic	0–310	< 100	1	1							2	2	
Ophidiidae	Cusk-eels																
Chilara taylori	Spotted Cusk-eel			Benthic	0–1128	30-190	1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Bythitidae	Livebearing Brotulas																
Brosmophycis marginata	Red Brotula			Benthic	3–256	> 20							1				
BATRACHOIDIFORMES	TOADFISHES																
Batrachoididae	Toadfishes																
Porichthys notatus	Plainfin Midshipman			Benthic, Pelagic	0–464	< 250	1	1								2	
ATHERINIFORMES	SILVERSIDES																
Atherinopsidae	New World Silversides																
Atherinops affinis	Topsmelt			Pelagic	S/0–26												
Atherinopsis californiensis	Jacksmelt			Pelagic	S/0–29												
BELONIFORMES	NEEDLEFISHES AND RELATIVES																
Exocoetidae	Flyingfishes																
Cheilopogon pinnatibarbatus	Smallhead Flyingfish			Pelagic	S–10												
Scomberesocidae	Sauries																
Cololabis saira	Pacific Saury			Pelagic	S/0–295												
CYPRINODONTIFORMES	KILLIFISHES AND RELATIVES																
Fundulidae	Topminnows																
Lucania parva	Rainwater Killifish	X	FW	WC	S–10												
GASTEROSTEIFORMES	STICKLEBACKS																
Aulorhynchidae	Tubesnouts																
Aulorhynchus flavidus	Tubesnout			WC	0–40	< 20		1					1		1	1	
Gasterosteidae	Sticklebacks																
Gasterosteus aculeatus	Threespine Stickleback		A, FW	WC, Benthic	0–27		1	1					2		2	2	
Syngnathidae	Pipefishes																
Syngnathus leptorhynchus	Bay Pipefish			WC, Benthic	0–18	< 3	2	2	2					2	2	1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
SCORPAENIFORMES	SCORPIONFISHES																
Scorpaenidae	Rockfishes and Thornyheads																
Sebastes aleutianus	Rougheye Rock-fish			Benthic	45–765	200–500						1	1				
Sebastes alutus	Pacific Ocean Perch			Benthic, WC	70–1125	100–400	1	1			1	1	1				
Sebastes auriculatus	Brown Rockfish			Benthic	0–287		2	2		2			1	2		2	
Sebastes aurora	Aurora Rockfish			Benthic	81–1176	300-500	1	2					1				
Sebastes babcocki	Redbanded Rockfish			Benthic	21–1150	150-450	2		2		2		1				
Sebastes borealis	Shortraker Rockfish			Benthic	25–1200	300-500	2	2				1	1				
Sebastes brevispinis	Silvergray Rock-fish			Benthic	17–622	100-300	2	2			2	1	1		2		
Sebastes carnatus	Gopher Rockfish			Benthic	0–88	12-50							1		1	2	
Sebastes caurinus	Copper Rockfish			Benthic	0–408	5–70	2	2				1	1				
Sebastes chlorostictus	Greenspotted Rockfish			Benthic	30–431	80-200	2	2				1	1				
Sebastes chrysomelas	Black-and-Yellow Rockfish			Benthic	0–37	2-15							1		1		
Sebastes crameri	Darkblotched Rockfish			Benthic	29–915	140-210	1	2			1	1	1				
Sebastes diaconus	Deacon Rockfish			WC	8–72	< 50							1				
Sebastes diploproa	Splitnose Rock-fish			Benthic	50–1050	150–450	1			2			2				
Sebastes elongatus	Greenstriped Rockfish			Benthic	12–1151	100–300	1	1		1	1	1	1				
Sebastes emphaeus	Puget Sound Rockfish			Benthic	3–470	10–366						1	1		1		
Sebastes ensifer	Swordspine Rockfish			Benthic	50–433	90-140	2				1	1	1				
Sebastes entomelas	Widow Rockfish			Benthic, WC	0–800	30-200					2		1	2	2		
Sebastes eos	Pink Rockfish			Benthic	45–366	200-350						1	1				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Sebastes flavidus	Yellowtail Rock-fish			WC	0–549	90–180						1	1	2	1	2	
Sebastes gilli	Bronzespotted Rockfish			Benthic	75–413	130-250						1	1				
Sebastes goodei	Chilipepper			Benthic, Midwa-ter	30–515	75-325	2	2					1		2		
Sebastes helvomacu-latus	Rosethorn Rock-fish			Benthic	27–1151	80-350	2				2	2	1				
Sebastes hopkinsi	Squarespot Rockfish			Benthic, Midwa-ter	15–305	55-115					2	1	1				
Sebastes jordani	Shortbelly Rock-fish			Benthic	26–515	150-270	1	1				2	1		2		
Sebastes levis	Cowcod			Benthic	40–522	130-215	2	2			2	1	1				
Sebastes maliger	Quillback Rock-fish			Benthic	0–398	10-140							1		1	1	
Sebastes melanops	Black Rockfish			WC	0–366	< 75							1	2	1	2	
Sebastes melanostic-tus	Blackspotted Rockfish			Benthic	25–1000	350-450	2	2				1	1				
Sebastes melanosto-mus	Blackgill Rockfish			Benthic	88–768	200-600	1	2				1	1				
Sebastes miniatus	Vermilion Rock-fish			Benthic	12–478	< 100	2	2			1	1	1				
Sebastes mystinus	Blue Rockfish			WC, Benthic	0–156	2-55							1		1		
Sebastes nebulosus	China Rockfish			Benthic	3–177	10–100		2			2	1	1		1	2	
Sebastes nigrocinctus	Tiger Rockfish			Benthic	2–298	> 30						1	1				
Sebastes ovalis	Speckled Rock-fish			Benthic	30–366						2	1	1				
Sebastes paucispinis	Bocaccio			Benthic, WC	20–475							1	1		1		
Sebastes pinniger	Canary Rockfish			Benthic, WC	18–458	80-200	2				2	1	1				
Sebastes proriger	Redstripe Rock-fish			Benthic	0–68	0-15							1	1	1	1	
Sebastes rastrelliger	Grass Rockfish			Benthic	4–550	55-300	2	2	1		1	1	1				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Sebastes reedi	Yellowmouth Rockfish			Benthic	52–585							1	1				
Sebastes rosaceus	Rosy Rockfish			Benthic	7–328		2	2			1	1	1				
Sebastes ruberrimus	Yelloweye Rockfish			Benthic	11–732	90–180						1	1				
Sebastes rubrivinctus	Flag Rockfish			Benthic	30–431						2	1	1		1		
Sebastes rufus	Bank Rockfish			Benthic	31–512	90-360	2				2	1	1				
Sebastes saxicola	Stripetail Rockfish			Benthic	25–547	100-200	1	1		1	1		1				
Sebastes semicinctus	Halfbanded Rockfish			Benthic	15–440		2	1			1	2	1	2	2		
Sebastes serranoides	Olive Rockfish			Benthic, WC	0–172	< 55							1		2	2	
Sebastes variegatus	Harlequin Rockfish			Benthic	6–558	50-300							1				
Sebastes wilsoni	Pygmy Rockfish			Benthic	29–391	200-300	1	1			1	1	1				
Sebastes zacentrus	Sharpchin Rockfish			Benthic	25–660	200-300	1			1	1	1	1				
Sebastolobus alascanus	Shortspine Thornyhead			Benthic	17–1524	200-800	1		2		2		2				
Sebastolobus altivelis	Longspine Thornyhead			Benthic	72–1756	500-1300	1						2				
Triglidae	Searobins																
Prionotus stephanophrys	Lumptail Searobin			Benthic	2–255	10-100	2	1									
Anoplopomatidae	Sablefishes																
Anoplopoma fimbria	Sablefish			Benthic, Pelagic	12–2740	300-1000	1				2	2					
Zaniolepididae	Combfishes																
Oxylebius pictus	Painted Greenling			Benthic	0–249	< 50	2	2				1	1				
Zaniolepis frenata	Shortspine Combfish			Benthic, Midwater	7–450	100-215	1	2	1		1						
Zaniolepis latipinnis	Longspine Combfish			Benthic, Midwater	16–421	50-205	1	2					2				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Hexagrammidae	Greenlings																
Hexagrammos decagrammus	Kelp Greenling			Benthic	0–303	0-100							1	1	1	1	
Hexagrammos lagocephalus	Rock Greenling			Benthic	0–80	0-20					1		1	1	1	1	
Hexagrammos stelleri	Whitespotted Greenling			Benthic	0–305	< 100		1					1	1	1	1	
Ophiodon elongatus	Lingcod			Benthic	0–750	30-200	1	1		1		1	1		1	1	
Pleurogrammus monopterygius	Atka Mackerel			Benthic, WC	0–720	< 225							1				
Jordaniidae	Longfin Sculpins																
Jordania zonope	Longfin Sculpin			Benthic	0–497	10–40							1		1		
Paricelinus hopliticus	Thornback Sculpin			Benthic	16–352	> 76							1				
Scorpaenichthyidae	Cabezon																
Scorpaenichthys marmoratus	Cabezon			Benthic	0–226	< 73	2				2		1		2	2	
Rhamphocottidae	Grunt Sculpins																
Rhamphocottus richardsonii	Grunt Sculpin			Benthic	0–258	< 10		2		2			1	2			
Cottidae	Freshwater Sculpins																
Cottus aleuticus	Coastrange Sculpin		FW	Benthic				1	1		1						
Cottus asper	Prickly Sculpin		FW	Benthic	< 92	< 10		1	1		1	1					
Leptocottus armatus	Pacific Staghorn Sculpin		FW	Benthic	0–335	< 10	1	1		1						1	
Psychrolutidae	Marine Sculpins																
Artedius corallinus	Coralline Sculpin			Benthic	0–70							1	1	1			
Artedius fenestralis	Padded Sculpin			Benthic	0–122	< 10	2	2	2		2	2	1		2	2	
Artedius harringtoni	Scalyhead Sculpin			Benthic	0–40						1		1	1		1	
Artedius lateralis	Smoothhead Sculpin			Benthic	0–70	0-10		1	1		1		1	1		1	
Artedius notospilotus	Bonyhead Sculpin			Benthic	0–52								1	1			

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Ascelichthys rhodorus	Rosylip Sculpin			Benthic	0–15	0-5	1	1	1				1	1	1	1	
Asemichthys taylori	Spinynose Sculpin			Benthic	0–212	> 10		1		1			2				
Chitonotus pugetensis	Roughback Sculpin			Benthic	0–329		1	1	2				2			2	
Clinocottus acuticeps	Sharpnose Sculpin		FW	Benthic	0–114	< 1		1	1		1	1	1	1		1	
Clinocottus embryum	Calico Sculpin			Benthic	0–2					1			1	1			
Clinocottus globiceps	Mosshead Sculpin			Benthic	0–44						2		1				
Dasycottus setiger	Spiny Sculpin			Benthic	15–1205	< 800	1	1					2				
Enophrys bison	Buffalo Sculpin			Benthic	0–194	< 45		1	1		1		1	1	1	1	
Icelinus borealis	Northern Sculpin			Benthic	5–453		1	1	1	1			1			1	
Icelinus burchami	Dusky Sculpin			Benthic	61–622		1	1					2				
Icelinus filamentosus	Threadfin Sculpin			Benthic	18–482		1	1	1								
Icelinus fimbriatus	Fringed Sculpin			Benthic	30–265		1	1					2				
Icelinus tenuis	Spotfin Sculpin			Benthic	7–375	60–100	1	1		1			2				
Malacocottus zonurus	Darkfin Sculpin			Benthic	30–1172		1	1					1				
Myoxocephalus polyacanthocephalus	Great Sculpin			Benthic	0–825	< 200	1	1			1		1	1	1	1	
Oligocottus maculosus	Tidepool Sculpin			Benthic	0–9			1			1		1	1		1	
Oligocottus rimensis	Saddleback Sculpin			Benthic	0–21				1				1	1	1	1	
Oligocottus snyderi	Fluffy Sculpin			Benthic	0–6			2			1		1	1		1	
Orthonopias triacis	Snubnose Sculpin			Benthic	0–30	5-21							1	1			
Psychrolutes paradoxus	Tadpole Sculpin			Benthic	3–419		1	1					1		2	1	
Psychrolutes sigalutes	Soft Sculpin			Benthic	3–500		2	2					1	1			
Radulinus asprellus	Slim Sculpin			Benthic	9–699		1										
Radulinus boleoides	Darter Sculpin			Benthic	15–182		1	1	1	1							
Ruscarius meanyi	Puget Sound Sculpin			Benthic	0–82								1				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Synchirus gilli	Manacled Sculpin			Benthic	0–21								1	1	1	1	
Triglops macellus	Roughspine Sculpin			Benthic	18–350		1	1									
Triglops pingelii	Ribbed Sculpin			Benthic	4–930	20–150	1	1					2				
Agonidae	Poachers																
Agonomalus mozinoi	Kelp Poacher			Benthic	0–15								1	1	1	1	
Agonopsis vulsa	Northern Spearnose Poacher			Benthic	0–581	10–180	1	1									
Anoplagonus inermis	Smooth Alligatorfish			Benthic	2–465			1	1				1				
Bathyagonus alascanus	Gray Starsnout			Benthic	18–332		1	1									
Bathyagonus infraspinatus	Spinycheek Starsnout			Benthic	6–415		1	1									
Bathyagonus nigripinnis	Blackfin Poacher			Benthic	18–1596	50–800	1	1									
Bathyagonus pentacanthus	Bigeye Poacher			Benthic	50–1197	100–375	1	1									
Blepsias cirrhosus	Silverspotted Sculpin			Benthic	0–97	< 60					1		1		1	1	
Bothragonus swanii	Rockhead			Benthic	0–21				1			1	1		1		
Chesnonia verrucosa	Warty Poacher			Benthic	0–337		1	1									
Hemilepidotus hemilepidotus	Red Irish Lord			Benthic	0–235	< 10		1	1	1	1		1	1	1	1	
Hemilepidotus spinosus	Brown Irish Lord			Benthic	0–175								1	1			
Hemitripterus bolini	Bigmouth Sculpin			Benthic	25–925		1	1									
Hypsagonus quadricornis	Fourhorn Poacher			Benthic	0–452	< 200		1	1	1	1		1				
Nautichthys oculofasciatus	Sailfin Sculpin			Benthic	0–208	2-30							1		1	1	
Nautichthys robustus	Shortmast Sculpin			Benthic	< 97			1	1				1				
Odontopyxis trispinosa	Pygmy Poacher			Benthic	5–373	< 70	1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Pallasina barbata	Tubenose Poacher			Benthic, Pelagic	0–128	< 60		1	1					1		1	
Podothecus accipens-erinus	Sturgeon Poacher			Benthic	0–570	< 100	1	1							1	1	
Stellerina xyosterna	Pricklebreast Poacher			Benthic	2–100	< 76	1	1									
Xeneretmus latifrons	Blacktip Poacher			Benthic	2–1291	> 120	1	1									
Xeneretmus leiops	Smootheye Poacher			Benthic	24–803		1	1									
Xeneretmus triacan-thus	Bluespotted Poacher			Benthic	15–624		1	1									
Cyclopteridae	Lumpfishes or Lumpsuckers																
Eumicrotremus orbis	Pacific Spiny Lumpsucker			Benthic	2–447	< 200		1	1				1		1	1	
Liparidae	Snailfishes																
Careproctus colletti	Alaska Snailfish			Benthic	64–1556		1	1									
Careproctus cypselurus	Falcate Snailfish			Benthic	35–1993		1	1									
Careproctus gilberti	Smalldisk Snail-fish			Benthic, Midwa-ter	55–2040								1				
Careproctus melanurus	Blacktail Snail-fish			Benthic	50–2286	> 400	1										
Liparis adiastolus	Rosybrown Snailfish			Benthic	0–10									1			
Liparis callyodon	Spotted Snailfish			Benthic	0–49					1			1	1	1	1	
Liparis cyclopus	Ribbon Snailfish			Benthic	0–183					1			1	1	1	1	
Liparis dennyi	Marbled Snail-fish			Benthic	0–225		1	1		1			1				
Liparis florae	Tidepool Snail-fish			Benthic	0–15					1	1	1	1	1	1	1	
Liparis fucensis	Slipskin Snailfish			Benthic	0–388					1			1				
Liparis greeni	Lobefin Snailfish			Benthic	0–21									1	1		
Liparis mucosus	Slimy Snailfish			Benthic	0–18	< 6	2	2				1	1	1			
Liparis pulchellus	Showy Snailfish			Benthic	0–191		1	1								2	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Lipariscus nanus	Pygmy Snailfish			Benthic	58–910		1										
Nectoliparis pelagicus	Tadpole Snailfish			Benthic, Midwater	2–3383	45–439	1										
Paraliparis deani	Prickly Snailfish			Benthic	18–1008		1										
Rhinoliparis barbulifer	Longnose Snailfish			Benthic	28–1500		1										
PERCIFORMES	PERCHES																
Moronidae	Temperate Basses																
Morone saxatilis	Striped Bass	X	A	Benthic, WC	0–55		1	1	1			1	1				
Serranidae	Sea Basses																
Paralabrax clathratus	Kelp Bass			WC	0–61	< 30											
Priacanthidae	Bigeyes																
Pristigenys serrula	Popeye Catalufa			Benthic	3–1226		2	2					1				
Malacanthidae	Tilefishes																
Caulolatilus princeps	Ocean Whitefish			Benthic, WC	3–189			1					1		2	1	
Carangidae	Jacks																
Seriola dorsalis	Yellowtail			Pelagic	S–91												
Trachurus symmetricus	Jack Mackerel			Pelagic	S/0–403												
Coryphaenidae	Dolphinfishes																
Coryphaena hippurus	Dolphinfish			Pelagic	S–262												
Echeneidae	Remoras																
Remora australis	Whalesucker			Pelagic	S–200												
Remora remora	Remora			Pelagic	S–300												
Sciaenidae	Drums and Croakers																
Atractoscion nobilis	White Seabass			Benthic, WC	0–245			2					1	2	1	2	
Genyonemus lineatus	White Croaker			Benthic	0–238	2-130	1	1									
Seriphus politus	Queenfish			Benthic	0–181	2-40	1	1								2	
Kyphosidae	Sea Chubs																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Girella nigricans	Opaleye			Benthic	0–32		2	2					1		1	1	
Kyphosus azureus	Zebraperch			Benthic	0–15								1		1	1	
Medialuna californ-iensis	Halfmoon			Benthic, WC	0–44								1	1	1	1	
Oplegnathidae	Knifejaws																
Oplegnathus fasciatus	Barred Knifejaw			Benthic	0–10								1	2			
Embiotocidae	Surfperches																
Amphistichus koelzi	Calico Surfperch			Benthic	0–9			1								2	
Amphistichus rhodoterus	Redtail Surf-perch			Benthic	0–7			1					2				
Brachyistius frenatus	Kelp Perch			WC	0–76	1-15		2				2	2	1	1	2	
Cymatogaster aggre-gata	Shiner Perch		FW	Benthic	0–310	1-90		2					2			1	
Embiotoca lateralis	Striped Seaperch			Benthic, Pelagic	0–111	< 30		2					1	1	1	1	
Hyperprosopon argen-teum	Walleye Surf-perch			Benthic, Midwa-ter	0–182	0-20		1					1		1	1	
Hyperprosopon ellip-ticum	Silver Surfperch			Benthic	0–110	1-4							1		1	1	
Hypocritichthys analis	Spotfin Surf-perch			Benthic	0–101	< 35	2	1							2		
Phanerodon atripes	Sharpnose Sea-perch			Benthic	12–229	< 80							1		1	1	
Phanerodon furcatus	White Seaperch			Benthic, WC	0–104	1-50		1					1		1	1	
Phanerodon vacca	Pile Perch			Benthic, WC	0–132	2–55		2					1		1	1	
Bathymasteridae	Ronquils																
Ronquilus jordani	Northern Ron-quil			Benthic	3–337	< 150		1					1				
Zoarcidae	Eelpouts																
Bothrocara pusillum	Alaska Eelpout			Benthic	55–642		1	1									
Bothrocara molle	Soft Eelpout			Benthic	60–2688		1	1									
Lycenchelys crotalinus	Snakehead Eelpout			Benthic	63–2816		1										

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Lycodes brevipes	Shortfin Eelpout			Benthic	76–1091	> 200	1										
Lycodes cortezianus	Bigfin Eelpout			Benthic	18–1280	70-400	1	1									
Lycodes diapterus	Black Eelpout			Benthic	24–1472	146-844	1	1									
Lycodes pacificus	Blackbelly Eelpout			Benthic	7–1036	50–400	1										
Lycodes palearis	Wattled Eelpout			Benthic	2–925	< 200	1	1									
Lyconema barbatum	Bearded Eelpout			Benthic	45–472		1	2									
Stichaeidae	Pricklebacks																
Anoplarchus insignis	Slender Cockscomb			Benthic	0–84								1	1			
Anoplarchus purpurescens	High Cockscomb			Benthic	0–35					1	1		1	1	1	1	
Cebidichthys violaceus	Monkeyface Prickleback			Benthic	0–24	0-3							1	1	1		
Chirolophis decoratus	Decorated Warbonnet			Benthic	5–297								1	1			
Chirolophis nugator	Mosshead Warbonnet			Benthic	0–80	1-30				1			1		2		
Leptoclinus maculatus	Daubed Shanny			Benthic	2–773	< 170	1	1	1								
Lumpenus sagitta	Snake Prickleback			Benthic, WC	0–425	0-200	1	1	1		1					1	
Plectobranchus evides	Bluebarred Prickleback			Benthic	57–368		1	1									
Poroclinus rothrocki	Whitebarred Prickleback			Benthic	35–350		2	2		1			1				
Xiphister atropurpureus	Black Prickleback			Benthic	0–27				1		1	1	1	1			
Xiphister mucosus	Rock Prickleback			Benthic	0–18						1	1	1	1			
Cryptacanthodidae	Wrymouths																
Cryptacanthodes aleutensis	Dwarf Wrymouth			Benthic	18–964		1										
Cryptacanthodes giganteus	Giant Wrymouth			Benthic	6–331	< 20	1										
Pholidae	Gunnels																
Apodichthys flavidus	Penpoint Gunnel			Benthic	0–11	0-2	1	1	1		1	1	1	1		1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Apodichthys fucorum	Rockweed Gunnel			Benthic	0–9	0-6							1	1		1	
Pholis clemensi	Longfin Gunnel			Benthic	7–64	6-18		1					1	1		1	
Pholis laeta	Crescent Gunnel			Benthic	0–99	0-10					1		1	1	1	1	
Pholis ornata	Saddleback Gunnel			Benthic	0–60		1	1					1	1		1	
Pholis schultzi	Red Gunnel			Benthic	0–102	0-8							1		1	1	
Anarhichadidae	Wolffishes																
Anarrhichthys ocellatus	Wolf-Eel			Benthic, Pelagic	0–417								1	2	2		
Ptilichthyidae	Quillfishes																
Ptilichthys goodei	Quillfish			Benthic, WC	5–360		1	1									
Zaproridae	Prowfishes																
Zaprora silenus	Prowfish			Benthic, Pelagic	10–801	100-250	2				2		1				
Scytalinidae	Graveldivers																
Scytalina cerdale	Graveldiver			Benthic	0–8			2	1	1			2				
Trichodontidae	Sandfishes																
Trichodon trichodon	Pacific Sandfish			Benthic, Pelagic	0–375	< 150		1			2		2			2	
Ammodytidae	Sand Lances																
Ammodytes personatus	Pacific Sand Lance			Benthic, WC	0–272	0-80		1	1								
Clinidae	Kelp Blennies																
Gibbonsia metzi	Striped Kelpfish			Benthic	0–18	> 2							1	1	1	1	
Gibbonsia montereyensis	Crevice Kelpfish			Benthic	0–49	0-8							1	1	1	1	
Heterostichus rostratus	Giant Kelpfish			Benthic, WC	0–40	5-25							1	1	1	1	
Icosteidae	Ragfishes																
Icosteus aenigmaticus	Ragfish			Pelagic, Benthic	0–1420												
Gobiesocidae	Clingfishes																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Gobiesox maeandricus	Northern Clingfish			Benthic	0–18	< 10					2		1	2	2	2	
Rimicola muscarum	Kelp Clingfish			WC	0–5								2	1	1	1	
Gobiidae	Gobies																
Clevelandia ios	Arrow Goby		FW	Benthic	0–45	0-10	1	1								1	
Eucyclogobius newberryi	Northern Tidewater Goby		FW	Benthic	0–15		1	1						2		2	
Lepidogobius lepidus	Bay Goby			Benthic	0–305	< 70	1	1								1	
Rhinogobiops nicholsii	Blackeye Goby			Benthic	0–195	< 80	1	1	1				1		2	2	
Sphyraenidae	Barracudas																
Sphyraena argentea	Pacific Barracuda			Pelagic	S/0–383												
Scombridae	Mackerels																
Sarda chiliensis	Pacific Bonito			Pelagic	S–110												
Scomber japonicus	Pacific Chub Mackerel			Pelagic	S/0-300												
Stromateidae	Butterfishes																
Peprilus simillimus	Pacific Pompano			Benthic, Pelagic	0–302	3–70		1									
PLEURONECTIFORMES	FLATFISHES																
Paralichthyidae	Sand Flounders																
Citharichthys sordidus	Pacific Sanddab			Benthic	0–581	< 150	1	1		1						2	
Citharichthys stigmaeus	Speckled Sanddab			Benthic	0–366	< 60	1	1							2	2	
Paralichthys californicus	California Halibut			Benthic	0–317		1	1									
Pleuronectidae	Righteye Flounders																
Atheresthes evermanni	Kamchatka Flounder			Benthic	25–1200	100-600	1	1									
Atheresthes stomias	Arrowtooth Flounder			Benthic	9–1186	100–500	1	1	2				2				
Eopsetta jordani	Petrale Sole			Benthic	0–640	55-457	1	1	2		2						
Glyptocephalus zachirus	Rex Sole			Benthic	0–1237	100–500	1	2			2		2				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Hippoglossoides elassodon	Flathead Sole			Benthic	0–1050	100–300	1	1									
Hippoglossus stenolepis	Pacific Halibut			Benthic, Midwater	2–2000	27-274	1	1				2	2			2	
Isopsetta isolepis	Butter Sole			Benthic	2–425		1										
Lepidopsetta bilineata	Southern Rock Sole			Benthic	1–476			1	1								
Lepidopsetta polyxystra	Northern Rock Sole			Benthic	0–700	< 200	1	1		2							
Limanda aspera	Yellowfin Sole			Benthic	2–714	< 250	1	1								2	
Lyopsetta exilis	Slender Sole			Benthic	9–1258	90-350	1						2				
Microstomus bathybius	Deepsea Sole			Benthic	41–1743	500-1400	1	1			1	1	1				
Microstomus pacificus	Dover Sole			Benthic	2–1400		1	2					2				
Parophrys vetulus	English Sole			Benthic	0–608	< 200	1	1								1	
Platichthys stellatus	Starry Flounder		FW	Benthic, Pelagic	0–660	< 100	1	1	1					2		1	
Pleuronichthys coenosus	C-O Sole			Benthic	0–350	5-30	1	1					1			1	
Pleuronichthys decurrens	Curlfin Sole			Benthic	0–440	18-70	1	1					2				
Pleuronichthys verticalis	Hornyhead Turbot			Benthic	5–496	10-100	1	1									
Psettichthys melanostictus	Sand Sole			Benthic	0–325	< 50		1								2	
Reinhardtius hippoglossoides	Greenland Halibut			Benthic, Pelagic	10–2000	50-1000	1	1									
Cynoglossidae	Tonguefishes																
Symphurus atricauda	California Tonguefish			Benthic	0–463	5-140	1	1								1	

APPENDIX 9

Qualitative Assessment of Relative Abundance Among Documented Fishes Off the Central California Ecoregion

This assessment is based on a review of relevant field guides (e.g., Miller and Lea 1972; Love et al. 2002; Ebert 2003; Love 2011; Butler et al. 2012; Kells et al. 2016), primary literature, and landings or survey data. Included in the following table are the taxon (order, family, genus, species), common name, and abundance estimates throughout the ecoregion (Overall), in the Core and Seaward Zones, and among the Central California subregions. Only fishes with multiple documented records in the ecoregion are included. Blank entries indicate that the species has not been documented in a particular subregion.

Key: CMPR = Cape Mendocino to Point Reyes, PRPS = Point Reyes to Point Sur, PSPA = Point Sur to Point Arguello, and PAS = Point Arguello South. A = abundant, C = common, and R = rare.

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
MYXINIFORMES	HAGFISHES							
Myxinidae	Hagfishes							
Eptatretus deani	Black Hagfish	R		R	R	R	R	R
Eptatretus stoutii	Pacific Hagfish	C	R	C	C	C	C	C
PETROMYZONTIFORMES	LAMPREYS							
Petromyzontidae	Lampreys							
Entosphenus tridentatus	Pacific Lamprey	C	R	C	C	C	C	C
Lampetra ayresii	Western River Lamprey	R	R	R	R	R		
CHIMAERIFORMES	CHIMAERAS							
Chimaeridae	Shortnose Chimaeras							
Hydrolagus colliei	Spotted Ratfish	C	R	C	A	A	C	C
Hydrolagus melanophasma	Eastern Pacific Black Ghostshark	R		R		R	R	R
HETERODONTIFORMES	HORN SHARKS							
Heterodontidae	Horn Sharks							
Heterodontus francisci	Horn Shark	R	R	R			R	R
ORECTOLOBIFORMES	CARPET SHARKS							
Rhincodontidae	Whale Sharks							
Rhincodon typus	Whale Shark	R	R	R	R	R	R	R
LAMNIFORMES	MACKEREL SHARKS							
Alopiidae	Thresher Sharks							

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Alopias vulpinus	Common Thresher Shark	R	R	R	R	R	R	R
Cetorhinidae	Basking Sharks							
Cetorhinus maximus	Basking Shark	R	R	R	R	R	R	R
Lamnidae	Mackerel Sharks							
Carcharodon carcharias	White Shark	C	R	C	C	C	C	C
Isurus oxyrinchus	Shortfin Mako	R	R	R	R	R	R	R
Lamna ditropis	Salmon Shark	C	R	C	C	C	R	R
CARCHARHINIFORMES	GROUND SHARKS							
Scyliorhinidae	Cat Sharks							
Apristurus brunneus	Brown Cat Shark	R	R	R	R	R	R	R
Cephaloscyllium ventriosum	Swell Shark	R	R	R			R	R
Parmaturus xaniurus	Filetail Cat Shark	R	R	R	R	R	R	R
Triakidae	Hound Sharks							
Galeorhinus galeus	Soupfin Shark	C	R	C	C	C	C	C
Mustelus californicus	Gray Smoothhound	C	C	R	R	C	C	C
Mustelus henlei	Brown Smoothhound	A	A	A	C	A	A	A
Triakis semifasciata	Leopard Shark	A	A	C	A	A	A	A
Carcharhinidae	Requiem Sharks							
Prionace glauca	Blue Shark	C	R	C	C	C	C	C
Sphyrnidae	Hammerhead Sharks							
Sphyrna zygaena	Smooth Hammerhead	R	R	R	R	R	R	R
HEXANCHIFORMES	SIX-GILL SHARKS							
Hexanchidae	Cow Sharks							
Hexanchus griseus	Bluntnose Sixgill Shark	C	C	C	C	C	C	C
Notorynchus cepedianus	Broadnose Sevengill Shark	R	R	R	R	C	R	R
ECHINORHINIFORMES	BRAMBLE SHARKS							
Echinorhinidae	Bramble Sharks							
Echinorhinus cookei	Prickly Shark	R	R	R	R	C	R	R
SQUALIFORMES	DOGFISH SHARKS							
Squalidae	Dogfish Sharks							
Squalus suckleyi	Pacific Spiny Dogfish	C	R	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Somniosidae	Sleeper Sharks							
Somniosus pacificus	Pacific Sleeper Shark	R	R	R	R	R	R	R
SQUATINIFORMES	ANGEL SHARKS							
Squatinidae	Angel Sharks							
Squatina californica	Pacific Angel Shark	R	R	R	R	R	R	C
TORPEDINIFORMES	ELECTRIC RAYS							
Torpedinidae	Electric Rays							
Tetronarce californica	Pacific Electric Ray	C	C	C	C	C	C	C
RAJIFORMES	SKATES							
Rhinobatidae	Guitarfishes							
Pseudobatos productus	Shovelnose Guitarfish	R	R	R	R	R	R	R
Arhynchobatidae	Softnose Skates							
Bathyraja aleutica	Aleutian Skate	R	R	R	R	R		
Bathyraja kincaidii	Sandpaper Skate	R	R	R	R	C	R	R
Rajidae	Hardnose Skates							
Beringraja binoculata	Big Skate	C	C	C	C	C	C	C
Beringraja inornata	California Skate	C	R	C	C	C	R	R
Beringraja rhina	Longnose Skate	C	R	C	C	C	C	C
Beringraja stellulata	Starry Skate	R	R	C	R	R	C	C
MYLIOBATIFORMES	STINGRAYS							
Platyrhynidae	Thornbacks							
Platyrhinoidis triseriata	Thornback Ray	C	C	R	R	C	C	C
Urotrygonidae	Round Stingrays							
Urobatis helleri	Round Stingray	R	R	R	R	R	R	R
Myliobatis californica	Bat Ray	C	C	C	C	C	C	C
Mobulidae	Devil Rays							
Mobula birostris	Manta	R	R	R				R
Mobula mobular	Spinetail Devil Ray	R	R	R		R	R	R
ACIPENSERIFORMES	STURGEONS							
Acipenseridae	Sturgeons							
Acipenser medirostris	Green Sturgeon	C	C	C	C	C	R	R
Acipenser transmontanus	White Sturgeon	C	C	C	C	C	R	R

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
ALBULIFORMES	BONEFISHES							
Albulidae	Bonefishes							
Albula gilberti	Cortez Bonefish	R	R			R	R	R
ANGUILLIFORMES	EELS							
Ophichthidae	Snake Eels							
Ophichthus triserialis	Pacific Snake Eel	R	R	R	R	R	R	R
Ophichthus zophochir	Yellow Snake Eel	R	R	R	R	R	R	R
Congridae	Conger Eels							
Gnathophis cinctus	Hardtail Conger	R	R	R	R	R	R	R
Nettastomatidae	Duckbill Eels							
Facciolella equatorialis	Dogface Witch Eel	R		R		C	R	R
CLUPEIFORMES	ANCHOVIES AND HERRINGS							
Engraulidae	Anchovies							
Anchoa compressa	Deepbody Anchovy	R	R				R	R
Engraulis mordax	Northern Anchovy	A	A	A	A	A	A	A
Clupeidae	Herrings							
Alosa sapidissima	American Shad	R	R	R	R	R	R	R
Clupea pallasii	Pacific Herring	A	A	A	A	A	A	C
Dorosoma petenense	Threadfin Shad	R	R		R	R	R	R
Etrumeus acuminatus	Pacific Round Herring	R	R	R		R	R	R
Sardinops sagax	Pacific Sardine	A	A	A	C	A	A	A
ARGENTINIFORMES	ARGENTINES							
Argentinidae	Argentines							
Argentina sialis	Pacific Argentine	R	R	R	R	R	R	R
OSMERIFORMES	FRESHWATER SMELTS							
Osmeridae	Smelts							
Allosmerus elongatus	Whitebait Smelt	R	C	C	C	R	R	R
Hypomesus pretiosus	Surf Smelt	C	C	C	C	C	R	R
Spirinchus starksi	Night Smelt	C	C	C	C	C	R	R
Spirinchus thaleichthys	Longfin Smelt	C	C	C	C	C	R	R
Thaleichthys pacificus	Eulachon	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
SALMONIFORMES	SALMON AND TROUTS							
Salmonidae	Salmon and Trouts							
Oncorhynchus gorbuscha	Pink Salmon	R	R	R	R	R	R	R
Oncorhynchus keta	Chum Salmon	R	R	R	R	R	R	R
Oncorhynchus kisutch	Coho Salmon	C	C	C	C	C	R	R
Oncorhynchus mykiss	Steelhead	C	C	C	C	C	R	R
Oncorhynchus nerka	Sockeye Salmon	R	R	R	R	R	R	R
Oncorhynchus tshawytscha	Chinook Salmon	C	C	C	C	C	C	R
AULOPIFORMES	LIZARDFISHES							
Synodontidae	Lizardfishes							
Synodus lucioceps	California Lizardfish	R	R	R	R	R	R	R
Alepisauridae	Lancetfishes							
Alepisaurus ferox	Longnose Lancetfish	R	R	R	R	R	R	R
Lophotidae	Crestfishes							
Lophotus capellei	North Pacific Crestfish	R	R	R	R	R	R	R
GADIFORMES	CODS							
Moridae	Codlings, Deepsea Cods, or Moras							
Physiculus rastrelliger	Hundred-fathom Codling	R	R	R	R	R	R	R
Merlucciidae	Hakes							
Merluccius productus	Pacific Hake	C	R	C	C	C	C	C
Gadidae	Cods							
Gadus chalcogrammus	Walleye Pollock	R	R	R	R	R		
Gadus macrocephalus	Pacific Cod	R	R	R	R	R	R	R
Microgadus proximus	Pacific Tomcod	R	R	R	R	R	R	
Ophidiidae	Cusk-eels							
Chilara taylori	Spotted Cusk-eel	A	A	A	A	A	A	A
Ophidion scrippsae	Basketweave Cusk-eel	R	R	R				R
Bythitidae	Livebearing Brotulas							
Brosmophycis marginata	Red Brotula	R	R	R	R	R	R	R

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BATRACHOIDIFORMES	TOADFISHES							
Batrachoididae	Toadfishes							
Porichthys myriaster	Specklefin Midshipman	R	R	R				R
Porichthys notatus	Plainfin Midshipman	C	C	C	C	C	C	C
LOPHIFORMES	ANGLERFISHES							
Lophiidae	Goosefishes							
Lophiodes caulinaris	Spottedtail Goosefish	R	R	R		R	R	R
Lophiodes spilurus	Threadfin Goosefish	R	R	R		R	R	R
MUGILIFORMES	MULLETS							
Mugilidae	Mullets							
Mugil cephalus	Striped Mullet	R	R	R	R	R	R	R
ATHERINIFORMES	SILVERSIDES							
Atherinopsidae	New World Silversides							
Atherinops affinis	Topsmelt	A	A		A	A	A	A
Atherinopsis californiensis	Jacksmelt	A	A		A	A	A	A
Leuresthes tenuis	California Grunion	C	C		R	C	C	C
Menidia audens	Mississippi Silverside	R	R			R		
BELONIFORMES	NEEDLEFISHES AND RELATIVES							
Exocoetidae	Flyingfishes							
Cheilopogon pinnatibarbatus	Smallhead Flyingfish	R	R	R	R	R	R	R
Belonidae	Needlefishes							
Strongylura exilis	California Needlefish	R	R	R		R	R	R
Scomberesocidae	Sauries							
Cololabis saira	Pacific Saury	C	C	C	C	C	C	C
CYPRINODONTIFORMES	KILLIFISHES AND RELATIVES							
Fundulidae	Topminnows							
Fundulus parvipinnis	California Killifish	R	R				R	R
Lucania parva	Rainwater Killifish	R	R			R		
GASTEROSTEIFORMES	STICKLEBACKS							
Aulorhynchidae	Tubesnouts							
Aulorhynchus flavidus	Tubesnout	A	A	R	A	A	A	A

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Gasterosteidae	Sticklebacks							
Gasterosteus aculeatus	Threespine Stickleback	C	C		A	C		
Syngnathidae	Pipefishes							
Cosmocampus arctus	Snubnose Pipefish	R	R		R	R	R	R
Syngnathus californiensis	Kelp Pipefish	C	C		C	C	C	C
Syngnathus euchrous	Chocolate Pipefish	R	R					R
Syngnathus leptorhynchus	Bay Pipefish	A	A		A	A	A	A
SCORPAENIFORMES	SCORPIONFISHES							
Scorpaenidae	Rockfishes and Thornyheads							
Scorpaena guttata	California Scorpionfish	R	R	R	R	R	C	C
Sebastes aleutianus	Rougheye Rockfish	R		R	R			
Sebastes alutus	Pacific Ocean Perch	R	R	R	R	R	R	R
Sebastes atrovirens	Kelp Rockfish	R	C	R	R	C	C	C
Sebastes auriculatus	Brown Rockfish	R	R	R	R	R	C	C
Sebastes aurora	Aurora Rockfish	R		R	R	R	R	R
Sebastes babcocki	Redbanded Rockfish	R	R	R	R	R	R	R
Sebastes borealis	Shortraker Rockfish	R	R	R	R	R	R	R
Sebastes brevispinis	Silvergray Rockfish	R	R	R	R	R	R	R
Sebastes carnatus	Gopher Rockfish	C	C	C	C	C	C	C
Sebastes caurinus	Copper Rockfish	C	C	C	C	C	C	C
Sebastes chlorostictus	Greenspotted Rockfish	R	R	R	R	R	R	R
Sebastes chrysomelas	Black-and-Yellow Rockfish	C	C	R	R	C	C	C
Sebastes constellatus	Starry Rockfish	C	R	C	R	C	C	C
Sebastes crameri	Darkblotched Rockfish	R	R	R	R	R	R	R
Sebastes crocotulus	Sunset Rockfish	R	R	R		R	R	R
Sebastes dallii	Calico Rockfish	C	R	C		C	C	R
Sebastes diaconus	Deacon Rockfish	C	C	C	C	C	R	R
Sebastes diploproa	Splitnose Rockfish	R		R	R	R	R	R
Sebastes elongatus	Greenstriped Rockfish	R	R	R	R	R	R	R
Sebastes emphaeus	Puget Sound Rockfish	R	R	R	R	R	R	
Sebastes ensifer	Swordspine Rockfish	R		R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Sebastes entomelas	Widow Rockfish	R	R	C	R	R	R	R
Sebastes eos	Pink Rockfish	R		R	R	R	R	R
Sebastes flavidus	Yellowtail Rockfish	C	R	A	C	C	C	C
Sebastes gilli	Bronzespotted Rockfish	R		R	R	R	R	R
Sebastes goodei	Chilipepper	R	R	R	R	R	R	R
Sebastes helvomaculatus	Rosethorn Rockfish	R	R	R	R	R	R	R
Sebastes hopkinsi	Squarespot Rockfish	C	R	C	R	C	C	C
Sebastes jordani	Shortbelly Rockfish	R	R	R	R	R	R	R
Sebastes levis	Cowcod	R		R	R	R	R	R
Sebastes macdonaldi	Mexican Rockfish	R		R		R	R	R
Sebastes maliger	Quillback Rockfish	C	C	C	C	C	R	R
Sebastes melanops	Black Rockfish	C	C	C	C	C	R	R
Sebastes melanostictus	Blackspotted Rockfish	R	R	R	R	R	R	R
Sebastes melanostomus	Blackgill Rockfish	R		R	R	R	R	R
Sebastes miniatus	Vermilion Rockfish	A	A	A	A	A	A	A
Sebastes moseri	Whitespotted Rockfish	R		R		R	R	R
Sebastes mystinus	Blue Rockfish	C	C	C	R	C	C	C
Sebastes nebulosus	China Rockfish	C	C	C	C	C	R	R
Sebastes nigrocinctus	Tiger Rockfish	R	R	R	R	R	R	R
Sebastes ovalis	Speckled Rockfish	R	R	R	R	R	R	R
Sebastes paucispinis	Bocaccio	C	R	C	R	C	C	C
Sebastes pinniger	Canary Rockfish	C	R	C	C	C	R	R
Sebastes proriger	Redstripe Rockfish	R	R	R	R	R	R	R
Sebastes rastrelliger	Grass Rockfish	R	R	R	R	R	R	R
Sebastes reedi	Yellowmouth Rockfish	R		R	R	R		
Sebastes rosaceus	Rosy Rockfish	C	R	C	C	C	C	C
Sebastes rosenblatti	Greenblotched Rockfish	R		R	R	R	R	R
Sebastes ruberrimus	Yelloweye Rockfish	R	R	R	R	R	R	R
Sebastes rubrivinctus	Flag Rockfish	R	R	C	R	R	C	C
Sebastes rufinanus	Dwarf-Red Rockfish	R		R				R
Sebastes rufus	Bank Rockfish	R		R	R	R	R	R

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Sebastes saxicola	Stripetail Rockfish	R	R	R	R	R	R	R
Sebastes semicinctus	Halfbanded Rockfish	C	R	A	R	C	C	C
Sebastes serranoides	Olive Rockfish	A	A	A	C	A	A	A
Sebastes serriceps	Treefish	R	R	R		R	R	R
Sebastes umbrosus	Honeycomb Rockfish	R	R	R		R	R	R
Sebastes wilsoni	Pygmy Rockfish	C	R	A	C	C	C	C
Sebastes zacentrus	Sharpchin Rockfish	R	R	R	R	R	R	R
Sebastolobus alascanus	Shortspine Thornyhead	R	R	R	R	R	R	R
Sebastolobus altivelis	Longspine Thornyhead	R		R	R	R	R	R
Triglidae	Searobins							
Prionotus stephanophrys	Lumptail Searobin	R	R	R	R	R	R	R
Anoplopomatidae	Sablefishes							
Anoplopoma fimbria	Sablefish	R	R	R	R	R	R	R
Zaniolepididae	Combfishes							
Oxylebius pictus	Painted Greenling	C	C	C	C	C	C	C
Zaniolepis frenata	Shortspine Combfish	R	R	C	R	R	R	R
Zaniolepis latipinnis	Longspine Combfish	C	R	C	R	C	C	C
Hexagrammidae	Greenlings							
Hexagrammos decagrammus	Kelp Greenling	C	C	C	C	C	R	R
Hexagrammos lagocephalus	Rock Greenling	C	C	C	C	C	R	R
Hexagrammos stelleri	Whitespotted Greenling	R	R	R	R	R		
Ophiodon elongatus	Lingcod	C	C	C	C	C	C	C
Pleurogrammus monopterygius	Atka Mackerel	R	R	R	R	R	R	R
Jordaniidae	Longfin Sculpins							
Jordania zonope	Longfin Sculpin	R	R	R	R	R	R	R
Paricelinus hopliticus	Thornback Sculpin	R	R	R	R	R	R	R
Scorpaenichthyidae	Cabezon							
Scorpaenichthys marmoratus	Cabezon	C	C	C	C	C	C	C
Rhamphocottidae	Grunt Sculpins							
Rhamphocottus richardsonii	Grunt Sculpin	R	R	R	R	R	R	R
Cottidae	Freshwater Sculpins							

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Cottus aleuticus	Coastrange Sculpin	R	R		R	R	R	
Cottus asper	Prickly Sculpin	R	R	R	R	R	R	R
Leptocottus armatus	Pacific Staghorn Sculpin	C	C	R	C	C	C	C
Psychrolutidae	Marine Sculpins							
Artedius corallinus	Coralline Sculpin	R	R	R	R	C	R	R
Artedius fenestralis	Padded Sculpin	R	R	R	C	R	R	R
Artedius harringtoni	Scalyhead Sculpin	C	C	R	C	C	C	R
Artedius lateralis	Smoothhead Sculpin	C	C	R	C	C	R	R
Artedius notospilotus	Bonyhead Sculpin	R	R	R	R	R	R	R
Ascelichthys rhodorus	Rosylip Sculpin	R	R	R	C	R		
Asemichthys taylori	Spinynose Sculpin	R	R	R	R	R		
Chitonotus pugetensis	Roughback Sculpin	C	C	R	C	C	C	C
Clinocottus acuticeps	Sharpnose Sculpin	R	R	R	R	R		
Clinocottus analis	Woolly Sculpin	A	A		A	A	A	A
Clinocottus embryum	Calico Sculpin	R	R		R	R	R	R
Clinocottus globiceps	Mosshead Sculpin	C	C	R	C	R	R	R
Clinocottus recalvus	Bald Sculpin	C	C		C	C	C	R
Enophrys bison	Buffalo Sculpin	R	R	R	R	R	R	R
Enophrys taurina	Bull Sculpin	R	R	R	R	R	R	R
Icelinus burchami	Dusky Sculpin	R		R	R	R	R	R
Icelinus cavifrons	Pit-Head Sculpin	R	R	R		R	R	R
Icelinus filamentosus	Threadfin Sculpin	R	R	R	R	R	R	R
Icelinus fimbriatus	Fringed Sculpin	R	R	R	R	R	R	R
Icelinus quadriseriatus	Yellowchin Sculpin	R	R	R	R	R	R	R
Icelinus tenuis	Spotfin Sculpin	C	R	C	C	C	C	C
Oligocottus maculosus	Tidepool Sculpin	C	C		A	C	C	R
Oligocottus rimensis	Saddleback Sculpin	C	C		C	C	R	R
Oligocottus rubellio	Rosy Sculpin	R	R	R	R	R	R	R
Oligocottus snyderi	Fluffy Sculpin	C	C		C	C	R	R
Orthonopias triacis	Snubnose Sculpin	C	C		R	C	C	C
Radulinus asprellus	Slim Sculpin	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Radulinus boleoides	Darter Sculpin	R	R	R	R	R	R	R
Radulinus vinculus	Smoothgum Sculpin	R	R	R			R	R
Ruscarius creaseri	Roughcheek Sculpin	R	R	R		R	C	C
Ruscarius meanyi	Puget Sound Sculpin	R	R	R	R			
Synchirus gilli	Manacled Sculpin	C	C		C	C	R	R
Agonidae	Poachers							
Agonomalus mozinoi	Kelp Poacher	R	R		R	R	R	
Agonopsis sterletus	Southern Spearnose Poacher	R	R				R	R
Agonopsis vulsa	Northern Spearnose Poacher	R	R	R	R	R	R	
Anoplagonus inermis	Smooth Alligatorfish	R	R	R	R			
Bathyagonus infraspinatus	Spinycheek Starsnout	R	R	C	R			
Bathyagonus nigripinnis	Blackfin Poacher	R	R	R	R	R	R	
Bathyagonus pentacanthus	Bigeye Poacher	R		R	R	R	R	R
Blepsias cirrhosus	Silverspotted Sculpin	C	C	C	C	C	R	
Bothragonus swanii	Rockhead	R	R		R	R	R	R
Chesnonia verrucosa	Warty Poacher	R	R	R	R	R	R	
Hemilepidotus hemilepidotus	Red Irish Lord	R	R	R	C	R		
Hemilepidotus spinosus	Brown Irish Lord	C	C	C	C	C	R	R
Nautichthys oculofasciatus	Sailfin Sculpin	C	C	C	C	C	R	R
Odontopyxis trispinosa	Pygmy Poacher	C	C	C	C	C	C	C
Pallasina barbata	Tubenose Poacher	R	R	R	R			
Podothecus accipenserinus	Sturgeon Poacher	R	R	R	R			
Stellerina xyosterna	Pricklebreast Poacher	R	R	R	R	R	R	R
Xeneretmus latifrons	Blacktip Poacher	R	R	R	R	R	R	R
Xeneretmus leiops	Smootheye Poacher	R	R	R	R	R	R	R
Xeneretmus triacanthus	Bluespotted Poacher	R	R	R	R	R	R	R
Liparidae	Snailfishes							
Careproctus colletti	Alaska Snailfish	R		R	R	R	R	R
Careproctus cypselurus	Falcate Snailfish	R		R	R	R	R	
Careproctus gilberti	Smalldisk Snailfish	R		R	R	R	R	
Careproctus melanurus	Blacktail Snailfish	R		R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Liparis florae	Tidepool Snailfish	C	C		C	C	R	R
Liparis fucensis	Slipskin Snailfish	R	R	R	C	R	R	
Liparis mucosus	Slimy Snailfish	C	C		C	C	C	C
Liparis pulchellus	Showy Snailfish	C	C	C	C	R		
Lipariscus nanus	Pygmy Snailfish	R		R	R	R		
Nectoliparis pelagicus	Tadpole Snailfish	R	R	R	R	R	R	R
Paraliparis deani	Prickly Snailfish	R	R	R	R	R		
Rhinoliparis barbulifer	Longnose Snailfish	R	R	R	R	R	R	R
PERCIFORMES	PERCHES							
Moronidae	Temperate Basses							
Morone saxatilis	Striped Bass	C	C	C	C	A	C	R
Polyprionidae	Wreckfishes							
Stereolepis gigas	Giant Sea Bass	R	R	R	R	R	R	R
Epinephelidae	Groupers							
Hyporthodus niphobles	Star-Studded Grouper	R	R	R		R	R	R
Mycteroperca xenarcha	Broomtail Grouper	R	R	R		R	R	R
Serranidae	Sea Basses							
Paralabrax clathratus	Kelp Bass	R	R	R	R	R	R	R
Paralabrax maculatofasciatus	Spotted Sand Bass	R	R	R		R	R	R
Paralabrax nebulifer	Barred Sand Bass	R	R	R		R	R	R
Priacanthidae	Bigeyes							
Pristigenys serrula	Popeye Catalufa	R	R	R	R	R	R	R
Malacanthidae	Tilefishes							
Caulolatilus princeps	Ocean Whitefish	R	R	R	R	R	R	R
Carangidae	Jacks							
Caranx caballus	Green Jack	R	R	R	R	R	R	R
Decapterus muroadsi	Amberstripe Scad	R	R	R		R	R	R
Seriola dorsalis	Yellowtail	R	R	R	R	R	R	R
Trachinotus rhodopus	Gafftopsail Pompano	R	R	R			R	R
Trachurus symmetricus	Jack Mackerel	R	R	R	R	R	R	R
Coryphaenidae	Dolphinfishes							

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Coryphaena hippurus	Dolphinfish	R	R	R	R	R	R	R
Echeneidae	Remoras							
Remora albescens	White Suckerfish	R	R	R		R	R	R
Remora australis	Whalesucker	R	R	R	R	R	R	R
Remora remora	Remora	R	R	R	R	R	R	R
Lutjanidae	Snappers							
Lutjanus colorado	Colorado Snapper	R	R	R			R	R
Lutjanus novemfasciatus	Pacific Dog Snapper	R	R	R			R	R
Haemulidae	Grunts							
Anisotremus davidsonii	Sargo	R	R	R		R	R	R
Brachygenys californiensis	Salema	R	R	R		R	R	R
Polynemidae	Threadfins							
Polydactylus approximans	Blue Bobo	R	R	R		R	R	R
Sciaenidae	Drums and Croakers							
Atractoscion nobilis	White Seabass	C	C	C	R	C	C	C
Genyonemus lineatus	White Croaker	A	A	A	C	A	A	A
Menticirrhus undulatus	California Corbina	R	R				R	R
Seriphus politus	Queenfish	R	R	R	R	R	R	R
Kyphosidae	Sea Chubs							
Girella nigricans	Opaleye	C	C	R	R	C	C	C
Kyphosus azureus	Zebraperch	R	R		R	R	R	R
Kyphosus ocyurus	Bluestriped Chub	R	R				R	R
Kyphosus vaigiensis	Brassy Chub	R	R	R		R	R	R
Medialuna californiensis	Halfmoon	R	R		R	R	R	R
Oplegnathidae	Knifejaws							
Oplegnathus fasciatus	Barred Knifejaw	R	R		R	R		
Embiotocidae	Surfperches							
Amphistichus argenteus	Barred Surfperch	C	C	R	R	C	C	C
Amphistichus koelzi	Calico Surfperch	C	C		C	C	C	C
Amphistichus rhodoterus	Redtail Surfperch	R	R		R	R	R	
Brachyistius frenatus	Kelp Perch	C	C	R	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Cymatogaster aggregata	Shiner Perch	A	A	A	A	A	A	A
Embiotoca caryi	Rainbow Seaperch	A	A	A	C	A	A	A
Embiotoca jacksoni	Black Perch	C	C	R	R	C	C	C
Embiotoca lateralis	Striped Seaperch	C	C	R	C	C	C	C
Hyperprosopon argenteum	Walleye Surfperch	C	C	R	R	C	C	C
Hyperprosopon ellipticum	Silver Surfperch	C	C	R	C	C	C	C
Hypocritichthys analis	Spotfin Surfperch	C	C	R	C	C	C	C
Micrometrus aurora	Reef Perch	C	C		R	C	C	C
Micrometrus minimus	Dwarf Perch	C	C	R	R	C	C	C
Phanerodon atripes	Sharpnose Seaperch	R	R	R	R	R	R	R
Phanerodon furcatus	White Seaperch	C	C	C	C	C	C	C
Phanerodon vacca	Pile Perch	C	C	C	C	C	C	C
Rhacochilus toxotes	Rubberlip Seaperch	C	C	C	R	C	C	C
Zalembius rosaceus	Pink Seaperch	C	R	C	R	C	C	C
Pomacentridae	Damselfishes							
Chromis punctipinnis	Blacksmith	R	R	R		R	R	R
Hypsypops rubicundus	Garibaldi	R	R	R		R	R	C
Labridae	Wrasses							
Bodianus pulcher	California Sheephead	R	R	R		R	R	R
Halichoeres californicus	Señorita	C	C	C	R	C	C	C
Halichoeres semicinctus	Rock Wrasse	R	R	R		R	R	R
Bathymasteridae	Ronquils							
Ronquilus jordani	Northern Ronquil	R	R	R	R	R	R	R
Zoarcidae	Eelpouts							
Bothrocara molle	Soft Eelpout	R		R	R	R	R	R
Eucryphycus californicus	Persimmon Eelpout	R		R		R	R	R
Lycenchelys crotalinus	Snakehead Eelpout	R		R	R	R	R	R
Lycodes brevipes	Shortfin Eelpout	R	R	R	R	R	R	
Lycodes cortezianus	Bigfin Eelpout	R	R	R	R	R	R	R
Lycodes diapterus	Black Eelpout	R	R	R	R	R	R	R
Lycodes pacificus	Blackbelly Eelpout	C	R	C	C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Lyconema barbatum	Bearded Eelpout	R		R	R	R	R	R
Stichaeidae	Pricklebacks							
Anoplarchus insignis	Slender Cockscomb	R	R	R	R			
Anoplarchus purpurescens	High Cockscomb	A	A	R	A	A	A	C
Cebidichthys violaceus	Monkeyface Prickleback	C	C	R	C	C	C	R
Chirolophis decoratus	Decorated Warbonnet	R	R	R	R	R		
Chirolophis nugator	Mosshead Warbonnet	C	C	C	C	C	R	R
Ernogrammus walkeri	Masked Prickleback	R	R			R	R	R
Esselenichthys carli	Threeline Prickleback	R	R			R	R	R
Esselenichthys laurae	Twoline Prickleback	R	R	R		R	R	R
Kasatkia seigeli	Sixspot Prickleback	R	R		R	R	R	
Lumpenus sagitta	Snake Prickleback	R	R	R	R	R		
Phytichthys chirus	Ribbon Prickleback	R	R			R	R	R
Plectobranchus evides	Bluebarred Prickleback	R		R	R	R	R	R
Poroclinus rothrocki	Whitebarred Prickleback	R		R	R	R	R	R
Xiphister atropurpureus	Black Prickleback	C	C		C	C	R	R
Xiphister mucosus	Rock Prickleback	C	C		C	C	R	R
Cryptacanthodidae	Wrymouths							
Cryptacanthodes giganteus	Giant Wrymouth	R	R	R	R			
Pholidae	Gunnels							
Apodichthys flavidus	Penpoint Gunnel	A	A		A	A	C	C
Apodichthys fucorum	Rockweed Gunnel	A	A		A	A	A	A
Pholis clemensi	Longfin Gunnel	R	R	R	R	R		
Pholis laeta	Crescent Gunnel	R	R	R	R			
Pholis ornata	Saddleback Gunnel	R	R	R	R	R	R	R
Pholis schultzi	Red Gunnel	R	R	R	R	R	R	
Ulvicola sanctaerosae	Kelp Gunnel	R	R			R	R	R
Anarhichadidae	Wolffishes							
Anarrhichthys ocellatus	Wolf-Eel	C	C	C	C	C	R	R
Zaproridae	Prowfishes							
Zaprora silenus	Prowfish	R	R	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Scytalinidae	Graveldivers							
Scytalina cerdale	Graveldiver	R	R		R	R	R	
Trichodontidae	Sandfishes							
Trichodon trichodon	Pacific Sandfish	R	R	R	R			
Ammodytidae	Sand Lances							
Ammodytes personatus	Pacific Sand Lance	C	C	C	A	C	C	C
Uranoscopidae	Stargazers							
Kathetostoma averruncus	Smooth Stargazer	R	R	R		R	R	R
Blenniidae	Combtooth Blennies							
Hypsoblennius gentilis	Bay Blenny	R	R			R	R	R
Hypsoblennius gilberti	Rockpool Blenny	R	R			R	R	R
Hypsoblennius jenkinsi	Mussel Blenny	R	R			R	R	R
Clinidae	Kelp Blennies							
Gibbonsia elegans	Spotted Kelpfish	C	C	R	C	C	A	A
Gibbonsia metzi	Striped Kelpfish	R	R		R	R	R	R
Gibbonsia montereyensis	Crevice Kelpfish	C	C	R	C	C	R	R
Heterostichus rostratus	Giant Kelpfish	R	R	R	R	R	R	R
Labrisomidae	Labrisomid Blennies							
Alloclinus holderi	Island Kelpfish	R	R	R				C
Cryptotrema corallinum	Deepwater Blenny	R	R	R				C
Chaenopsidae	Tube Blennies							
Neoclinus blanchardi	Sarcastic Fringehead	R	R	R	R	R	R	R
Neoclinus stephensae	Yellowfin Fringehead	C	C			C	C	C
Neoclinus uninotatus	Onespot Fringehead	C	C	R	R	C	C	C
Icosteidae	Ragfishes							
Icosteus aenigmaticus	Ragfish	R	R	R	R	R	R	R
Gobiesocidae	Clingfishes							
Gobiesox maeandricus	Northern Clingfish	C	C		C	C	R	R
Gobiesox rhessodon	California Clingfish	R	R				R	R
Rimicola eigenmanni	Slender Clingfish	R	R					R
Rimicola muscarum	Kelp Clingfish	C	C		C	C	C	C

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Gobiidae	Gobies							
Acanthogobius flavimanus	Yellowfin Goby	R	R		R	C	R	R
Clevelandia ios	Arrow Goby	C	C	R	C	C	C	C
Eucyclogobius newberryi	Northern Tidewater Goby	R	R		R	R	R	R
Gillichthys mirabilis	Longjaw Mudsucker	C	C		R	C	C	C
Ilypnus gilberti	Cheekspot Goby	R	R		R	R	R	R
Lepidogobius lepidus	Bay Goby	C	C	C	C	C	C	C
Lethops connectens	Halfblind Goby	R	R			R	R	R
Lythrypnus dalli	Bluebanded Goby	R	R	R	R	R	R	R
Lythrypnus zebra	Zebra Goby	R	R	R		R	R	R
Quietula y-cauda	Shadow Goby	R	R				R	R
Rhinogobiops nicholsii	Blackeye Goby	A	A	A	A	A	A	A
Tridentiger barbatus	Shokihaze Goby	R	R			R		
Tridentiger trigonocephalus	Chameleon Goby	R	R			R		
Typhlogobius californiensis	Blind Goby	R	R				R	R
Sphyraenidae	Barracudas							
Sphyraena argentea	Pacific Barracuda	R	R	R	R	R	C	C
Scombridae	Mackerels							
Auxis rochei	Bullet Tuna	R	R	R		R	R	R
Euthynnus affinis	Kawakawa	R	R	R			R	R
Euthynnus lineatus	Black Skipjack	R	R	R			R	R
Sarda chiliensis	Pacific Bonito	R	R	R	R	R	C	C
Scomber japonicus	Pacific Chub Mackerel	C	C	C	C	C	C	C
Scomberomorus concolor	Gulf Sierra	R	R	R		R	R	R
Stromateidae	Butterfishes							
Peprilus simillimus	Pacific Pompano	R	R	R	R	R	C	C
PLEURONECTIFORMES	FLATFISHES							
Paralichthyidae	Sand Flounders							
Citharichthys sordidus	Pacific Sanddab	A	A	A	A	A	A	A
Citharichthys stigmaeus	Speckled Sanddab	C	C	C	C	C	C	C
Citharichthys xanthostigma	Longfin Sanddab	R	R	R		R	R	R
Hippoglossina stomata	Bigmouth Sole	R	R	R		R	R	R

Taxon	Common Name	Overall	Core	Seaward	CMPR	PRPS	PSPA	PAS
Paralichthys californicus	California Halibut	C	C	C	R	C	C	C
Xystreurys liolepis	Fantail Sole	R	R	R		R	R	R
Pleuronectidae	Righteye Flounders							
Atheresthes evermanni	Kamchatka Flounder	R	R	R	R	R		
Atheresthes stomias	Arrowtooth Flounder	R	R	R	R	R	R	R
Eopsetta jordani	Petrale Sole	R	R	R	R	R	R	R
Glyptocephalus zachirus	Rex Sole	R	R	R	R	R	R	R
Hippoglossoides elassodon	Flathead Sole	R	R	R	R			
Hippoglossus stenolepis	Pacific Halibut	R	R	R	R	R	R	R
Isopsetta isolepis	Butter Sole	R	R	R	R	R	R	R
Lepidopsetta bilineata	Southern Rock Sole	R	R	R	R	R	R	R
Lyopsetta exilis	Slender Sole	R	R	R	R	R	R	R
Microstomus bathybius	Deepsea Sole	R		R	R	R	R	R
Microstomus pacificus	Dover Sole	R	R	R	R	R	R	R
Parophrys vetulus	English Sole	C	C	C	C	C	C	C
Platichthys stellatus	Starry Flounder	C	C	C	C	C	C	R
Pleuronichthys coenosus	C-O Sole	C	C	R	C	C	C	C
Pleuronichthys decurrens	Curlfin Sole	C	R	C	C	C	C	C
Pleuronichthys guttulatus	Diamond Turbot	C	C	R	R	C	C	C
Pleuronichthys ritteri	Spotted Turbot	R	R	R	R	R	R	R
Pleuronichthys verticalis	Hornyhead Turbot	C	C	C	R	C	C	C
Psettichthys melanostictus	Sand Sole	C	C	C	C	C	R	R
Reinhardtius hippoglossoides	Greenland Halibut	R	R	R	R	R	R	R
Cynoglossidae	Tonguefishes							
Symphurus atricauda	California Tonguefish	C	C	C	C	C	C	C
TETRADONTIFORMES	PUFFERFISHES AND RELATIVES							
Balistidae	Triggerfishes							
Balistes polylepis	Finescale Triggerfish	R	R	R	R	R	R	R
Ostraciidae	Boxfishes							
Lactoria diaphana	Spiny Boxfish	R	R	R			R	R
Diodontidae	Porcupinefishes							
Diodon holocanthus	Balloonfish	R	R	R		R	R	R

APPENDIX 10

Depth and Habitat Associations of Documented Fishes in the Central California Ecoregion

These associations are based on Ebert (2002), Love et al. (2005), Love (2011), Butler et al. (2012), Kells et al. (2016), and a review of primary literature, fishery-independent survey catches, and museum records. Included in the following table is the vertical zonation, which is classified as Benthic (benthic and demersal), Midwater, Pelagic, and WC (meaning, found throughout the water column). The table also lists the depth range in meters (i.e., the minimum [Min] and maximum [Max]) and the common depth in meters. For each seafloor habitat (mud, sand, gravel, shell, etc.) a numeral indicates whether it is a primary or secondary habitat: 1 = primary habitat or similar utilization of habitat types for generalist species. 2 = secondary habitat. Gravel includes pebbles. SFMI stands for structure-forming marine invertebrates.

Habitat associations are for combined juvenile and adult life stages. Only benthic habitat associations are indicated. Fishes are primarily marine with the following exceptions: Exotic = non-native species and FW = freshwater usage (X = yes, A = anadromous). S = surface depth. 0 = bottom depth.

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
MYXINIFORMES	HAGFISHES																
Myxinidae	Hagfishes																
Eptatretus deani	Black Hagfish			Benthic	52–2743	600–1200	1		2								
Eptatretus stoutii	Pacific Hagfish			Benthic	16–1247	91–366	1						2				2
PETROMYZONTIFORMES	LAMPREYS																
Petromyzontidae	Lampreys																
Entosphenus tridentatus	Pacific Lamprey		A	WC	16–1508	< 500											
Lampetra ayresii	Western River Lamprey		A	Pelagic	S–119												
CHIMAERIFORMES	CHIMAERAS																
Chimaeridae	Shortnose Chimaeras																
Hydrolagus colliei	Spotted Ratfish			Benthic	0–1593	50–400	1	1	1		1	1	1				
Hydrolagus melanophasma	Eastern Pacific Black Ghostshark			Benthic	31–1903		1				2						
HETERODONTIFORMES	HORN SHARKS																
Heterodontidae	Horn Sharks																
Heterodontus francisci	Horn Shark			Benthic	0–201			1					1	1	1	2	2

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
ORECTOLOBIFORMES	CARPET SHARKS																
Rhincodontidae	Whale Sharks																
Rhincodon typus	Whale Shark			Pelagic	S–1928												
LAMNIFORMES	MACKEREL SHARKS																
Alopiidae	Thresher Sharks																
Alopias vulpinus	Common Thresher Shark			Pelagic	S–650												
Cetorhinidae	Basking Sharks																
Cetorhinus maximus	Basking Shark			Pelagic	S–1501												
Lamnidae	Mackerel Sharks																
Carcharodon carcharias	White Shark			WC	0–1200												
Isurus oxyrinchus	Shortfin Mako			Pelagic	S–888												
Lamna ditropis	Salmon Shark			Pelagic	S–1864												
CARCHARHINIFORMES	GROUND SHARKS																
Scyliorhinidae	Cat Sharks																
Apristurus brunneus	Brown Cat Shark			Benthic, Midwater	24–1401	> 200	1	1					2				
Cephaloscyllium ventriosum	Swell Shark			Benthic	5–457	5-40							1	1	1		
Parmaturus xaniurus	Filetail Cat Shark			Benthic, Midwater	88–1519	> 200	1	1					2				
Triakidae	Hound Sharks																
Galeorhinus galeus	Soupfin Shark			WC	0–826												
Mustelus californicus	Gray Smoothhound			Benthic	0–265		1	1								2	
Mustelus henlei	Brown Smoothhound			Benthic, WC	0–369		1	1									
Triakis semifasciata	Leopard Shark			Benthic	0–156		1	1					1		1	2	
Carcharhinidae	Requiem Sharks																
Prionace glauca	Blue Shark			Pelagic	S–1136												
Sphyrnidae	Hammerhead Sharks																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Sphyrna zygaena	Smooth Hammerhead			Pelagic	S–200												
HEXANCHIFORMES	SIX-GILL SHARKS																
Hexanchidae	Cow Sharks																
Hexanchus griseus	Bluntnose Sixgill Shark			Benthic, WC	10–2490	> 91	1	1	1		1	1	1				
Notorynchus cepedianus	Broadnose Sevengill Shark			Benthic	1–570	< 50	2	2					1	1			
ECHINORHINIFORMES	BRAMBLE SHARKS																
Echinorhinidae	Bramble Sharks																
Echinorhinus cookei	Prickly Shark			Benthic	4–1100	100-650	1	1									
SQUALIFORMES	DOGFISH SHARKS																
Squalidae	Dogfish Sharks																
Squalus suckleyi	Pacific Spiny Dogfish			WC, Benthic	0–1460	10-250	1	1	1		1	1	1			1	
Somniosidae	Sleeper Sharks																
Somniosus pacificus	Pacific Sleeper Shark			Benthic, WC	0–2205		1	2					2				
SQUATINIFORMES	ANGEL SHARKS																
Squatinidae	Angel Sharks																
Squatina californica	Pacific Angel Shark			Benthic, Midwater	0–205		1	1					2		2	2	
TORPEDINIFORMES	ELECTRIC RAYS																
Torpedinidae	Electric Rays																
Tetronarce californica	Pacific Electric Ray			Benthic, Midwater	0–406	60-200	1	1				2	1		2		
RAJIFORMES	SKATES																
Rhinobatidae	Guitarfishes																
Pseudobatos productus	Shovelnose Guitarfish			Benthic	0–91	< 12	1	1							2	2	
Arhynchobatidae	Softnose Skates																
Bathyraja aleutica	Aleutian Skate			Benthic	15–1602		1										
Bathyraja kincaidii	Sandpaper Skate			Benthic	18–1372	200–500	1	2			2	2	2				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Rajidae	Hardnose Skates																
Beringraja binoculata	Big Skate			Benthic	2–501	< 100	1	1	2	2							
Beringraja inornata	California Skate			Benthic	3–300	< 120	1	1									
Beringraja rhina	Longnose Skate			Benthic	9–1294	200–400	1	1	1		2		2				
Beringraja stellulata	Starry Skate			Benthic	2–400	80-140	2	1					1				
MYLIOBATIFORMES	STINGRAYS																
Platyrhynidae	Thornbacks																
Platyrhinoidis triseriata	Thornback Ray			Benthic	0–137	< 28	1	1							2	2	
Urotrygonidae	Round Stingrays																
Urobatis helleri	Round Stingray			Benthic	0–91	< 28	1	1					1			1	
Myliobatis californica	Bat Ray			Benthic, WC	0–176	< 50	1	1					2		2	2	
Mobulidae	Devil Rays																
Mobula birostris	Manta			Pelagic	S–1000												
Mobula mobular	Spinetail Devil Ray			Pelagic	S–700												
ACIPENSERIFORMES	STURGEONS																
Acipenseridae	Sturgeons																
Acipenser medirostris	Green Sturgeon		A	Benthic	168		1	1	1		1	1	1				
Acipenser transmon-tanus	White Sturgeon		A	Benthic	122	< 50	1	1	1		1	1	1				
ALBULIFORMES	BONEFISHES																
Albulidae	Bonefishes																
Albula gilberti	Cortez Bonefish			Benthic	0–27		1	1								1	
ANGUILLIFORMES	EELS																
Ophichthidae	Snake Eels																
Ophichthus triserialis	Pacific Snake Eel			Benthic	0–155		1	1									
Ophichthus zophochir	Yellow Snake Eel			Benthic, WC	0–110		1	1					1				
Congridae	Conger Eels																
Gnathophis cinctus	Hardtail Conger			Benthic	9–366		1	1									
Nettastomatidae	Duckbill Eels																
Facciolella equatorialis	Dogface Witch Eel			Benthic	64–1000		1										

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
CLUPEIFORMES	ANCHOVIES AND HERRINGS																
Engraulidae	Anchovies																
Anchoa compressa	Deepbody Anchovy			Pelagic	S/0–19	< 12											
Engraulis mordax	Northern Anchovy			Pelagic	S/0–528												
Clupeidae	Herrings																
Alosa sapidissima	American Shad	X	A	Pelagic	S–250												
Clupea pallasii	Pacific Herring			Pelagic	S–250	< 150											
Dorosoma petenense	Threadfin Shad	X	FW	Pelagic	S–20												
Etrumeus acuminatus	Pacific Round Herring			Pelagic	S–200	< 12											
Sardinops sagax	Pacific Sardine			Pelagic	S/0–383												
ARGENTINIFORMES	ARGENTINES																
Argentinidae	Argentines																
Argentina sialis	Pacific Argentine			Benthic	11–1093	170-220	1	1									
OSMERIFORMES	FRESHWATER SMELTS																
Osmeridae	Smelts																
Allosmerus elongatus	Whitebait Smelt			Pelagic	S–495												
Hypomesus pretiosus	Surf Smelt			Benthic, Pelagic	0–185	< 50									1	1	
Spirinchus starksi	Night Smelt			Pelagic	S/0–128												
Spirinchus thaleichthys	Longfin Smelt		A	Pelagic	S/0–137												
Thaleichthys pacificus	Eulachon		A	WC, Benthic	10–400	20–150	1	1	2		2						
SALMONIFORMES	SALMON AND TROUTS																
Salmonidae	Salmon and Trouts																
Oncorhynchus gorbus-cha	Pink Salmon		A	Pelagic	S–74	< 10											
Oncorhynchus keta	Chum Salmon		A	Pelagic	S–253	< 10											

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Oncorhynchus kisutch	Coho Salmon		A	Pelagic	S–97	< 10											
Oncorhynchus mykiss	Steelhead		A, FW	Pelagic	S	< 20											
Oncorhynchus nerka	Sockeye Salmon		A	Pelagic	S–83	< 10											
Oncorhynchus tshawytscha	Chinook Salmon		A	Pelagic, WC	S–538	< 150											
AULOPIFORMES	LIZARDFISHES																
Synodontidae	Lizardfishes																
Synodus lucioceps	California Lizard-fish			Benthic	1–250		1	1	2			2	2				
Alepisauridae	Lancetfishes																
Alepisaurus ferox	Longnose Lan-cetfish			Pelagic, Midwa-ter	5–1830												
Lophotidae	Crestfishes																
Lophotus capellei	North Pacific Crestfish			Pelagic, Benthic	S/0–1100												
GADIFORMES	CODS																
Moridae	Codlings, Deep-sea Cods, or Moras																
Physiculus rastrelliger	Hundred-Fathom Codling			Benthic	21–1369								1				
Merlucciidae	Hakes																
Merluccius productus	Pacific Hake			Pelagic, Benthic	12–1437	50–450											
Gadidae	Cods																
Gadus chalcogrammus	Walleye Pollock			Benthic, Pelagic	0–1280	30–400	1	1	2		2	2	2				
Gadus macrocephalus	Pacific Cod			Benthic, Pelagic	0–1280	< 300	1	1	2		1	2	2		1	1	1
Microgadus proximus	Pacific Tomcod			Benthic, Pelagic	0–310	< 100	1	1							2	2	
Ophidiidae	Cusk-eels																
Chilara taylori	Spotted Cusk-Eel			Benthic	0–1128	30-190	1	1									
Ophidion scrippsae	Basketweave Cusk-Eel			Benthic	2–1098	< 110	1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Bythitidae	Livebearing Bro-tulas																
Brosmophycis margi-nata	Red Brotula			Benthic	3–256								1				
BATRACHOIDIFORMES	TOADFISHES																
Batrachoididae	Toadfishes																
Porichthys myriaster	Specklefin Mid-shipman			Benthic	0–126	< 60	1	1					1				
Porichthys notatus	Plainfin Midship-man			Benthic, Pelagic	0–464	< 250	1	1								2	
LOPHIFORMES	ANGLERFISHES																
Lophiidae	Goosefishes																
Lophiodes caulinaris	Spottedtail Goosefish			Benthic	15–888		1	1									
Lophiodes spilurus	Threadfin Goosefish			Benthic	55–850		1	1									
MUGILIFORMES	MULLETS																
Mugilidae	Mullets																
Mugil cephalus	Striped Mullet		FW	Benthic, WC	0–122		1	1									
ATHERINIFORMES	SILVERSIDES																
Atherinopsidae	New World Silver-sides																
Atherinops affinis	Topsmelt			Pelagic	S/0–26												
Atherinopsis californ-iensis	Jacksmelt			Pelagic	S/0–29												
Leuresthes tenuis	California Grun-ion			WC	0–18												
Menidia audens	Mississippi Sil-verside	X	FW	Pelagic	S												
BELONIFORMES	NEEDLEFISHES AND RELATIVES																
Exocoetidae	Flyingfishes																
Cheilopogon pinnati-barbatus	Smallhead Fly-ingfish			Pelagic	S–10												
Belonidae	Needlefishes																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Strongylura exilis	California Needlefish		FW	Pelagic	S/0–100												
Scomberesocidae	Sauries																
Cololabis saira	Pacific Saury			Pelagic	S/0–295												
CYPRINODONTIFORMES	KILLIFISHES AND RELATIVES																
Fundulidae	Topminnows																
Fundulus parvipinnis	California Killifish		FW	WC	S–10	< 3											
Lucania parva	Rainwater Killifish	X	FW	WC	S–10												
GASTEROSTEIFORMES	STICKLEBACKS																
Aulorhynchidae	Tubesnouts																
Aulorhynchus flavidus	Tubesnout			WC	0–40	< 20		1					1		1	1	
Gasterosteidae	Sticklebacks																
Gasterosteus aculeatus	Threespine Stickleback		A, FW	WC, Benthic	0–27		1	1					2		2	2	
Syngnathidae	Pipefishes																
Cosmocampus arctus	Snubnose Pipefish			Benthic	0–20								1	1			
Syngnathus californiensis	Kelp Pipefish			WC, Benthic	0–15	< 12									1	2	
Syngnathus euchrous	Chocolate Pipefish			Benthic, WC	0–18								1	1		1	
Syngnathus leptorhynchus	Bay Pipefish			WC, Benthic	0–18	< 3	2	2	2					2	2	1	
SCORPAENIFORMES	SCORPIONFISHES																
Scorpaenidae	Rockfishes and Thornyheads																
Scorpaena guttata	California Scorpionfish			Benthic, WC	0–266	10-85	2	2		2			1	2	2	2	2
Sebastes aleutianus	Rougheye Rockfish			Benthic	45–765	200–500						1	1				
Sebastes alutus	Pacific Ocean Perch			Benthic, WC	70–1125	100–400	1	1			1	1	1				1
Sebastes atrovirens	Kelp Rockfish			WC	3–114	2-30							1		1		

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Sebastes auriculatus	Brown Rockfish			Benthic	0–287		2	2		2			1	2		2	
Sebastes aurora	Aurora Rockfish			Benthic	81–1176	300-500	1	2					1				
Sebastes babcocki	Redbanded Rockfish			Benthic	21–1150	150-450	2		2		2		1				
Sebastes borealis	Shortraker Rockfish			Benthic	25–1200	300-500	2	2				1	1				
Sebastes brevispinis	Silvergray Rock-fish			Benthic	17–622	100-300	2	2			2	1	1		2		
Sebastes carnatus	Gopher Rockfish			Benthic	0–88	12-50							1		1	2	
Sebastes caurinus	Copper Rockfish			Benthic	0–408	5–70	2	2				1	1				
Sebastes chlorostictus	Greenspotted Rockfish			Benthic	30–431	80-200	2	2				1	1				2
Sebastes chrysomelas	Black-and-Yellow Rockfish			Benthic	0–37	2-15							1		1		
Sebastes constellatus	Starry Rockfish			Benthic	15–274	40-160					2	1	1				2
Sebastes crameri	Darkblotched Rockfish			Benthic	29–915	140-210	1	2			1	1	1				2
Sebastes crocotulus	Sunset Rockfish			Benthic	30-439	> 100							1				
Sebastes dallii	Calico Rockfish			Benthic	0–305	45-70	2	2					1				2
Sebastes diaconus	Deacon Rockfish			WC	8–72	< 50							1				
Sebastes diploproa	Splitnose Rock-fish			Benthic	50–1050	150–450	1			2			2				
Sebastes elongatus	Greenstriped Rockfish			Benthic	12–1151	100–300	1	1		1	1	1	1				
Sebastes emphaeus	Puget Sound Rockfish			Benthic	3–470	10–366						1	1		1		
Sebastes ensifer	Swordspine Rockfish			Benthic	50–433	90-140	2				1	1	1				2
Sebastes entomelas	Widow Rockfish			Benthic, WC	0–800	30-200					2		1	2	2		
Sebastes eos	Pink Rockfish			Benthic	45–366	200-350						1	1				
Sebastes flavidus	Yellowtail Rock-fish			WC	0–549	90–180						1	1	2	1	2	
Sebastes gilli	Bronzespotted Rockfish			Benthic	75–413	130-250						1	1				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Sebastes goodei	Chilipepper			Benthic, Midwater	30–515	75-325	2	2					1		2		
Sebastes helvomaculatus	Rosethorn Rockfish			Benthic	27–1151	80-350	2				2	2	1				
Sebastes hopkinsi	Squarespot Rockfish			Benthic, Midwater	15–305	55-115					2	1	1				
Sebastes jordani	Shortbelly Rockfish			Benthic	26–515	150-270	1	1				2	1		2		
Sebastes levis	Cowcod			Benthic	40–522	130-215	2	2			2	1	1				2
Sebastes macdonaldi	Mexican Rockfish			Benthic	73–354								1				
Sebastes maliger	Quillback Rockfish			Benthic	0–398	10-140							1		1	1	1
Sebastes melanops	Black Rockfish			WC	0–366	< 75							1	2	1	2	
Sebastes melanostictus	Blackspotted Rockfish			Benthic	25–1000	350-450	2	2				1	1				
Sebastes melanostomus	Blackgill Rockfish			Benthic	88–768	200-600	1	2				1	1				2
Sebastes miniatus	Vermilion Rockfish			Benthic	12–478	< 100	2	2			1	1	1				
Sebastes moseri	Whitespotted Rockfish			Benthic	50–274	80-200					2		1				
Sebastes mystinus	Blue Rockfish			WC, Benthic	0–156	2-55							1		1		
Sebastes nebulosus	China Rockfish			Benthic	3–177	10–100		2			2	1	1		1	2	2
Sebastes nigrocinctus	Tiger Rockfish			Benthic	2–298	> 30						1	1				
Sebastes ovalis	Speckled Rockfish			Benthic	30–366						2	1	1				
Sebastes paucispinis	Bocaccio			Benthic, WC	20–475							1	1		1		
Sebastes pinniger	Canary Rockfish			Benthic, WC	18–458	80-200	2				2	1	1				
Sebastes proriger	Redstripe Rockfish			Benthic	4–550	55-300	2	2	1		1	1	1				
Sebastes rastrelliger	Grass Rockfish			Benthic	0–68	0-15							1	1	1	1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Sebastes reedi	Yellowmouth Rockfish			Benthic	52–585							1	1				
Sebastes rosaceus	Rosy Rockfish			Benthic	7–328		2	2			1	1	1				2
Sebastes rosenblatti	Greenblotched Rockfish			Benthic	55–500		2					1	1				
Sebastes ruberrimus	Yelloweye Rockfish			Benthic	11–732	90–180						1	1				
Sebastes rubrivinctus	Flag Rockfish			Benthic	30–431						2	1	1		1		
Sebastes rufinanus	Dwarf-Red Rockfish			Benthic	58–220						1	1	1				
Sebastes rufus	Bank Rockfish			Benthic	31–512	90-360	2				2	1	1				2
Sebastes saxicola	Stripetail Rockfish			Benthic	25–547	100-200	1	1		1	1		1				1
Sebastes semicinctus	Halfbanded Rockfish			Benthic	15–440		2	1			1	2	1	2	2		2
Sebastes serranoides	Olive Rockfish			Benthic, WC	0–172	< 55							1		2	2	
Sebastes serriceps	Treefish			Benthic	0–103	< 50						1	1		1		
Sebastes umbrosus	Honeycomb Rockfish			Benthic	18–270	30-90					1	1	2				
Sebastes wilsoni	Pygmy Rockfish			Benthic	29–391	200-300	1	1			1	1	1				1
Sebastes zacentrus	Sharpchin Rockfish			Benthic	25–660	200-300	1			1	1	1	1				1
Sebastolobus alascanus	Shortspine Thornyhead			Benthic	17–1524	200-800	1		2		2		2				2
Sebastolobus altivelis	Longspine Thornyhead			Benthic	72–1756	500-1300	1						2				2
Triglidae	Searobins																
Prionotus stephanophrys	Lumptail Searobin			Benthic	2–255	10-100	2	1									
Anoplopomatidae	Sablefishes																
Anoplopoma fimbria	Sablefish			Benthic, Pelagic	12–2740	300-1000	1				2	2					
Zaniolepididae	Combfishes																
Oxylebius pictus	Painted Greenling			Benthic	0–249	< 50	2	2				1	1				2

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Zaniolepis frenata	Shortspine Combfish			Benthic, Midwater	7–450	100-215	1	2	1		1						
Zaniolepis latipinnis	Longspine Combfish			Benthic, Midwater	16–421	50-205	1	2					2				
Hexagrammidae	Greenlings																
Hexagrammos decagrammus	Kelp Greenling			Benthic	0–303	0-100							1	1	1	1	
Hexagrammos lagocephalus	Rock Greenling			Benthic	0–80	0-20					1		1	1	1	1	
Hexagrammos stelleri	Whitespotted Greenling			Benthic	0–305	< 100		1					1	1	1	1	
Ophiodon elongatus	Lingcod			Benthic	0–750	30-200	1	1		1		1	1		1	1	1
Pleurogrammus monopterygius	Atka Mackerel			Benthic, WC	0–720	< 225							1				
Jordaniidae	Longfin Sculpins																
Jordania zonope	Longfin Sculpin			Benthic	0–497	10–40							1		1		1
Paricelinus hopliticus	Thornback Sculpin			Benthic	16–352	> 76							1				
Scorpaenichthyidae	Cabezon																
Scorpaenichthys marmoratus	Cabezon			Benthic	0–226	< 73	2				2		1		2	2	
Rhamphocottidae	Grunt Sculpins																
Rhamphocottus richardsonii	Grunt Sculpin			Benthic	0–258	< 10		2		2			1	2			
Cottidae	Freshwater Sculpins																
Cottus aleuticus	Coastrange Sculpin		FW	Benthic				1	1		1						
Cottus asper	Prickly Sculpin		FW	Benthic	< 92			1	1		1	1					
Leptocottus armatus	Pacific Staghorn Sculpin		FW	Benthic	0–335	< 10	1	1		1						1	
Psychrolutidae	Marine Sculpins																
Artedius corallinus	Coralline Sculpin			Benthic	0–70							1	1	1			
Artedius fenestralis	Padded Sculpin			Benthic	0–122	< 10	2	2	2		2	2	1		2	2	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Artedius harringtoni	Scalyhead Sculpin			Benthic	0–40						1		1	1		1	1
Artedius lateralis	Smoothhead Sculpin			Benthic	0–70	0-10		1	1		1		1	1		1	
Artedius notospilotus	Bonyhead Sculpin			Benthic	0–52								1	1			
Ascelichthys rhodorus	Rosylip Sculpin			Benthic	0–15	0-5	1	1	1				1	1	1	1	
Asemichthys taylori	Spinynose Sculpin			Benthic	0–212			1		1			2				
Chitonotus pugetensis	Roughback Sculpin			Benthic	0–329		1	1	2				2			2	
Clinocottus acuticeps	Sharpnose Sculpin		FW	Benthic	0–114	< 1		1	1		1	1	1	1		1	
Clinocottus analis	Woolly Sculpin			Benthic	0–18	< 2		1	1		1		1	1			
Clinocottus embryum	Calico Sculpin			Benthic	0–2					1			1	1			
Clinocottus globiceps	Mosshead Sculpin			Benthic	0–44						2		1				
Clinocottus recalvus	Bald Sculpin			Benthic	0–2								1				
Enophrys bison	Buffalo Sculpin			Benthic	0–194	< 45		1	1		1		1	1	1	1	1
Enophrys taurina	Bull Sculpin			Benthic	11–439		1	1									
Icelinus burchami	Dusky Sculpin			Benthic	61–622		1	1					2				2
Icelinus cavifrons	Pit-Head Sculpin			Benthic	11–110		1	1					2				
Icelinus filamentosus	Threadfin Sculpin			Benthic	18–482		1	1	1								
Icelinus fimbriatus	Fringed Sculpin			Benthic	30–265		1	1					2				
Icelinus quadriseriatus	Yellowchin Sculpin			Benthic	0–201	20-100	1	1									
Icelinus tenuis	Spotfin Sculpin			Benthic	7–375	60–100	1	1		1			2				
Oligocottus maculosus	Tidepool Sculpin			Benthic	0–9			1			1		1	1		1	1
Oligocottus rimensis	Saddleback Sculpin			Benthic	0–21				1				1	1	1	1	
Oligocottus rubellio	Rosy Sculpin			Benthic	0–34								1	1			
Oligocottus snyderi	Fluffy Sculpin			Benthic	0–6			2			1		1	1		1	
Orthonopias triacis	Snubnose Sculpin			Benthic	0–30	5-21							1	1			

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Radulinus asprellus	Slim Sculpin			Benthic	9–699		1										
Radulinus boleoides	Darter Sculpin			Benthic	15–182		1	1	1	1							
Radulinus vinculus	Smoothgum Sculpin			Benthic	21–100		1	1	1	1							
Ruscarius creaseri	Roughcheek Sculpin			Benthic	0–37	6-15							1				
Ruscarius meanyi	Puget Sound Sculpin			Benthic	0–82								1				
Synchirus gilli	Manacled Sculpin			Benthic	0–21								1	1	1	1	
Agonidae	Poachers																
Agonomalus mozinoi	Kelp Poacher			Benthic	0–15								1	1	1	1	
Agonopsis sterletus	Southern Spearnose Poacher			Benthic	3–213		1	1					2				
Agonopsis vulsa	Northern Spearnose Poacher			Benthic	0–581	10–180	1	1									
Anoplagonus inermis	Smooth Alligatorfish			Benthic	2–465			1	1				1				
Bathyagonus infraspinatus	Spinycheek Starsnout			Benthic	6–415		1	1									
Bathyagonus nigripinnis	Blackfin Poacher			Benthic	18–1596	50–800	1	1									
Bathyagonus pentacanthus	Bigeye Poacher			Benthic	50–1197	100–375	1	1									
Blepsias cirrhosus	Silverspotted Sculpin			Benthic	0–97	< 60					1		1		1	1	
Bothragonus swanii	Rockhead			Benthic	0–21				1			1	1		1		1
Chesnonia verrucosa	Warty Poacher			Benthic	0–337		1	1									
Hemilepidotus hemilepidotus	Red Irish Lord			Benthic	0–235	< 10		1	1	1	1		1	1	1	1	
Hemilepidotus spinosus	Brown Irish Lord			Benthic	0–175								1	1			
Nautichthys oculofasciatus	Sailfin Sculpin			Benthic	0–208	2-30							1		1	1	
Odontopyxis trispinosa	Pygmy Poacher			Benthic	5–373	< 70	1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Pallasina barbata	Tubenose Poacher			Benthic, Pelagic	0–128	< 60		1	1					1		1	
Podothecus accipens-erinus	Sturgeon Poacher			Benthic	0–570	< 100	1	1							1	1	
Stellerina xyosterna	Pricklebreast Poacher			Benthic	2–100	< 76	1	1									
Xeneretmus latifrons	Blacktip Poacher			Benthic	2–1291	> 120	1	1									
Xeneretmus leiops	Smootheye Poacher			Benthic	24–803		1	1									
Xeneretmus triacan-thus	Bluespotted Poacher			Benthic	15–624		1	1									
Liparidae	Snailfishes																
Careproctus colletti	Alaska Snailfish			Benthic	64–1556		1	1									
Careproctus cypselurus	Falcate Snailfish			Benthic	35–1993		1	1									
Careproctus gilberti	Smalldisk Snail-fish			Benthic, Midwa-ter	55–2040								1				
Careproctus melanurus	Blacktail Snail-fish			Benthic	50–2286	> 400	1										
Liparis florae	Tidepool Snail-fish			Benthic	0–15					1	1	1	1	1	1	1	
Liparis fucensis	Slipskin Snailfish			Benthic	0–388					1			1				
Liparis mucosus	Slimy Snailfish			Benthic	0–18	< 6	2	2				1	1	1			
Liparis pulchellus	Showy Snailfish			Benthic	0–191	13-26	1	1								2	
Lipariscus nanus	Pygmy Snailfish			Benthic	58–910		1										
Nectoliparis pelagicus	Tadpole Snailfish			Benthic, Midwa-ter	2–3383	45–439	1										
Paraliparis deani	Prickly Snailfish			Benthic	18–1008		1										
Rhinoliparis barbulifer	Longnose Snail-fish			Benthic	28–1500		1										
PERCIFORMES	PERCHES																
Moronidae	Temperate Basses																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Morone saxatilis	Striped Bass	X	A	Benthic, WC	0–55		1	1	1			1	1				
Polyprionidae	Wreckfishes																
Stereolepis gigas	Giant Sea Bass			Benthic	5–55			2					1	2	1		
Epinephelidae	Groupers																
Hyporthodus niphobles	Star-Studded Grouper			Benthic	1–450												
Mycteroperca xenarcha	Broomtail Grouper			Benthic, WC	0–70		2	2					1		2		
Serranidae	Sea Basses																
Paralabrax clathratus	Kelp Bass			WC	0–61	< 30											
Paralabrax maculatofasciatus	Spotted Sand Bass			Benthic, WC	0–90	0-50		1					1			1	
Paralabrax nebulifer	Barred Sand Bass			Benthic, WC	0–183	< 45	1	1		1			1		1	1	1
Priacanthidae	Bigeyes																
Pristigenys serrula	Popeye Catalufa			Benthic	3–1226		2	2					1				
Malacanthidae	Tilefishes																
Caulolatilus princeps	Ocean Whitefish			Benthic, WC	3–189			1					1		2	1	2
Carangidae	Jacks																
Caranx caballus	Green Jack			WC	0–100												
Decapterus muroadsi	Amberstripe Scad			Pelagic	S–320												
Seriola dorsalis	Yellowtail			Pelagic	S–91												
Trachinotus rhodopus	Gafftopsail Pompano			WC	S–30												
Trachurus symmetricus	Jack Mackerel			Pelagic	S/0–403												
Coryphaenidae	Dolphinfishes																
Coryphaena hippurus	Dolphinfish			Pelagic	S–262												
Echeneidae	Remoras																
Remora albescens	White Suckerfish			Pelagic	S–50												
Remora australis	Whalesucker			Pelagic	S–200												
Remora remora	Remora			Pelagic	S–300												

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Lutjanidae	Snappers																
Lutjanus colorado	Colorado Snapper		FW	Pelagic	S–90												
Lutjanus novemfasciatus	Pacific Dog Snapper		FW	Benthic	0–60		2	2					1	1			
Haemulidae	Grunts																
Anisotremus davidsonii	Sargo			Benthic	0–61	< 9	2	2					1		1	1	
Brachygenys californiensis	Salema			Benthic, WC	1–40								1	1	1	1	
Polynemidae	Threadfins																
Polydactylus approximans	Blue Bobo		FW	Benthic	0–107		1	1									
Sciaenidae	Drums and Croakers																
Atractoscion nobilis	White Seabass			Benthic, WC	0–245			2					1	2	1	2	
Genyonemus lineatus	White Croaker			Benthic	0–238	2-130	1	1									
Menticirrhus undulatus	California Corbina			Benthic	0–27	1-12		1									
Seriphus politus	Queenfish			Benthic	0–181	2-40	1	1								2	
Kyphosidae	Sea Chubs																
Girella nigricans	Opaleye			Benthic	0–32		2	2					1		1	1	
Kyphosus azureus	Zebraperch			Benthic	0–15								1		1	1	
Kyphosus ocyurus	Bluestriped Chub			Pelagic, Benthic	0–30								1				
Kyphosus vaigiensis	Brassy Chub			Benthic, WC	S–24								1	1	1		
Medialuna californiensis	Halfmoon			Benthic, WC	0–44								1	1	1	1	
Oplegnathidae	Knifejaws																
Oplegnathus fasciatus	Barred Knifejaw			Benthic	0–10								1	2			
Embiotocidae	Surfperches																
Amphistichus argenteus	Barred Surfperch			Benthic	0–80			1					2			1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Amphistichus koelzi	Calico Surfperch			Benthic	0–9			1								2	
Amphistichus rhodoterus	Redtail Surf-perch			Benthic	0–7			1					2				
Brachyistius frenatus	Kelp Perch			WC	0–76	1-15		2				2	2	1	1	2	
Cymatogaster aggregata	Shiner Perch		FW	Benthic	0–310	1-90		2					2			1	
Embiotoca caryi	Rainbow Seap-erch			Benthic	0–50			1			1		1	1	1		
Embiotoca jacksoni	Black Perch			Benthic, Pelagic	0–73	1-24		1			1		1	1	1	1	
Embiotoca lateralis	Striped Seaperch			Benthic, Pelagic	0–111	< 30		2					1	1	1	1	
Hyperprosopon argenteum	Walleye Surf-perch			Benthic, Midwa-ter	0–182	0-20		1					1		1	1	
Hyperprosopon ellipticum	Silver Surfperch			Benthic	0–110	1-4							1		1	1	
Hypocritichthys analis	Spotfin Surf-perch			Benthic	0–101	< 35	2	1							2		
Micrometrus aurora	Reef Perch			Benthic	0–6	0-2							1	1		1	
Micrometrus minimus	Dwarf Perch			Benthic	0–20	1-4							1	1		1	
Phanerodon atripes	Sharpnose Sea-perch			Benthic	12–229	< 80							1		1	1	
Phanerodon furcatus	White Seaperch			Benthic, WC	0–104	1-50		1					1		1	1	
Phanerodon vacca	Pile Perch			Benthic, WC	0–132	2–55		2					1		1	1	
Rhacochilus toxotes	Rubberlip Sea-perch			Benthic, Pelagic	0–91	2–50		2			1		1		1	1	
Zalembius rosaceus	Pink Seaperch			Benthic	0–276	50-150	1	1			1		2				
Pomacentridae	Damselfishes																
Chromis punctipinnis	Blacksmith			Benthic, WC	2–67	< 40							1		1	1	
Hypsypops rubicundus	Garibaldi			Benthic	0–39	2–25							1		1	1	
Labridae	Wrasses																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Bodianus pulcher	California Sheephead			Benthic, Pelagic	0–150	2–55	2	2			1		1	1	1	2	1
Halichoeres californicus	Señorita			Benthic, Pelagic	0–101	5-50							1		1	1	
Halichoeres semicinctus	Rock Wrasse			Benthic	0–79	2–15		2			1	1	1		1	1	
Bathymasteridae	Ronquils																
Ronquilus jordani	Northern Ronquil			Benthic	3–337	< 150		1					1				
Zoarcidae	Eelpouts																
Bothrocara molle	Soft Eelpout			Benthic	60–2688		1	1									
Eucryphycus californicus	Persimmon Eelpout			Benthic	60–545		2	2						1	1	1	
Lycenchelys crotalinus	Snakehead Eelpout			Benthic	63–2816		1										
Lycodes brevipes	Shortfin Eelpout			Benthic	2–973		1	1									
Lycodes cortezianus	Bigfin Eelpout			Benthic	18–1280	70-400	1	1									
Lycodes diapterus	Black Eelpout			Benthic	24–1472	146-844	1	1									
Lycodes pacificus	Blackbelly Eelpout			Benthic	7–1036	50–400	1										
Lyconema barbatum	Bearded Eelpout			Benthic	45–472		1	2									
Stichaeidae	Pricklebacks																
Anoplarchus insignis	Slender Cockscomb			Benthic	0–84								1	1			
Anoplarchus purpurescens	High Cockscomb			Benthic	0–35					1	1		1	1	1	1	
Cebidichthys violaceus	Monkeyface Prickleback			Benthic	0–24	0-3							1	1	1		
Chirolophis decoratus	Decorated Warbonnet			Benthic	5–297								1	1			1
Chirolophis nugator	Mosshead Warbonnet			Benthic	0–80	1-30				1			1		2		
Ernogrammus walkeri	Masked Prickleback			Benthic	0–21								1				
Esselenichthys carli	Threeline Prickleback			Benthic	1–29			1					1	1	1		

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Esselenichthys laurae	Twoline Prickle-back			Benthic	11–46		1	1					2				
Kasatkia seigeli	Sixspot Prickle-back			Benthic	9–26								1	1	1	1	
Lumpenus sagitta	Snake Prickle-back			Benthic, WC	0–425	0-200	1	1	1		1					1	
Phytichthys chirus	Ribbon Prickle-back			Benthic	0–12								1	1	1	1	1
Plectobranchus evides	Bluebarred Prickleback			Benthic	57–368		1	1									
Poroclinus rothrocki	Whitebarred Prickleback			Benthic	35–350		2	2		1			1				
Xiphister atropurpu-reus	Black Prickleback			Benthic	0–27				1		1	1	1	1			
Xiphister mucosus	Rock Prickleback			Benthic	0–18						1	1	1	1			
Cryptacanthodidae	Wrymouths																
Cryptacanthodes giganteus	Giant Wrymouth			Benthic	6–331	< 20	1										
Pholidae	Gunnels																
Apodichthys flavidus	Penpoint Gunnel			Benthic	0–11	0-2	1	1	1		1	1	1	1		1	
Apodichthys fucorum	Rockweed Gun-nel			Benthic	0–9	0-6							1	1		1	
Pholis clemensi	Longfin Gunnel			Benthic	7–64	6-18		1					1	1		1	1
Pholis laeta	Crescent Gunnel			Benthic	0–99	0-10					1		1	1	1	1	
Pholis ornata	Saddleback Gunnel			Benthic	0–60		1	1					1	1		1	
Pholis schultzi	Red Gunnel			Benthic	0–102	0-8							1		1	1	
Ulvicola sanctaerosae	Kelp Gunnel			WC	0–12										1		
Anarhichadidae	Wolffishes																
Anarrhichthys ocella-tus	Wolf-Eel			Benthic, Pelagic	0–417								1	2	2		
Zaproridae	Prowfishes																
Zaprora silenus	Prowfish			Benthic, Pelagic	10–801	100-250	2				2		1				
Scytalinidae	Graveldivers																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Scytalina cerdale	Graveldiver			Benthic	0–8			2	1	1			2				
Trichodontidae	Sandfishes																
Trichodon trichodon	Pacific Sandfish			Benthic, Pelagic	0–375	< 150		1			2		2			2	
Ammodytidae	Sand Lances																
Ammodytes personatus	Pacific Sand Lance			Benthic, WC	0–272	0-80		1	1								
Uranoscopidae	Stargazers																
Kathetostoma averruncus	Smooth Stargazer			Benthic	1–385			1									
Blenniidae	Combtooth Blennies																
Hypsoblennius gentilis	Bay Blenny			Benthic	0–24	0-10					2		1	1		1	1
Hypsoblennius gilberti	Rockpool Blenny			Benthic	0–18	0-5							1				
Hypsoblennius jenkinsi	Mussel Blenny			Benthic	0–40	0-10							1			1	1
Clinidae	Kelp Blennies																
Gibbonsia elegans	Spotted Kelpfish			Benthic	0–56	0-30							1	1	1	1	
Gibbonsia metzi	Striped Kelpfish			Benthic	0–18	> 2							1	1	1	1	
Gibbonsia montereyensis	Crevice Kelpfish			Benthic	0–49	0-8							1	1	1	1	
Heterostichus rostratus	Giant Kelpfish			Benthic, WC	0–40	5-25							1	1	1	1	
Labrisomidae	Labrisomid Blennies																
Alloclinus holderi	Island Kelpfish			Benthic	0–91					1			1			2	
Cryptotrema corallinum	Deepwater Blenny			Benthic	15–195			1		1			1				
Chaenopsidae	Tube Blennies																
Neoclinus blanchardi	Sarcastic Fringehead			Benthic	3-83		1			1			1				1
Neoclinus stephensae	Yellowfin Fringehead			Benthic	0–30		1			1			1				1
Neoclinus uninotatus	Onespot Fringehead			Benthic	0–55		1			1			1				1
Icosteidae	Ragfishes																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Icosteus aenigmaticus	Ragfish			Pelagic, Benthic	0–1420												
Gobiesocidae	Clingfishes																
Gobiesox maeandricus	Northern Cling-fish			Benthic	0–18	< 10					2		1	2	2	2	
Gobiesox rhessodon	California Cling-fish			Benthic	0–11						1		1				
Rimicola eigenmanni	Slender Clingfish			Benthic	0–15						1		1				
Rimicola muscarum	Kelp Clingfish			WC	0–5								2	1	1	1	
Gobiidae	Gobies																
Acanthogobius flavi-manus	Yellowfin Goby	X	FW	Benthic	0–14		1									1	
Clevelandia ios	Arrow Goby		FW	Benthic	0–45	0-10	1	1								1	
Eucyclogobius new-berryi	Northern Tide-water Goby		FW	Benthic	0–15		1	1						2		2	
Gillichthys mirabilis	Longjaw Mud-sucker			Benthic	0–5		1							2		2	
Ilypnus gilberti	Cheekspot Goby			Benthic	0–24		1	1								2	
Lepidogobius lepidus	Bay Goby			Benthic	0–305	< 70	1	1								1	
Lethops connectens	Halfblind Goby			Benthic, WC	0–21								1		1		
Lythrypnus dalli	Bluebanded Goby			Benthic	0–76	> 3				1			1				1
Lythrypnus zebra	Zebra Goby			Benthic	0–97					1			1				1
Quietula y-cauda	Shadow Goby			Benthic	0–6		1								2	2	
Rhinogobiops nicholsii	Blackeye Goby			Benthic	0–195	< 80	1	1	1				1		2	2	2
Tridentiger barbatus	Shokihaze Goby	X	FW	Benthic	2–26		1			2			2				
Tridentiger trigono-cephalus	Chameleon Goby	X	FW	Benthic	0–15		1			2			2				
Typhlogobius californ-iensis	Blind Goby			Benthic	0–15		1	1					2				2
Sphyraenidae	Barracudas																
Sphyraena argentea	Pacific Barra-cuda			Pelagic	S/0–383												
Scombridae	Mackerels																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Auxis rochei	Bullet Tuna			Pelagic	S–200												
Euthynnus affinis	Kawakawa			Pelagic	S–73												
Euthynnus lineatus	Black Skipjack			Pelagic	S–73												
Sarda chiliensis	Pacific Bonito			Pelagic	S–110												
Scomber japonicus	Pacific Chub Mackerel			Pelagic	S/0-300												
Scomberomorus concolor	Gulf Sierra			Pelagic	S–15												
Stromateidae	Butterfishes																
Peprilus simillimus	Pacific Pompano			Benthic, Pelagic	0–302	3–70		1									
PLEURONECTIFORMES	FLATFISHES																
Paralichthyidae	Sand Flounders																
Citharichthys sordidus	Pacific Sanddab			Benthic	0–581	< 150	1	1		1						2	
Citharichthys stigmaeus	Speckled Sanddab			Benthic	0–366	< 60	1	1							2	2	
Citharichthys xanthostigma	Longfin Sanddab			Benthic	2–298		2	1									
Hippoglossina stomata	Bigmouth Sole			Benthic	2–478		2	1									
Paralichthys californicus	California Halibut			Benthic	0–317		1	1									
Xystreurys liolepis	Fantail Sole			Benthic	0–136		1	1					2		2	2	
Pleuronectidae	Righteye Flounders																
Atheresthes evermanni	Kamchatka Flounder			Benthic	25–1200	100-600	1	1									
Atheresthes stomias	Arrowtooth Flounder			Benthic	9–1186	100–500	1	1	2				2				
Eopsetta jordani	Petrale Sole			Benthic	0–640	55-457	1	1	2		2						
Glyptocephalus zachirus	Rex Sole			Benthic	0–1237	100–500	1	2			2		2				
Hippoglossoides elassodon	Flathead Sole			Benthic	0–1050	100–300	1	1									
Hippoglossus stenolepis	Pacific Halibut			Benthic, Midwater	2–2000	27-274	1	1				2	2			2	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Isopsetta isolepis	Butter Sole			Benthic	2–425		1										
Lepidopsetta bilineata	Southern Rock Sole			Benthic	1–476			1	1								
Lyopsetta exilis	Slender Sole			Benthic	9–1258	90-350	1						2				
Microstomus bathybius	Deepsea Sole			Benthic	41–1743	500-1400	1	1			1	1	1				
Microstomus pacificus	Dover Sole			Benthic	2–1400		1	2					2				
Parophrys vetulus	English Sole			Benthic	0–608	< 200	1	1								1	
Platichthys stellatus	Starry Flounder		FW	Benthic, Pelagic	0–660	< 100	1	1	1					2		1	
Pleuronichthys coenosus	C-O Sole			Benthic	0–350	5-30	1	1					1			1	
Pleuronichthys decurrens	Curlfin Sole			Benthic	0–440	18-70	1	1					2				
Pleuronichthys guttulatus	Diamond Turbot			Benthic	0–46	< 20	1	1								1	
Pleuronichthys ritteri	Spotted Turbot			Benthic	1–219		1	1									
Pleuronichthys verticalis	Hornyhead Turbot			Benthic	5–496	10-100	1	1									
Psettichthys melanostictus	Sand Sole			Benthic	0–325	< 50		1								2	
Reinhardtius hippoglossoides	Greenland Halibut			Benthic, Pelagic	10–2000	50-1000	1	1									
Cynoglossidae	Tonguefishes																
Symphurus atricauda	California Tonguefish			Benthic	0–463	5-140	1	1								1	
TETRADONTIFORMES	PUFFERFISHES AND RELATIVES																
Balistidae	Triggerfishes																
Balistes polylepis	Finescale Triggerfish			Benthic	2–512	< 30		2			2		1	2			
Ostraciidae	Boxfishes																
Lactoria diaphana	Spiny Boxfish			Benthic, Pelagic	20-171								1				
Diodontidae	Porcupinefishes																
Diodon holocanthus	Balloonfish			Benthic	1–100			2					1				

APPENDIX 11

Qualitative Assessment of Relative Abundance Among Documented Fishes in the Southern California Bight

This assessment is based on a review of relevant field guides (e.g., Miller and Lea 1972; Love et al. 2002; Ebert 2003, Love 2011; Butler et al. 2012; Kells et al. 2016), primary literature, and landings or survey data. Included in the following tables are the taxon (order, family, genus, species), common name, and abundance estimates throughout the ecoregion (Overall), in the Core and Seaward Zones, and between the Southern California Bight subregions. Only fishes with multiple documented records in the ecoregion are included. Blank entries indicate that the species has not been documented in a particular subregion.

Key: PCPV = Point Conception to Palos Verde and PVMX = Palos Verde to Mexican Border. A = abundant, C = common, and R = rare.

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
MYXINIFORMES	HAGFISHES					
Myxinidae	Hagfishes					
Eptatretus deani	Black Hagfish	R		R	R	R
Eptatretus mcconnaugheyi	Shorthead Hagfish	R		R	R	R
Eptatretus stoutii	Pacific Hagfish	C	R	C	R	R
PETROMYZONTIFORMES	LAMPREYS					
Petromyzontidae	Lampreys					
Entosphenus tridentatus	Pacific Lamprey	C	R	C	R	R
CHIMAERIFORMES	CHIMAERAS					
Chimaeridae	Shortnose Chimaeras					
Hydrolagus colliei	Spotted Ratfish	C	R	C	C	C
Hydrolagus melanophasma	Eastern Pacific Black Ghostshark	R		R	R	R
HETERODONTIFORMES	HORN SHARKS					
Heterodontidae	Horn Sharks					
Heterodontus francisci	Horn Shark	C	C	C	C	C
ORECTOLOBIFORMES	CARPET SHARKS					
Rhincodontidae	Whale Sharks					
Rhincodon typus	Whale Shark	R	R	R	R	R
LAMNIFORMES	MACKEREL SHARKS					
Odontaspididae	Sand Tigers					
Odontaspis ferox	Ragged-tooth Shark	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Megachasmidae	Megamouth Sharks					
Megachasma pelagios	Megamouth Shark	R	R	R	R	R
Alopiidae	Thresher Sharks					
Alopias vulpinus	Common Thresher Shark	C	R	C	C	C
Cetorhinidae	Basking Sharks					
Cetorhinus maximus	Basking Shark	R	R	R	R	R
Lamnidae	Mackerel Sharks					
Carcharodon carcharias	White Shark	R	C	C	C	C
Isurus oxyrinchus	Shortfin Mako	C	R	C	C	C
Lamna ditropis	Salmon Shark	R	R	R	R	R
CARCHARHINIFORMES	GROUND SHARKS					
Scyliorhinidae	Cat Sharks					
Apristurus brunneus	Brown Cat Shark	R	R	R		
Cephaloscyllium ventriosum	Swell Shark	C	A	C	C	C
Parmaturus xaniurus	Filetail Cat Shark	R	R	R		
Triakidae	Hound Sharks					
Galeorhinus galeus	Soupfin Shark	C	R	C	C	C
Mustelus californicus	Gray Smoothhound	C	C	C	C	C
Mustelus henlei	Brown Smoothhound	A	A	A	A	A
Mustelus lunulatus	Sicklefin Smoothhound	R	R	R	R	R
Triakis semifasciata	Leopard Shark	A	A	C	A	A
Carcharhinidae	Requiem Sharks					
Carcharhinus brachyurus	Narrowtooth Shark	R	R	R	R	R
Carcharhinus obscurus	Dusky Shark	R	R	R	R	R
Galeocerdo cuvier	Tiger Shark	R	R	R	R	R
Prionace glauca	Blue Shark	C	R	C	C	C
Sphyrnidae	Hammerhead Sharks					
Sphyrna lewini	Scalloped Hammerhead	R	R	R	R	R
Sphyrna zygaena	Smooth Hammerhead	R	R	R	R	R
HEXANCHIFORMES	SIX-GILL SHARKS					
Hexanchidae	Cow Sharks					

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Hexanchus griseus	Bluntnose Sixgill Shark	C	C	C	C	C
Notorynchus cepedianus	Broadnose Sevengill Shark	C	R	C	C	C
ECHINORHINIFORMES	BRAMBLE SHARKS					
Echinorhinidae	Bramble Sharks					
Echinorhinus cookei	Prickly Shark	R	R	R	R	R
SQUALIFORMES	DOGFISH SHARKS					
Squalidae	Dogfish Sharks					
Squalus suckleyi	Pacific Spiny Dogfish	C	R	C	C	C
Somniosidae	Sleeper Sharks					
Somniosus pacificus	Pacific Sleeper Shark	R	R	R	R	R
SQUATINIFORMES	ANGEL SHARKS					
Squatinidae	Angel Sharks					
Squatina californica	Pacific Angel Shark	C	C	C	C	C
TORPEDINIFORMES	ELECTRIC RAYS					
Torpedinidae	Electric Rays					
Tetronarce californica	Pacific Electric Ray	C	C	C	C	C
RAJIFORMES	SKATES					
Rhinobatidae	Guitarfishes					
Pseudobatos productus	Shovelnose Guitarfish	C	C	R	C	C
Trygonorrhinidae	Banjo Rays					
Zapteryx exasperata	Banded Guitarfish	R	R	R	R	R
Arhynchobatidae	Softnose Skates					
Bathyraja kincaidii	Sandpaper Skate	R	R	R	R	R
Rajidae	Hardnose Skates					
Beringraja binoculata	Big Skate	C	C	C	C	C
Beringraja inornata	California Skate	R	R	R	R	R
Beringraja rhina	Longnose Skate	C	R	C	C	C
Beringraja stellulata	Starry Skate	C	R	C	C	C
MYLIOBATIFORMES	STINGRAYS					
Platyrhynidae	Thornbacks					
Platyrhinoidis triseriata	Thornback Ray	C	C	R	C	C

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Urotrygonidae	Round Stingrays					
Urobatis helleri	Round Stingray	C	C	R	C	C
Dasyatidae	Whiptail Stingrays					
Hypanus dipterurus	Diamond Stingray	R	R	R	R	R
Gymnuridae	Butterfly Rays					
Gymnura marmorata	California Butterfly Ray	R	R	R	R	C
Myliobatidae	Eagle Rays					
Myliobatis californica	Bat Ray	C	C	C	C	C
Mobulidae	Devil Rays					
Mobula birostris	Manta	R	R	R	R	R
Mobula mobular	Spinetail Devil Ray	R	R	R	R	R
ACIPENSERIFORMES	STURGEONS					
Acipenseridae	Sturgeons					
Acipenser medirostris	Green Sturgeon	R	R	R	R	R
Acipenser transmontanus	White Sturgeon	R	R	R	R	R
ELOPIFORMES	TENPOUNDERS					
Elopidae	Tenpounders					
Elops affinis	Machete	R	R	R	R	R
ALBULIFORMES	BONEFISHES					
Albulidae	Bonefishes					
Albula gilberti	Cortez Bonefish	R	R		R	R
ANGUILLIFORMES	EELS					
Muraenidae	Morays					
Gymnothorax mordax	California Moray	C	C	R	C	C
Muraena argus	Argus Moray	R	R	R	R	R
Ophichthidae	Snake Eels					
Myrophis vafer	Pacific Worm Eel	R	R	R		R
Ophichthus triserialis	Pacific Snake Eel	C	C	C	C	C
Ophichthus zophochir	Yellow Snake Eel	C	C	C	R	C
Congridae	Conger Eels					
Gnathophis cinctus	Hardtail Conger	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Nettastomatidae	Duckbill Eels					
Facciolella equatorialis	Dogface Witch Eel	R		R	R	R
CLUPEIFORMES	ANCHOVIES AND HERRINGS					
Engraulidae	Anchovies					
Anchoa compressa	Deepbody Anchovy	C	C		R	C
Anchoa delicatissima	Slough Anchovy	C	C		R	C
Cetengraulis mysticetus	Anchoveta	R	R	R		R
Engraulis mordax	Northern Anchovy	A	A	A	A	A
Clupeidae	Herrings					
Alosa sapidissima	American Shad	R	R	R	R	R
Clupea pallasii	Pacific Herring	R	R	R	R	R
Dorosoma petenense	Threadfin Shad	R	R		R	R
Etrumeus acuminatus	Pacific Round Herring	R	R	R	R	R
Harengula thrissina	Flatiron Herring	R	R			R
Opisthonema libertate	Deepbody Thread Herring	R	R	R	R	R
Opisthonema medirastre	Middling Thread Herring	R	R		R	R
Sardinops sagax	Pacific Sardine	A	A	A	A	A
GONORYNCHIFORMES	MILKFISH AND RELATIVES					
Chanidae	Milkfishes					
Chanos chanos	Milkfish	R	R			R
SILURIFORMES	CATFISHES					
Ariidae	Sea Catfishes					
Bagre panamensis	Chihuil	R	R	R	R	R
ARGENTINIFORMES	ARGENTINES					
Argentinidae	Argentines					
Argentina sialis	Pacific Argentine	R	R	R	R	R
OSMERIFORMES	FRESHWATER SMELTS					
Osmeridae	Smelts					
Hypomesus pretiosus	Surf Smelt	R	R	R	R	R
Spirinchus starksi	Night Smelt	R	R	R	R	
Spirinchus thaleichthys	Longfin Smelt	R	R	R	R	

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Thaleichthys pacificus	Eulachon	R	R	R	R	
SALMONIFORMES	SALMON AND TROUTS					
Salmonidae	Salmon and Trouts					
Oncorhynchus gorbuscha	Pink Salmon	R	R	R	R	R
Oncorhynchus keta	Chum Salmon	R	R	R	R	R
Oncorhynchus mykiss	Steelhead	R	R	R	R	R
Oncorhynchus nerka	Sockeye Salmon	R	R	R	R	
Oncorhynchus tshawytscha	Chinook Salmon	R	R	R	R	R
AULOPIFORMES	LIZARDFISHES					
Synodontidae	Lizardfishes					
Synodus lucioceps	California Lizardfish	C	C	C	C	C
Alepisauridae	Lancetfishes					
Alepisaurus ferox	Longnose Lancetfish	R	R	R	R	R
Paralepididae	Barracudinas					
Macroparalepis johnfitchi	Black Barracudina	R	R	R	R	R
Lophotidae	Crestfishes					
Lophotus capellei	North Pacific Crestfish	R	R	R	R	R
GADIFORMES	CODS					
Moridae	Codlings, Deepsea Cods, or Moras					
Physiculus rastrelliger	Hundred-fathom Codling	R	R	R	R	R
Merlucciidae	Hakes					
Merluccius productus	Pacific Hake	R	R	R	R	R
Gadidae	Cods					
Gadus macrocephalus	Pacific Cod	R	R	R	R	R
Ophidiidae	Cusk-eels					
Brotula clarkae	Pacific Bearded Brotula	R	R	R		R
Chilara taylori	Spotted Cusk-eel	A	A	A	A	A
Ophidion scrippsae	Basketweave Cusk-eel	R	R	R	R	R
Bythitidae	Livebearing Brotulas					
Brosmophycis marginata	Red Brotula	R	R	R	R	R
Grammonus diagrammus	Purple Brotula	R	R	R	R	

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BATRACHOIDIFORMES	TOADFISHES					
Batrachoididae	Toadfishes					
Porichthys myriaster	Specklefin Midshipman	R	R	R	R	R
Porichthys notatus	Plainfin Midshipman	C	C	C	C	C
LOPHIFORMES	ANGLERFISHES					
Lophiidae	Goosefishes					
Lophiodes caulinaris	Spottedtail Goosefish	R	R	R	R	R
Lophiodes spilurus	Threadfin Goosefish	R	R	R	R	R
Antennariidae	Frogfishes					
Fowlerichthys avalonis	Roughjaw Frogfish	R	R	R		R
Ogcocephalidae	Batfishes					
Zalieutes elater	Roundel Batfish	R	R	R	R	R
MUGILIFORMES	MULLETS					
Mugilidae	Mullets					
Mugil cephalus	Striped Mullet	C	C	C	C	C
Mugil setosus	Liseta Mullet	R	R		R	R
ATHERINIFORMES	SILVERSIDES					
Atherinopsidae	New World Silversides					
Atherinops affinis	Topsmelt	A	A		A	A
Atherinopsis californiensis	Jacksmelt	A	A		A	A
Leuresthes tenuis	California Grunion	A	A		A	A
BELONIFORMES	NEEDLEFISHES AND RELATIVES					
Exocoetidae	Flyingfishes					
Cheilopogon heterurus	Blotchwing Flyingfish	R	R	R	R	R
Cheilopogon pinnatibarbatus	Smallhead Flyingfish	C	C	C	C	C
Fodiator rostratus	Sharpchin Flyingfish	R	R	R	R	R
Hemiramphidae	Halfbeaks					
Euleptorhamphus viridis	Ribbon Halfbeak	R	R	R	R	R
Hemiramphus saltator	Longfin Halfbeak	R	R	R		R
Hyporhamphus naos	Pacific Silverstripe Halfbeak	R	R	R		R

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Hyporhamphus rosae	California Halfbeak	R	R	R	R	R
Belonidae	Needlefishes					
Strongylura exilis	California Needlefish	C	C	C	R	C
Scomberesocidae	Sauries					
Cololabis saira	Pacific Saury	C	C	C	C	C
CYPRINODONTIFORMES	KILLIFISHES AND RELATIVES					
Fundulidae	Topminnows					
Fundulus parvipinnis	California Killifish	R	R		R	R
Lucania goodei	Bluefin Killifish	R	R			R
Poeciliidae	Livebearers					
Poecilia latipinna	Sailfin Molly	R	R		R	R
ZEIFORMES	DORIES AND BOARFISHES					
Zeidae	Dories					
Zenopsis nebulosa	Mirror Dory	R	R	R	R	R
GASTEROSTEIFORMES	STICKLEBACKS					
Aulorhynchidae	Tubesnouts					
Aulorhynchus flavidus	Tubesnout	A	A	R	A	A
Syngnathidae	Pipefishes					
Cosmocampus arctus	Snubnose Pipefish	R	R		R	R
Hippocampus ingens	Pacific Seahorse	R	R	R	R	R
Syngnathus auliscus	Barred Pipefish	R	R		R	R
Syngnathus californiensis	Kelp Pipefish	C	C		C	C
Syngnathus euchrous	Chocolate Pipefish	R	R		R	R
Syngnathus leptorhynchus	Bay Pipefish	A	A		A	A
Fistulariidae	Cornetfishes					
Fistularia commersonii	Reef Cornetfish	R	R	R		R
Fistularia corneta	Deepwater Cornetfish	R	R	R		R
SCORPAENIFORMES	SCORPIONFISHES					
Scorpaenidae	Rockfishes and Thornyheads					
Scorpaena guttata	California Scorpionfish	A	A	A	A	A
Scorpaena mystes	Stone Scorpionfish	R	R	R	R	R

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Scorpaenodes xyris	Rainbow Scorpionfish	R	R	R		R
Sebastes alutus	Pacific Ocean Perch	R	R	R	R	R
Sebastes atrovirens	Kelp Rockfish	C	C	R	C	C
Sebastes auriculatus	Brown Rockfish	C	C	C	C	C
Sebastes aurora	Aurora Rockfish	R		R	R	R
Sebastes babcocki	Redbanded Rockfish	R	R	R	R	R
Sebastes brevispinis	Silvergray Rockfish	R	R	R	R	R
Sebastes carnatus	Gopher Rockfish	C	C	C	C	C
Sebastes caurinus	Copper Rockfish	C	C	C	C	C
Sebastes chlorostictus	Greenspotted Rockfish	R	R	R	R	R
Sebastes chrysomelas	Black-and-Yellow Rockfish	C	C	R	C	C
Sebastes constellatus	Starry Rockfish	C	R	C	C	C
Sebastes crameri	Darkblotched Rockfish	R	R	R	R	R
Sebastes dallii	Calico Rockfish	C	R	C	C	C
Sebastes diaconus	Deacon Rockfish	R	R	R	R	
Sebastes diploproa	Splitnose Rockfish	R		R	R	R
Sebastes elongatus	Greenstriped Rockfish	R	R	R	R	R
Sebastes ensifer	Swordspine Rockfish	R		R	R	R
Sebastes entomelas	Widow Rockfish	R	R	R	R	R
Sebastes eos	Pink Rockfish	R		R	R	R
Sebastes flavidus	Yellowtail Rockfish	R	R	R	R	R
Sebastes gilli	Bronzespotted Rockfish	R		R	R	R
Sebastes goodei	Chilipepper	R	R	R	R	R
Sebastes helvomaculatus	Rosethorn Rockfish	R	R	R	R	R
Sebastes hopkinsi	Squarespot Rockfish	C	R	C	C	C
Sebastes jordani	Shortbelly Rockfish	R	R	R	R	R
Sebastes lentiginosus	Freckled Rockfish	R	R	R	R	R
Sebastes levis	Cowcod	R		R	R	R
Sebastes macdonaldi	Mexican Rockfish	R		R	R	R
Sebastes maliger	Quillback Rockfish	R	R	R	R	
Sebastes melanops	Black Rockfish	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Sebastes melanosema	Semaphore Rockfish	R	R	R	R	R
Sebastes melanostictus	Blackspotted Rockfish	R	R	R	R	R
Sebastes melanostomus	Blackgill Rockfish	R		R	R	R
Sebastes miniatus	Vermilion Rockfish	A	C	A	A	A
Sebastes crocotulus	Sunset Rockfish	R	R	R	R	R
Sebastes moseri	Whitespotted Rockfish	R		R	R	R
Sebastes mystinus	Blue Rockfish	A	A	A	A	A
Sebastes nebulosus	China Rockfish	R	R	R	R	
Sebastes nigrocinctus	Tiger Rockfish	R	R	R	R	R
Sebastes ovalis	Speckled Rockfish	C	R	C	C	C
Sebastes paucispinis	Bocaccio	C	R	C	C	C
Sebastes pinniger	Canary Rockfish	R	R	R	R	R
Sebastes proriger	Redstripe Rockfish	R	R	R	R	R
Sebastes rastrelliger	Grass Rockfish	R	R	R	R	R
Sebastes rosaceus	Rosy Rockfish	C	R	C	C	C
Sebastes rosenblatti	Greenblotched Rockfish	R		R	R	R
Sebastes ruberrimus	Yelloweye Rockfish	R	R	R	R	R
Sebastes rubrivinctus	Flag Rockfish	C	R	C	C	C
Sebastes rufinanus	Dwarf-Red Rockfish	R		R	R	R
Sebastes rufus	Bank Rockfish	R		R	R	R
Sebastes saxicola	Stripetail Rockfish	R	R	R	R	R
Sebastes semicinctus	Halfbanded Rockfish	C	R	A	C	C
Sebastes serranoides	Olive Rockfish	A	A	A	A	A
Sebastes serriceps	Treefish	C	C	C	C	C
Sebastes umbrosus	Honeycomb Rockfish	C	C	A	C	C
Sebastes wilsoni	Pygmy Rockfish	C	R	C	C	C
Sebastes zacentrus	Sharpchin Rockfish	R	R	R	R	R
Sebastolobus alascanus	Shortspine Thornyhead	R	R	R	R	R
Sebastolobus altivelis	Longspine Thornyhead	R		R	R	R
Triglidae	Searobins					
Prionotus albirostris	Whitesnout Searobin	R	R	R		R

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Prionotus stephanophrys	Lumptail Searobin	R	R	R	R	R
Anoplopomatidae	Sablefishes					
Anoplopoma fimbria	Sablefish	R	R	R	R	R
Zaniolepididae	Combfishes					
Oxylebius pictus	Painted Greenling	C	C	C	C	C
Zaniolepis frenata	Shortspine Combfish	R	R	C	R	R
Zaniolepis latipinnis	Longspine Combfish	A	C	A	A	A
Hexagrammidae	Greenlings					
Hexagrammos decagrammus	Kelp Greenling	R	R	R	R	R
Hexagrammos lagocephalus	Rock Greenling	R	R	R	R	
Ophiodon elongatus	Lingcod	C	C	C	C	C
Pleurogrammus monopterygius	Atka Mackerel	R	R	R	R	
Jordaniidae	Longfin Sculpins					
Paricelinus hopliticus	Thornback Sculpin	R	R	R	R	
Scorpaenichthyidae	Cabezon					
Scorpaenichthys marmoratus	Cabezon	C	C	C	C	C
Rhamphocottidae	Grunt Sculpins					
Rhamphocottus richardsonii	Grunt Sculpin	R	R	R	R	R
Cottidae	Freshwater Sculpins					
Cottus asper	Prickly Sculpin	R	R	R	R	
Leptocottus armatus	Pacific Staghorn Sculpin	C	C	R	C	C
Psychrolutidae	Marine Sculpins					
Artedius corallinus	Coralline Sculpin	R	R	R	R	R
Artedius notospilotus	Bonyhead Sculpin	R	R	R	R	R
Chitonotus pugetensis	Roughback Sculpin	C	R	C	C	C
Clinocottus analis	Woolly Sculpin	A	A		A	A
Clinocottus embryum	Calico Sculpin	R	R		R	R
Clinocottus globiceps	Mosshead Sculpin	R	R	R	R	R
Clinocottus recalvus	Bald Sculpin	R	R		R	R
Enophrys bison	Buffalo Sculpin	R	R	R	R	
Enophrys taurina	Bull Sculpin	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Icelinus burchami	Dusky Sculpin	R		R	R	R
Icelinus cavifrons	Pit-Head Sculpin	R	R	R	R	R
Icelinus filamentosus	Threadfin Sculpin	R	R	R	R	R
Icelinus fimbriatus	Fringed Sculpin	R	R	R	R	R
Icelinus limbaughi	Canyon Sculpin	R	R	R	R	R
Icelinus quadriseriatus	Yellowchin Sculpin	R	R	R	R	R
Icelinus tenuis	Spotfin Sculpin	C	R	C	C	C
Leiocottus hirundo	Lavender Sculpin	C	C	R	C	C
Oligocottus maculosus	Tidepool Sculpin	R	R		R	
Oligocottus rimensis	Saddleback Sculpin	R	R		R	R
Oligocottus rubellio	Rosy Sculpin	R	R	R	R	R
Oligocottus snyderi	Fluffy Sculpin	R	R		R	R
Orthonopias triacis	Snubnose Sculpin	C	C		C	C
Radulinus asprellus	Slim Sculpin	R	R	R	R	R
Radulinus boleoides	Darter Sculpin	R	R	R	R	R
Radulinus vinculus	Smoothgum Sculpin	R	R	R	R	
Ruscarius creaseri	Roughcheek Sculpin	A	A	R	A	A
Agonidae	Poachers					
Agonopsis sterletus	Southern Spearnose Poacher	R	R	R	R	R
Bathyagonus pentacanthus	Bigeye Poacher	R		R	R	R
Bothragonus swanii	Rockhead	R	R		R	
Hemilepidotus spinosus	Brown Irish Lord	R	R	R		
Odontopyxis trispinosa	Pygmy Poacher	C	C	C	C	C
Stellerina xyosterna	Pricklebreast Poacher	R	R	R	R	R
Xeneretmus latifrons	Blacktip Poacher	R	R	R	R	R
Xeneretmus leiops	Smootheye Poacher	R	R	R	R	R
Xeneretmus triacanthus	Bluespotted Poacher	R	R	R	R	R
Liparidae	Snailfishes					
Careproctus colletti	Alaska Snailfish	R		R	R	R
Careproctus melanurus	Blacktail Snailfish	R		R	R	R
Liparis florae	Tidepool Snailfish	R	R		R	

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Liparis mucosus	Slimy Snailfish	C	C		C	C
Nectoliparis pelagicus	Tadpole Snailfish	R	R	R	R	R
Rhinoliparis barbulifer	Longnose Snailfish	R	R	R	R	R
PERCIFORMES	PERCHES					
Moronidae	Temperate Basses					
Morone saxatilis	Striped Bass	R	R	R	R	R
Polyprionidae	Wreckfishes					
Stereolepis gigas	Giant Sea Bass	C	C	C	C	C
Epinephelidae	Groupers					
Cephalopholis colonus	Pacific Creolefish	R	R	R		R
Dermatolepis dermatolepis	Leather Bass	R	R	R	R	R
Epinephelus analogus	Spotted Cabrilla	R	R	R		R
Epinephelus labriformis	Flag Cabrilla	R	R	R		R
Hyporthodus acanthistius	Gulf Coney	R	R	R	R	R
Hyporthodus niphobles	Star-Studded Grouper	R	R	R	R	R
Mycteroperca jordani	Gulf Grouper	R	R	R		R
Mycteroperca xenarcha	Broomtail Grouper	R	R	R	R	R
Serranidae	Sea Basses					
Diplectrum maximum	Greater Sand Perch	R	R	R	R	
Hemanthias signifer	Hookthroat Bass	R	R	R	R	R
Paralabrax auroguttatus	Goldspotted Sand Bass	R	R	R	R	R
Paralabrax clathratus	Kelp Bass	C	C	C	C	C
Paralabrax maculatofasciatus	Spotted Sand Bass	R	R	R	R	C
Paralabrax nebulifer	Barred Sand Bass	C	C	C	C	C
Pronotogrammus multifasciatus	Threadfin Bass	R	R	R	R	R
Serranus aequidens	Deepwater Serrano	R		R		R
Priacanthidae	Bigeyes					
Heteropriacanthus carolinus	Pacific Glasseye	R	R	R	R	R
Pristigenys serrula	Popeye Catalufa	R	R	R	R	R
Apogonidae	Cardinalfishes					

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Apogon atricaudus	Plain Cardinalfish	R	R	R		R
Apogon guadalupensis	Guadalupe Cardinalfish	R	R			R
Apogon pacificus	Pink Cardinalfish	R	R	R		R
Apogon retrosella	Barspot Cardinalfish	R	R	R		R
Malacanthidae	Tilefishes					
Caulolatilus affinis	Pacific Golden-Eyed Tilefish	R	R	R		R
Caulolatilus princeps	Ocean Whitefish	C	C	C	C	C
Nematistiidae	Roosterfishes					
Nematistius pectoralis	Roosterfish	R	R	R		R
Carangidae	Jacks					
Carangoides vinctus	Cocinero	R	R	R		R
Caranx caballus	Green Jack	R	R	R	R	R
Caranx caninus	Pacific Crevalle Jack	R	R	R		R
Caranx sexfasciatus	Bigeye Trevally	R	R	R		R
Chloroscombrus orqueta	Pacific Bumper	R	R	R		R
Decapterus muroadsi	Amberstripe Scad	R	R	R	R	R
Selar crumenophthalmus	Bigeye Scad	R	R	R		R
Selene brevoortii	Mexican Lookdown	R	R	R		R
Selene peruviana	Pacific Moonfish	R	R	R		R
Seriola dorsalis	Yellowtail	C	C	C	C	C
Seriola rivoliana	Almaco Jack	R	R	R		R
Trachinotus paitensis	Paloma Pompano	R	R	R	R	R
Trachinotus rhodopus	Gafftopsail Pompano	R	R	R	R	R
Trachurus symmetricus	Jack Mackerel	C	C	C	C	C
Uraspis helvola	Cottonmouth Jack	R	R	R		R
Coryphaenidae	Dolphinfishes					
Coryphaena equiselis	Pompano Dolphinfish	R	R	R		R
Coryphaena hippurus	Dolphinfish	C	C	C	C	C
Echeneidae	Remoras					
Echeneis naucrates	Sharksucker	R	R	R	R	R
Remora albescens	White Suckerfish	R	R	R	R	R

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Remora australis	Whalesucker	R	R	R	R	R
Remora brachyptera	Spearfish Remora	R	R	R		R
Remora osteochir	Marlinsucker	R	R	R		R
Remora remora	Remora	R	R	R	R	R
Bramidae	Pomfrets					
Taractichthys steindachneri	Sickle Pomfret	R	R	R	R	R
Lutjanidae	Snappers					
Lutjanus argentiventris	Amarillo Snapper	R	R	R		R
Lutjanus colorado	Colorado Snapper	R	R	R	R	R
Lutjanus novemfasciatus	Pacific Dog Snapper	R	R	R	R	R
Lutjanus peru	Pacific Red Snapper	R	R	R		R
Lobotidae	Tripletails					
Lobotes pacificus	Pacific Tripletail	R	R	R		R
Gerreidae	Mojarras					
Eucinostomus currani	Pacific Flagfin Mojarra	R	R	R		R
Eucinostomus dowii	Pacific Spotfin Mojarra	R	R	R		R
Haemulidae	Grunts					
Anisotremus davidsonii	Sargo	A	A	A	C	A
Brachygenys californiensis	Salema	A	A	A	C	A
Conodon serrifer	Armed Grunt	R	R	R		R
Haemulon flaviguttatum	Cortez Grunt	R	R	R		R
Haemulopsis axillaris	Yellowstripe Grunt	R	R	R		R
Haemulopsis elongatus	Elongate Grunt	R	R	R		R
Microlepidotus inornatus	Wavyline Grunt	R	R			R
Sparidae	Porgies					
Calamus brachysomus	Pacific Porgy	R	R	R		R
Polynemidae	Threadfins					
Polydactylus approximans	Blue Bobo	R	R	R	R	R
Polydactylus opercularis	Yellow Bobo	R	R	R		R
Sciaenidae	Drums and Croakers					
Atractoscion nobilis	White Seabass	C	C	C	C	C

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Cheilotrema saturnum	Black Croaker	R	R	R	R	R
Cynoscion parvipinnis	Shortfin Corvina	R	R	R	R	R
Genyonemus lineatus	White Croaker	A	A	A	A	A
Menticirrhus undulatus	California Corbina	A	A		A	A
Roncador stearnsii	Spotfin Croaker	R	R		R	R
Seriphus politus	Queenfish	A	A	C	A	A
Umbrina roncador	Yellowfin Croaker	C	C	R	C	C
Mullidae	Goatfishes					
Pseudupeneus grandisquamis	Bigscale Goatfish	R	R	R		R
Kyphosidae	Sea Chubs					
Girella nigricans	Opaleye	C	C	R	C	C
Kyphosus azureus	Zebraperch	C	C		C	C
Kyphosus ocyurus	Bluestriped Chub	R	R		R	R
Kyphosus vaigiensis	Brassy Chub	R	R	R	R	R
Medialuna californiensis	Halfmoon	C	C	R	C	C
Chaetodontidae	Butterflyfishes					
Chaetodon humeralis	Threebanded Butterflyfish	R	R	R	R	R
Prognathodes falcifer	Scythe Butterflyfish	R	R	R		R
Embiotocidae	Surfperches					
Amphistichus argenteus	Barred Surfperch	C	C	R	C	C
Amphistichus koelzi	Calico Surfperch	R	R		R	R
Brachyistius frenatus	Kelp Perch	C	C	R	C	C
Cymatogaster aggregata	Shiner Perch	A	A	A	A	A
Embiotoca caryi	Rainbow Seaperch	A	A	A	A	A
Embiotoca jacksoni	Black Perch	C	C	R	C	C
Embiotoca lateralis	Striped Seaperch	R	R	R	R	R
Hyperprosopon argenteum	Walleye Surfperch	C	C	R	C	C
Hyperprosopon ellipticum	Silver Surfperch	R	R	R	R	R
Hypocritichthys analis	Spotfin Surfperch	R	R	R	R	R
Micrometrus aurora	Reef Perch	C	C		C	C
Micrometrus minimus	Dwarf Perch	C	C	R	C	C

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Phanerodon atripes	Sharpnose Seaperch	R	R	R	R	R
Phanerodon furcatus	White Seaperch	C	C	C	C	C
Phanerodon vacca	Pile Perch	C	C	C	C	C
Rhacochilus toxotes	Rubberlip Seaperch	C	C	C	C	C
Zalembius rosaceus	Pink Seaperch	C	R	C	C	C
Pomacentridae	Damselfishes					
Abudefduf troschelii	Panamic Sergeant Major	R	R		R	R
Azurina hirundo	Swallow Damselfish	R	R			R
Chromis alta	Silverstripe Chromis	R	R	R		R
Chromis punctipinnis	Blacksmith	C	C	C	C	C
Hypsypops rubicundus	Garibaldi	C	C	R	C	C
Stegastes leucorus	Whitetail Damselfish	R	R			R
Labridae	Wrasses					
Bodianus pulcher	California Sheephead	C	C	C	C	C
Decodon melasma	Blackspot Wrasse	R	R	R		R
Halichoeres californicus	Señorita	C	C	C	C	C
Halichoeres semicinctus	Rock Wrasse	C	C	R	C	C
Nicholsina denticulata	Loosetooth Parrotfish	R	R			R
Bathymasteridae	Ronquils					
Rathbunella hypoplecta	Bluebanded Ronquil	C	C	C	C	C
Ronquilus jordani	Northern Ronquil	R	R	R	R	R
Zoarcidae	Eelpouts					
Bothrocara molle	Soft Eelpout	R	R	R	R	R
Eucryphycus californicus	Persimmon Eelpout	R		R	R	R
Lycenchelys crotalinus	Snakehead Eelpout	R		R	R	R
Lycodes cortezianus	Bigfin Eelpout	R	R	R	R	R
Lycodes diapterus	Black Eelpout	R	R	R	R	R
Lycodes pacificus	Blackbelly Eelpout	C	R	C	C	C
Lyconema barbatum	Bearded Eelpout	R		R	R	R
Stichaeidae	Pricklebacks					
Anoplarchus purpurescens	High Cockscomb	R	R	R	R	R

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Cebidichthys violaceus	Monkeyface Prickleback	R	R	R	R	R
Chirolophis nugator	Mosshead Warbonnet	R	R	R	R	R
Esselenichthys carli	Threeline Prickleback	R	R		R	R
Esselenichthys laurae	Twoline Prickleback	R	R	R	R	R
Lumpenopsis clitella	Saddled Prickleback	R		R		R
Phytichthys chirus	Ribbon Prickleback	R	R		R	
Plectobranchus evides	Bluebarred Prickleback	R		R	R	R
Poroclinus rothrocki	Whitebarred Prickleback	R		R	R	R
Xiphister atropurpureus	Black Prickleback	R	R		R	R
Xiphister mucosus	Rock Prickleback	R	R		R	
Pholidae	Gunnels					
Apodichthys flavidus	Penpoint Gunnel	R	R		R	R
Apodichthys fucorum	Rockweed Gunnel	A	A		A	A
Pholis ornata	Saddleback Gunnel	R	R	R	R	R
Ulvicola sanctaerosae	Kelp Gunnel	R	R		R	R
Anarhichadidae	Wolffishes					
Anarrhichthys ocellatus	Wolf-Eel	R	R	R	R	R
Ammodytidae	Sand Lances					
Ammodytes personatus	Pacific Sand Lance	R	R	R	R	R
Uranoscopidae	Stargazers					
Astroscopus zephyreus	Pacific Stargazer	R	R	R		R
Kathetostoma averruncus	Smooth Stargazer	R	R	R	R	R
Blenniidae	Combtooth Blennies					
Hypsoblennius gentilis	Bay Blenny	C	C		C	C
Hypsoblennius gilberti	Rockpool Blenny	C	C		C	C
Hypsoblennius jenkinsi	Mussel Blenny	C	C		R	C
Ophioblennius steindachneri	Panamic Fanged Blenny	R	R			R
Plagiotremus azaleus	Sabertooth Blenny	R	R	R	R	R
Clinidae	Kelp Blennies					
Gibbonsia elegans	Spotted Kelpfish	A	A	R	A	A
Gibbonsia metzi	Striped Kelpfish	R	R		R	R

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Gibbonsia montereyensis	Crevice Kelpfish	R	R	R	R	R
Heterostichus rostratus	Giant Kelpfish	C	C	C	C	C
Labrisomidae	Labrisomid Blennies					
Alloclinus holderi	Island Kelpfish	C	C	C	C	C
Cryptotrema corallinum	Deepwater Blenny	C	R	C	C	C
Labrisomus xanti	Largemouth Blenny	R	R		R	R
Paraclinus integripinnis	Reef Finspot	R	R		R	R
Chaenopsidae	Tube Blennies					
Chaenopsis alepidota	Orangethroat Pikeblenny	R	R		R	
Neoclinus blanchardi	Sarcastic Fringehead	C	R	C	C	C
Neoclinus stephensae	Yellowfin Fringehead	A	A		A	A
Neoclinus uninotatus	Onespot Fringehead	C	C	R	C	C
Icosteidae	Ragfishes					
Icosteus aenigmaticus	Ragfish	R	R	R	R	R
Gobiesocidae	Clingfishes					
Gobiesox eugrammus	Lined Clingfish	R	R	R		R
Gobiesox maeandricus	Northern Clingfish	R	R		R	R
Gobiesox papillifer	Bearded Clingfish	R	R			R
Gobiesox rhessodon	California Clingfish	R	R		R	R
Rimicola cabrilloi	Channel Islands Clingfish	R	R		R	R
Rimicola dimorpha	Southern Clingfish	R	R		R	R
Rimicola eigenmanni	Slender Clingfish	R	R		R	R
Rimicola muscarum	Kelp Clingfish	C	C		C	C
Callionymidae	Dragonets					
Synchiropus atrilabiatus	Blacklip Dragonet	R	R	R		R
Eleotridae	Sleepers					
Dormitator latifrons	Pacific Fat Sleeper	R	R			R
Gobiidae	Gobies					
Acanthogobius flavimanus	Yellowfin Goby	R	R		R	R
Bollmannia stigmatura	Tailspot Goby	R	R	R		R
Clevelandia ios	Arrow Goby	C	C	R	C	C

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Ctenogobius sagittula	Longtail Goby	R	R		R	R
Eucyclogobius kristinae	Southern Tidewater Goby	R	R			R
Eucyclogobius newberryi	Northern Tidewater Goby	R	R		R	
Gillichthys mirabilis	Longjaw Mudsucker	C	C		C	C
Ilypnus gilberti	Cheekspot Goby	R	R		R	R
Lepidogobius lepidus	Bay Goby	C	C	C	C	C
Lethops connectens	Halfblind Goby	R	R	R	R	R
Lythrypnus dalli	Bluebanded Goby	C	C	C	C	C
Lythrypnus zebra	Zebra Goby	C	C	C	C	C
Quietula y-cauda	Shadow Goby	R	R		R	R
Rhinogobiops nicholsii	Blackeye Goby	A	A	A	A	A
Tridentiger trigonocephalus	Chameleon Goby	R	R			R
Typhlogobius californiensis	Blind Goby	R	R		R	R
Ephippidae	Spadefishes					
Chaetodipterus zonatus	Pacific Spadefish	R	R	R		R
Acanthuridae	Surgeonfishes					
Acanthurus xanthopterus	Yellowfin Surgeonfish	R	R	R	R	R
Sphyraenidae	Barracudas					
Sphyraena argentea	Pacific Barracuda	A	A	A	A	A
Sphyraena ensis	Mexican Barracuda	R	R	R		R
Scombridae	Mackerels					
Auxis rochei	Bullet Tuna	R	R	R	R	R
Auxis thazard	Frigate Tuna	R	R	R		R
Euthynnus affinis	Kawakawa	R	R	R	R	R
Euthynnus lineatus	Black Skipjack	R	R	R	R	R
Sarda chiliensis	Pacific Bonito	C	C	C	C	C
Scomber japonicus	Pacific Chub Mackerel	C	C	C	C	C
Scomberomorus concolor	Gulf Sierra	R	R	R	R	R
Scomberomorus sierra	Pacific Sierra	R	R	R	R	R
Stromateidae	Butterfishes					
Peprilus simillimus	Pacific Pompano	A	A	A	A	A

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
PLEURONECTIFORMES	FLATFISHES					
Paralichthyidae	Sand Flounders					
Citharichthys fragilis	Gulf Sanddab	R	R	R	R	R
Citharichthys sordidus	Pacific Sanddab	C	R	A	C	C
Citharichthys stigmaeus	Speckled Sanddab	C	C	C	C	C
Citharichthys xanthostigma	Longfin Sanddab	R	R	R	R	R
Hippoglossina stomata	Bigmouth Sole	R	R	A	C	C
Paralichthys californicus	California Halibut	C	C	C	C	C
Xystreurys liolepis	Fantail Sole	C	C	C	C	C
Pleuronectidae	Righteye Flounders					
Atheresthes stomias	Arrowtooth Flounder	R	R	R	R	R
Eopsetta jordani	Petrale Sole	R	R	R	R	R
Glyptocephalus zachirus	Rex Sole	R	R	R	R	R
Hippoglossus stenolepis	Pacific Halibut	R	R	R	R	R
Isopsetta isolepis	Butter Sole	R	R	R	R	R
Lepidopsetta bilineata	Southern Rock Sole	R	R	R	R	R
Lyopsetta exilis	Slender Sole	R	R	R	R	R
Microstomus bathybius	Deepsea Sole	R		R	R	R
Microstomus pacificus	Dover Sole	R	R	R	R	R
Parophrys vetulus	English Sole	C	C	C	C	C
Platichthys stellatus	Starry Flounder	R	R	R	R	R
Pleuronichthys coenosus	C-O Sole	C	C	R	C	C
Pleuronichthys decurrens	Curlfin Sole	C	R	C	C	C
Pleuronichthys guttulatus	Diamond Turbot	C	C	R	C	C
Pleuronichthys ritteri	Spotted Turbot	C	C	R	C	C
Pleuronichthys verticalis	Hornyhead Turbot	C	C	C	C	C
Psettichthys melanostictus	Sand Sole	R	R	R	R	R
Reinhardtius hippoglossoides	Greenland Halibut	R	R	R	R	R
Bothidae	Lefteye Flounders					
Engyophrys sanctilaurentii	Speckledtail Flounder	R	R	R		R
Cynoglossidae	Tonguefishes					

Taxon	Common Name	Overall	Core	Seaward	PCPV	PVMX
Symphurus atricauda	California Tonguefish	C	C	C	C	C
TETRADONTIFORMES	PUFFERFISHES AND RELATIVES					
Balistidae	Triggerfishes					
Balistes polylepis	Finescale Triggerfish	R	R	R	R	R
Ostraciidae	Boxfishes					
Lactoria diaphana	Spiny Boxfish	R	R	R	R	R
Tetraodontidae	Puffers					
Sphoeroides annulatus	Bullseye Puffer	R	R	R	R	R
Diodontidae	Porcupinefishes					
Chilomycterus reticulatus	Spotfin Burrfish	R	R	R	R	R
Diodon holocanthus	Balloonfish	R	R	R	R	R
Diodon hystrix	Porcupinefish	R	R	R	R	R

APPENDIX 12

Depth and Habitat Associations of Documented Fishes in the Southern California Bight

These associations are based on Ebert (2002), Love et al. (2005), Love (2011), Butler et al. (2012), Kells et al. (2016), and a review of primary literature, fishery-independent survey catches, and museum records. Included in the following table is the vertical zonation, which is classified as Benthic (benthic and demersal), Midwater, Pelagic, and WC (meaning, found throughout the water column). The table also lists the depth range in meters (i.e., the minimum [Min] and maximum [Max]) and the common depth in meters. For each seafloor habitat (mud, sand, gravel, shell, etc.) a numeral indicates whether it is a primary or secondary habitat: 1 = primary habitat or similar utilization of habitat types for generalist species. 2 = secondary habitat. Gravel includes pebbles. SFMI stands for structure-forming marine invertebrates.

Habitat associations are for combined juvenile and adult life stages. Only benthic habitat associations are indicated. Fishes are primarily marine with the following exceptions: Exotic = non-native species and FW = freshwater usage (X = yes, A = anadromous). S = surface depth. 0 = bottom depth.

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
MYXINIFORMES	HAGFISHES																
Myxinidae	Hagfishes																
Eptatretus deani	Black Hagfish			Benthic	52–2743	600–1201	1		2								
Eptatretus mcconnaugheyi	Shorthead Hagfish			Benthic	42–415		1										
Eptatretus stoutii	Pacific Hagfish			Benthic	16–1247	91–366	1						2				2
PETROMYZONTIFORMES	LAMPREYS																
Petromyzontidae	Lampreys																
Entosphenus tridentatus	Pacific Lamprey		A	WC	16–1508	< 500											
CHIMAERIFORMES	CHIMAERAS																
Chimaeridae	Shortnose Chimaeras																
Hydrolagus colliei	Spotted Ratfish			Benthic	0–1593	115-160	1	1	1		1	1	1				
Hydrolagus melanophasma	Eastern Pacific Black Ghostshark			Benthic	31–1903		1				2						
HETERODONTIFORMES	HORN SHARKS																
Heterodontidae	Horn Sharks																
Heterodontus francisci	Horn Shark			Benthic	0–201			1					1	1	1	2	2

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
ORECTOLOBIFORMES	CARPET SHARKS																
Rhincodontidae	Whale Sharks																
Rhincodon typus	Whale Shark			Pelagic	S–1928												
LAMNIFORMES	MACKEREL SHARKS																
Odontaspididae	Sand Tigers																
Odontaspis ferox	Ragged-tooth Shark			Benthic, Midwater	10–1015			1				1	1				
Megachasmidae	Megamouth Sharks																
Megachasma pelagios	Megamouth Shark			WC	5–1000												
Alopiidae	Thresher Sharks																
Alopias vulpinus	Common Thresher Shark			Pelagic	S–650												
Cetorhinidae	Basking Sharks																
Cetorhinus maximus	Basking Shark			Pelagic	S–1501												
Lamnidae	Mackerel Sharks																
Carcharodon carcharias	White Shark			WC	0–1200												
Isurus oxyrinchus	Shortfin Mako			Pelagic	S–888												
Lamna ditropis	Salmon Shark			Pelagic	S–1864												
CARCHARHINIFORMES	GROUND SHARKS																
Scyliorhinidae	Cat Sharks																
Apristurus brunneus	Brown Cat Shark			Benthic, Midwater	24–1401		1	1					2				
Cephaloscyllium ventriosum	Swell Shark			Benthic	5–457	< 23							1	1	1		
Parmaturus xaniurus	Filetail Cat Shark			Benthic, Midwater	88–1519		1	1					2				
Triakidae	Hound Sharks																
Galeorhinus galeus	Soupfin Shark			WC	0–826												

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Mustelus californicus	Gray Smooth-hound			Benthic	0–265		1	1								2	
Mustelus henlei	Brown Smooth-hound			Benthic, WC	0–369		1	1									
Mustelus lunulatus	Sicklefin Smoothhound			Benthic	1–200		1	1									
Triakis semifasciata	Leopard Shark			Benthic	0–156		1	1					1		1	2	
Carcharhinidae	Requiem Sharks																
Carcharhinus brachyurus	Narrowtooth Shark			WC	0–360												
Carcharhinus obscurus	Dusky Shark			WC	0–573												
Galeocerdo cuvier	Tiger Shark			WC	0–1153												
Prionace glauca	Blue Shark			Pelagic	S–1136												
Sphyrnidae	Hammerhead Sharks																
Sphyrna lewini	Scalloped Hammerhead			Pelagic	S–1043												
Sphyrna zygaena	Smooth Hammerhead			Pelagic	S–200												
HEXANCHIFORMES	SIX-GILL SHARKS																
Hexanchidae	Cow Sharks																
Hexanchus griseus	Bluntnose Sixgill Shark			Benthic, WC	10–2490	> 91	1	1	1		1	1	1				
Notorynchus cepedianus	Broadnose Sevengill Shark			Benthic	1–570	< 50	2	2					1	1			
ECHINORHINIFORMES	BRAMBLE SHARKS																
Echinorhinidae	Bramble Sharks																
Echinorhinus cookei	Prickly Shark			Benthic	4–1100	100-650	1	1									
SQUALIFORMES	DOGFISH SHARKS																
Squalidae	Dogfish Sharks																
Squalus suckleyi	Pacific Spiny Dogfish			WC, Benthic	0–1460	10-250	1	1	1		1	1	1			1	
Somniosidae	Sleeper Sharks																
Somniosus pacificus	Pacific Sleeper Shark			Benthic, WC	0–2205		1	2					2				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
SQUATINIFORMES	ANGEL SHARKS																
Squatinidae	Angel Sharks																
Squatina californica	Pacific Angel Shark			Benthic, Midwater	0–205	15-40	1	1					2		2	2	
TORPEDINIFORMES	ELECTRIC RAYS																
Torpedinidae	Electric Rays																
Tetronarce californica	Pacific Electric Ray			Benthic, Midwater	0–406	60-200	1	1				2	1		2		
RAJIFORMES	SKATES																
Rhinobatidae	Guitarfishes																
Pseudobatos productus	Shovelnose Guitarfish			Benthic	0–91	< 12	1	1							2	2	
Trygonorrhinidae	Banjo Rays																
Zapteryx exasperata	Banded Guitarfish			Benthic	0–200	< 9	1	1					1				
Arhynchobatidae	Softnose Skates																
Bathyraja kincaidii	Sandpaper Skate			Benthic	18–1372	200–500	1	2			2	2	2				
Rajidae	Hardnose Skates																
Beringraja binoculata	Big Skate			Benthic	2–501	< 100	1	1	2	2							
Beringraja inornata	California Skate			Benthic	3–300	< 120	1	1									
Beringraja rhina	Longnose Skate			Benthic	9–1294	200–400	1	1	1		2		2				
Beringraja stellulata	Starry Skate			Benthic	2–400	80-140	2	1					1				
MYLIOBATIFORMES	STINGRAYS																
Platyrhynidae	Thornbacks																
Platyrhinoidis triseriata	Thornback Ray			Benthic	0–137	< 28	1	1							2	2	
Urotrygonidae	Round Stingrays																
Urobatis helleri	Round Stingray			Benthic	0–91	< 28	1	1					1			1	
Dasyatidae	Whiptail Stingrays																
Hypanus dipterurus	Diamond Stingray			Benthic	0–150	< 17	1	1					2		2		
Gymnuridae	Butterfly Rays																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Gymnura marmorata	California Butter-fly Ray			Benthic	0–94	< 10	1	1									
Myliobatidae	Eagle Rays																
Myliobatis californica	Bat Ray			Benthic, WC	0–176	< 20	1	1					2		2	2	
Mobulidae	Devil Rays																
Mobula birostris	Manta			Pelagic	S–1000												
Mobula mobular	Spinetail Devil Ray			Pelagic	S–700												
ACIPENSERIFORMES	STURGEONS																
Acipenseridae	Sturgeons																
Acipenser medirostris	Green Sturgeon		A	Benthic	168		1	1	1		1	1	1				
Acipenser transmon-tanus	White Sturgeon		A	Benthic	122	< 50	1	1	1		1	1	1				
ELOPIFORMES	TENPOUNDERS																
Elopidae	Tenpounders																
Elops affinis	Machete			Benthic, WC	1–10		1	1					1				1
ALBULIFORMES	BONEFISHES																
Albulidae	Bonefishes																
Albula gilberti	Cortez Bonefish			Benthic	0–27		1	1								1	
ANGUILLIFORMES	EELS																
Muraenidae	Morays																
Gymnothorax mordax	California Moray			Benthic	0–40								1				
Muraena argus	Argus Moray			Benthic	5–120							1	1				1
Ophichthidae	Snake Eels																
Myrophis vafer	Pacific Worm Eel			Benthic, Midwa-ter	0–46		1	1									
Ophichthus triserialis	Pacific Snake Eel			Benthic	0–155		1	1									
Ophichthus zophochir	Yellow Snake Eel			Benthic, WC	0–110		1	1					1				
Congridae	Conger Eels																
Gnathophis cinctus	Hardtail Conger			Benthic	9–366		1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Nettastomatidae	Duckbill Eels																
Facciolella equatorialis	Dogface Witch Eel			Benthic	64–1000		1										
CLUPEIFORMES	ANCHOVIES AND HERRINGS																
Engraulidae	Anchovies																
Anchoa compressa	Deepbody Anchovy			Pelagic	S/0–19	< 12											
Anchoa delicatissima	Slough Anchovy			Pelagic	S/0–27												
Cetengraulis mysticetus	Anchoveta			Pelagic	S–38												
Engraulis mordax	Northern Anchovy			Pelagic	S/0–528												
Clupeidae	Herrings																
Alosa sapidissima	American Shad	X	A	Pelagic	S–250												
Clupea pallasii	Pacific Herring			Pelagic	S–250	< 150											
Dorosoma petenense	Threadfin Shad	X	FW	Pelagic	S–20												
Etrumeus acuminatus	Pacific Round Herring			Pelagic	S–200	< 12											
Harengula thrissina	Flatiron Herring			Pelagic	S–7												
Opisthonema libertate	Deepbody Thread Herring			Pelagic	S/0–70												
Opisthonema medirastre	Middling Thread Herring			Pelagic	S/0–10												
Sardinops sagax	Pacific Sardine			Pelagic	S/0–383												
GONORYNCHIFORMES	MILKFISH AND RELATIVES																
Chanidae	Milkfishes																
Chanos chanos	Milkfish		FW	Benthic, WC	S/0–20		1	1					1				1
SILURIFORMES	CATFISHES																
Ariidae	Sea Catfishes																
Bagre panamensis	Chihuil			Benthic, Midwater	0–177		1	2	2								

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
ARGENTINIFORMES	ARGENTINES																
Argentinidae	Argentines																
Argentina sialis	Pacific Argentine			Benthic	11–1093	170-220	1	1									
OSMERIFORMES	FRESHWATER SMELTS																
Osmeridae	Smelts																
Hypomesus pretiosus	Surf Smelt			Benthic, Pelagic	0–185	< 50									1	1	
Spirinchus starksi	Night Smelt			Pelagic	S/0–128												
Spirinchus thaleichthys	Longfin Smelt		A	Pelagic	S/0–137												
Thaleichthys pacificus	Eulachon		A	WC, Benthic	10–400	20–150	1	1	2		2						
SALMONIFORMES	SALMON AND TROUTS																
Salmonidae	Salmon and Trouts																
Oncorhynchus gorbuscha	Pink Salmon		A	Pelagic	S–74	< 10											
Oncorhynchus keta	Chum Salmon		A	Pelagic	S–253	< 10											
Oncorhynchus mykiss	Steelhead		A, FW	Pelagic	S	< 20											
Oncorhynchus nerka	Sockeye Salmon		A	Pelagic	S–83	< 10											
Oncorhynchus tshawytscha	Chinook Salmon		A	Pelagic, WC	S–538	< 150											
AULOPIFORMES	LIZARDFISHES																
Synodontidae	Lizardfishes																
Synodus lucioceps	California Lizardfish			Benthic	1–250		1	1	2			2	2				
Alepisauridae	Lancetfishes																
Alepisaurus ferox	Longnose Lancetfish			Pelagic, Midwater	5–1830												
Paralepididae	Barracudinas																
Macroparalepis johnfitchi	Black Barracudina			Pelagic	15/0–177												

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Lophotidae	Crestfishes																
Lophotus capellei	North Pacific Crestfish			Pelagic, Benthic	S/0–1100												
GADIFORMES	CODS																
Moridae	Codlings, Deep-sea Cods, or Moras																
Physiculus rastrelliger	Hundred-fathom Codling			Benthic	21–1369								1				
Merlucciidae	Hakes																
Merluccius productus	Pacific Hake			Pelagic, Benthic	12–1437	50–450											
Gadidae	Cods																
Gadus macrocephalus	Pacific Cod			Benthic, Pelagic	0–1280	< 300	1	1	2		1	2	2		1	1	1
Ophidiidae	Cusk-eels																
Brotula clarkae	Pacific Bearded Brotula			Benthic	1–645		1	1		1			1				
Chilara taylori	Spotted Cusk-eel			Benthic	0–1128	30-190	1	1									
Ophidion scrippsae	Basketweave Cusk-eel			Benthic	2–1098	< 110	1	1									
Bythitidae	Livebearing Brotulas																
Brosmophycis marginata	Red Brotula			Benthic	3–256								1				
Grammonus diagrammus	Purple Brotula			Benthic	3–81	6-18							1				
BATRACHOIDIFORMES	TOADFISHES																
Batrachoididae	Toadfishes																
Porichthys myriaster	Specklefin Midshipman			Benthic	0–126	< 60	1	1					1				
Porichthys notatus	Plainfin Midshipman			Benthic, Pelagic	0–464	< 250	1	1								2	
LOPHIFORMES	ANGLERFISHES																
Lophiidae	Goosefishes																
Lophiodes caulinaris	Spottedtail Goosefish			Benthic	15–888		1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Lophiodes spilurus	Threadfin Goosefish			Benthic	55–850		1	1									
Antennariidae	Frogfishes																
Fowlerichthys avalonis	Roughjaw Frog-fish			Benthic	0–311		1	1					1	1			
Ogcocephalidae	Batfishes																
Zalieutes elater	Roundel Batfish			Benthic	10–251		1	1									
MUGILIFORMES	MULLETS																
Mugilidae	Mullets																
Mugil cephalus	Striped Mullet		FW	Benthic, WC	0–122		1	1									
Mugil setosus	Liseta Mullet		FW	Benthic, WC	0–25		2	2					1				
ATHERINIFORMES	SILVERSIDES																
Atherinopsidae	New World Silver-sides																
Atherinops affinis	Topsmelt			Pelagic	S/0–26												
Atherinopsis californ-iensis	Jacksmelt			Pelagic	S/0–29												
Leuresthes tenuis	California Grun-ion			WC	0–18												
BELONIFORMES	NEEDLEFISHES AND RELATIVES																
Exocoetidae	Flyingfishes																
Cheilopogon heterurus	Blotchwing Fly-ingfish			Pelagic	S–S												
Cheilopogon pinnati-barbatus	Smallhead Fly-ingfish			Pelagic	S–10												
Fodiator rostratus	Sharpchin Fly-ingfish			Pelagic	S/0–S												
Hemiramphidae	Halfbeaks																
Euleptorhamphus viridis	Ribbon Halfbeak			Pelagic	S–5												
Hemiramphus saltator	Longfin Halfbeak			Pelagic	S–27												
Hyporhamphus naos	Pacific Silver-stripe Halfbeak			Pelagic	S–30												

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Hyporhamphus rosae	California Halfbeak		FW	Pelagic	S–2												
Belonidae	Needlefishes																
Strongylura exilis	California Needlefish		FW	Pelagic	S/0–100												
Scomberesocidae	Sauries																
Cololabis saira	Pacific Saury			Pelagic	S/0–295												
CYPRINODONTIFORMES	KILLIFISHES AND RELATIVES																
Fundulidae	Topminnows																
Fundulus parvipinnis	California Killifish		FW	WC	S–10	< 3											
Lucania goodei	Bluefin Killifish	X	FW	WC	S–10												
Poeciliidae	Livebearers																
Poecilia latipinna	Sailfin Molly	X	FW	Pelagic	S												
ZEIFORMES	DORIES AND BOARFISHES																
Zeidae	Dories																
Zenopsis nebulosa	Mirror Dory			Pelagic	30–800												
GASTEROSTEIFORMES	STICKLEBACKS																
Aulorhynchidae	Tubesnouts																
Aulorhynchus flavidus	Tubesnout			WC	0–40	< 20		1					1		1	1	
Syngnathidae	Pipefishes																
Cosmocampus arctus	Snubnose Pipefish			Benthic	0–20								1	1			
Hippocampus ingens	Pacific Seahorse			Benthic, WC	0–107								1	1		1	
Syngnathus auliscus	Barred Pipefish			Benthic, WC	0–20									1		1	
Syngnathus californiensis	Kelp Pipefish			WC, Benthic	0–15	< 12									1	2	
Syngnathus euchrous	Chocolate Pipefish			Benthic, WC	0–18								1	1		1	
Syngnathus leptorhynchus	Bay Pipefish			WC, Benthic	0–18	< 3	2	2	2					2	2	1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Fistulariidae	Cornetfishes																
Fistularia commersonii	Reef Cornetfish			Benthic	0–132			2					1				
Fistularia corneta	Deepwater Cornetfish			WC	S–50								1				
SCORPAENIFORMES	SCORPIONFISHES																
Scorpaenidae	Rockfishes and Thornyheads																
Scorpaena guttata	California Scorpionfish			Benthic, WC	0–266	10-85	2	2		2			1	2	2	2	2
Scorpaena mystes	Stone Scorpionfish			Benthic	0–100			2					1	1			
Scorpaenodes xyris	Rainbow Scorpionfish			Benthic	0–50								1				
Sebastes alutus	Pacific Ocean Perch			Benthic, WC	70–1125	100–400	1	1			1	1	1				1
Sebastes atrovirens	Kelp Rockfish			WC	3–114	2-30							1		1		
Sebastes auriculatus	Brown Rockfish			Benthic	0–287	< 70	2	2		2			1	2		2	
Sebastes aurora	Aurora Rockfish			Benthic	81–1176	300-500	1	2					1				
Sebastes babcocki	Redbanded Rockfish			Benthic	21–1150	150-450	2		2		2		1				
Sebastes brevispinis	Silvergray Rockfish			Benthic	17–622	100-300	2	2			2	1	1		2		
Sebastes carnatus	Gopher Rockfish			Benthic	0–88	12-50							1		1	2	
Sebastes caurinus	Copper Rockfish			Benthic	0–408	5–70	2	2				1	1				
Sebastes chlorostictus	Greenspotted Rockfish			Benthic	30–431	80-200	2	2				1	1				2
Sebastes chrysomelas	Black-and-Yellow Rockfish			Benthic	0–37	2-15							1		1		
Sebastes constellatus	Starry Rockfish			Benthic	15–274	40-160					2	1	1				2
Sebastes crameri	Darkblotched Rockfish			Benthic	29–915	140-210	1	2			1	1	1				2
Sebastes crocotulus	Sunset Rockfish			Benthic	30-439	> 100							1				
Sebastes dallii	Calico Rockfish			Benthic	0–305	45-70	2	2					1				2
Sebastes diaconus	Deacon Rockfish			WC	8–72	< 50							1				

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Sebastes diploproa	Splitnose Rockfish			Benthic	50–1050	150–450	1			2			2				
Sebastes elongatus	Greenstriped Rockfish			Benthic	12–1151	100–300	1	1		1	1	1	1				
Sebastes ensifer	Swordspine Rockfish			Benthic	50–433	90-140	2				1	1	1				2
Sebastes entomelas	Widow Rockfish			Benthic, WC	0–800	80-125					2		1	2	2		
Sebastes eos	Pink Rockfish			Benthic	45–366	200-350						1	1				
Sebastes flavidus	Yellowtail Rockfish			WC	0–549	90–180						1	1	2	1	2	
Sebastes gilli	Bronzespotted Rockfish			Benthic	75–413	130-250						1	1				
Sebastes goodei	Chilipepper			Benthic, Midwater	30–515	75-325	2	2					1		2		
Sebastes helvomaculatus	Rosethorn Rockfish			Benthic	27–1151	80-350	2				2	2	1				
Sebastes hopkinsi	Squarespot Rockfish			Benthic, Midwater	15–305	30-150					2	1	1				
Sebastes jordani	Shortbelly Rockfish			Benthic	26–515	150-270	1	1				2	1		2		
Sebastes lentiginosus	Freckled Rockfish			Benthic	22–311	70-80						1	1				
Sebastes levis	Cowcod			Benthic	40–522	130-215	2	2			2	1	1				2
Sebastes macdonaldi	Mexican Rockfish			Benthic	73–354								1				
Sebastes maliger	Quillback Rockfish			Benthic	0–398	10-140							1		1	1	1
Sebastes melanops	Black Rockfish			WC	0–366	< 75							1	2	1	2	
Sebastes melanosema	Semaphore Rockfish			Benthic	88–659		2	2					1				
Sebastes melanostictus	Blackspotted Rockfish			Benthic	25–1000	350-450	2	2				1	1				
Sebastes melanostomus	Blackgill Rockfish			Benthic	88–768	200-600	1	2				1	1				2

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Sebastes miniatus	Vermilion Rock-fish			Benthic	12–478	40-105	2	2			1	1	1				
Sebastes moseri	Whitespotted Rockfish			Benthic	50–274	80-200					2		1				
Sebastes mystinus	Blue Rockfish			WC, Benthic	0–156	2-55							1		1		
Sebastes nebulosus	China Rockfish			Benthic	3–177	10–100		2			2	1	1		1	2	2
Sebastes nigrocinctus	Tiger Rockfish			Benthic	2–298	> 30						1	1				
Sebastes ovalis	Speckled Rock-fish			Benthic	30–366	90-140					2	1	1				
Sebastes paucispinis	Bocaccio			Benthic, WC	20–475	95-225						1	1		1		
Sebastes pinniger	Canary Rockfish			Benthic, WC	18–458	80-200	2				2	1	1				
Sebastes proriger	Redstripe Rock-fish			Benthic	4–550	55-300	2	2	1		1	1	1				
Sebastes rastrelliger	Grass Rockfish			Benthic	0–68	0-15							1	1	1	1	
Sebastes rosaceus	Rosy Rockfish			Benthic	7–328	40-100	2	2			1	1	1				2
Sebastes rosenblatti	Greenblotched Rockfish			Benthic	55–500	170-270	2					1	1				
Sebastes ruberrimus	Yelloweye Rock-fish			Benthic	11–732	90–180						1	1				
Sebastes rubrivinctus	Flag Rockfish			Benthic	30–431	60-160					2	1	1		1		
Sebastes rufinanus	Dwarf-Red Rock-fish			Benthic	58–220						1	1	1				
Sebastes rufus	Bank Rockfish			Benthic	31–512	175-300	2				2	1	1				2
Sebastes saxicola	Stripetail Rock-fish			Benthic	25–547	180-270	1	1		1	1		1				1
Sebastes semicinctus	Halfbanded Rockfish			Benthic	15–440	60-135	2	1			1	2	1	2	2		2
Sebastes serranoides	Olive Rockfish			Benthic, WC	0–172	< 55							1		2	2	
Sebastes serriceps	Treefish			Benthic	0–103	< 50						1	1		1		
Sebastes umbrosus	Honeycomb Rockfish			Benthic	18–270	30-90					1	1	2				
Sebastes wilsoni	Pygmy Rockfish			Benthic	29–391	200-300	1	1			1	1	1				1

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Sebastes zacentrus	Sharpchin Rockfish			Benthic	25–660	200-300	1			1	1	1	1				1
Sebastolobus alascanus	Shortspine Thornyhead			Benthic	17–1524	200-800	1		2		2		2				2
Sebastolobus altivelis	Longspine Thornyhead			Benthic	72–1756	500-1300	1						2				2
Triglidae	Searobins																
Prionotus albirostris	Whitesnout Searobin			Benthic	6–134		2	1									
Prionotus stephanophrys	Lumptail Searobin			Benthic	2–255	10-100	2	1									
Anoplopomatidae	Sablefishes																
Anoplopoma fimbria	Sablefish			Benthic, Pelagic	12–2740	300-1000	1				2	2					
Zaniolepididae	Combfishes																
Oxylebius pictus	Painted Greenling			Benthic	0–249	< 50	2	2				1	1				2
Zaniolepis frenata	Shortspine Combfish			Benthic, Midwater	7–450	100-215	1	2	1		1						
Zaniolepis latipinnis	Longspine Combfish			Benthic, Midwater	16–421	50-205	1	2					2				
Hexagrammidae	Greenlings																
Hexagrammos decagrammus	Kelp Greenling			Benthic	0–303	0-100							1	1	1	1	
Hexagrammos lagocephalus	Rock Greenling			Benthic	0–80	0-20					1		1	1	1	1	
Ophiodon elongatus	Lingcod			Benthic	0–750	30-200	1	1		1		1	1		1	1	1
Pleurogrammus monopterygius	Atka Mackerel			Benthic, WC	0–720	< 225							1				
Jordaniidae	Longfin Sculpins																
Paricelinus hopliticus	Thornback Sculpin			Benthic	16–352	> 76							1				
Scorpaenichthyidae	Cabezon																
Scorpaenichthys marmoratus	Cabezon			Benthic	0–226	< 73	2				2		1		2	2	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Rhamphocottidae	Grunt Sculpins																
Rhamphocottus richardsonii	Grunt Sculpin			Benthic	0–258	< 10		2		2			1	2			
Cottidae	Freshwater Sculpins																
Cottus asper	Prickly Sculpin		FW	Benthic	< 92			1	1		1	1					
Leptocottus armatus	Pacific Staghorn Sculpin		FW	Benthic	0–335	< 10	1	1		1						1	
Psychrolutidae	Marine Sculpins																
Artedius corallinus	Coralline Sculpin			Benthic	0–70							1	1	1			
Artedius notospilotus	Bonyhead Sculpin			Benthic	0–52								1	1			
Chitonotus pugetensis	Roughback Sculpin			Benthic	0–329	30-70	1	1	2				2			2	
Clinocottus analis	Woolly Sculpin			Benthic	0–18	< 2		1	1		1		1	1			
Clinocottus embryum	Calico Sculpin			Benthic	0–2					1			1	1			
Clinocottus globiceps	Mosshead Sculpin			Benthic	0–44						2		1				
Clinocottus recalvus	Bald Sculpin			Benthic	0–2								1				
Enophrys bison	Buffalo Sculpin			Benthic	0–194	< 45		1	1		1		1	1	1	1	1
Enophrys taurina	Bull Sculpin			Benthic	11–439		1	1									
Icelinus burchami	Dusky Sculpin			Benthic	61–622		1	1					2				2
Icelinus cavifrons	Pit-Head Sculpin			Benthic	11–110		1	1					2				
Icelinus filamentosus	Threadfin Sculpin			Benthic	18–482	160-265	1	1	1								
Icelinus fimbriatus	Fringed Sculpin			Benthic	30–265		1	1					2				
Icelinus limbaughi	Canyon Sculpin			Benthic	16–86		1	1					1	1			
Icelinus quadriseriatus	Yellowchin Sculpin			Benthic	0–201	20-100	1	1									
Icelinus tenuis	Spotfin Sculpin			Benthic	7–375	60–100	1	1		1			2				
Leiocottus hirundo	Lavender Sculpin			Benthic	0–37	3-21		1					2	2		2	
Oligocottus maculosus	Tidepool Sculpin			Benthic	0–9			1			1		1	1		1	1
Oligocottus rimensis	Saddleback Sculpin			Benthic	0–21				1				1	1	1	1	
Oligocottus rubellio	Rosy Sculpin			Benthic	0–34								1	1			

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Oligocottus snyderi	Fluffy Sculpin			Benthic	0–6			2			1		1	1		1	
Orthonopias triacis	Snubnose Sculpin			Benthic	0–30	5-21							1	1			
Radulinus asprellus	Slim Sculpin			Benthic	9–699		1										
Radulinus boleoides	Darter Sculpin			Benthic	15–182		1	1	1	1							
Radulinus vinculus	Smoothgum Sculpin			Benthic	21–100		1	1	1	1							
Ruscarius creaseri	Roughcheek Sculpin			Benthic	0–37	6-15							1				
Agonidae	Poachers																
Agonopsis sterletus	Southern Spearnose Poacher			Benthic	3–213		1	1					2				
Bathyagonus pentacanthus	Bigeye Poacher			Benthic	50–1197	100–375	1	1									
Bothragonus swanii	Rockhead			Benthic	0–21				1			1	1		1		1
Hemilepidotus spinosus	Brown Irish Lord			Benthic	0–175								1	1			
Odontopyxis trispinosa	Pygmy Poacher			Benthic	5–373	< 70	1	1									
Stellerina xyosterna	Pricklebreast Poacher			Benthic	2–100	< 76	1	1									
Xeneretmus latifrons	Blacktip Poacher			Benthic	2–1291	> 120	1	1									
Xeneretmus leiops	Smootheye Poacher			Benthic	24–803		1	1									
Xeneretmus triacanthus	Bluespotted Poacher			Benthic	15–624		1	1									
Liparidae	Snailfishes																
Careproctus colletti	Alaska Snailfish			Benthic	64–1556		1	1									
Careproctus melanurus	Blacktail Snailfish			Benthic	50–2286	> 400	1										
Liparis florae	Tidepool Snailfish			Benthic	0–15					1	1	1	1	1	1	1	
Liparis mucosus	Slimy Snailfish			Benthic	0–18	< 6	2	2				1	1	1			
Nectoliparis pelagicus	Tadpole Snailfish			Benthic, Midwater	2–3383	45–439	1										

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Rhinoliparis barbulifer	Longnose Snail-fish			Benthic	28–1500		1										
PERCIFORMES	PERCHES																
Moronidae	Temperate Basses																
Morone saxatilis	Striped Bass	X	A	Benthic, WC	0–55		1	1	1			1	1				
Polyprionidae	Wreckfishes																
Stereolepis gigas	Giant Sea Bass			Benthic	5–55			2					1	2	1		
Epinephelidae	Groupers																
Cephalopholis colonus	Pacific Creolefish			Benthic, WC	1–120								1				
Dermatolepis derma-tolepis	Leather Bass			Benthic	2–90								1				
Epinephelus analogus	Spotted Cabrilla			Benthic	1–107		2	2					1				
Epinephelus labri-formis	Flag Cabrilla			Benthic	0–50								1				
Hyporthodus acanthis-tius	Gulf Coney			Benthic	12–409	> 46		2					1				
Hyporthodus nipho-bles	Star-Studded Grouper			Benthic	1–450												
Mycteroperca jordani	Gulf Grouper			Benthic	2–50								1				
Mycteroperca xenar-cha	Broomtail Grou-per			Benthic, WC	0–70		2	2					1		2		
Serranidae	Sea Basses																
Diplectrum maximum	Greater Sand Perch			Benthic	1–130		1	1									
Hemanthias signifer	Hookthroat Bass			Benthic	23–305								1				
Paralabrax aurogut-tatus	Goldspotted Sand Bass			Benthic	2–217	30-155							1				
Paralabrax clathratus	Kelp Bass			WC	0–61	< 30											
Paralabrax maculato-fasciatus	Spotted Sand Bass			Benthic, WC	0–90	0-50		1					1			1	
Paralabrax nebulifer	Barred Sand Bass			Benthic, WC	0–183	< 45	1	1		1			1		1	1	1

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Pronotogrammus multifasciatus	Threadfin Bass			Benthic, WC	14–300							1	1				
Serranus aequidens	Deepwater Serrano			Benthic	73–486		1	1									
Priacanthidae	Bigeyes																
Heteropriacanthus carolinus	Pacific Glasseye			Benthic	0–300								1				
Pristigenys serrula	Popeye Catalufa			Benthic	3–1226		2	2					1				
Apogonidae	Cardinalfishes																
Apogon atricaudus	Plain Cardinalfish			Benthic	1–50								1				
Apogon guadalupensis	Guadalupe Cardinalfish			Benthic	10–30								1				
Apogon pacificus	Pink Cardinalfish			Benthic	1–96								1				
Apogon retrosella	Barspot Cardinalfish			Benthic	0–61								1				
Malacanthidae	Tilefishes																
Caulolatilus affinis	Pacific Golden-Eyed Tilefish			Benthic	30–230			1					1				
Caulolatilus princeps	Ocean Whitefish			Benthic, WC	3–189			1					1		2	1	2
Nematistiidae	Roosterfishes																
Nematistius pectoralis	Roosterfish			WC	0–62		2	1									
Carangidae	Jacks																
Carangoides vinctus	Cocinero		FW	WC	4–50												
Caranx caballus	Green Jack			WC	0–100												
Caranx caninus	Pacific Crevalle Jack		FW	Pelagic	S–350												
Caranx sexfasciatus	Bigeye Trevally		FW	WC	1–146												
Chloroscombrus orqueta	Pacific Bumper			WC	2–53												
Decapterus muroadsi	Amberstripe Scad			Pelagic	S–320												
Selar crumenophthalmus	Bigeye Scad			Pelagic	S–230												

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Selene brevoortii	Mexican Look-down			Benthic	2–165			1									
Selene peruviana	Pacific Moonfish			Benthic	4–450			1									
Seriola dorsalis	Yellowtail			Pelagic	S–91												
Seriola rivoliana	Almaco Jack			Pelagic	S–367												
Trachinotus paitensis	Paloma Pom-pano			Benthic	1–100			1									
Trachinotus rhodopus	Gafftopsail Pom-pano			WC	S–30												
Trachurus symmetri-cus	Jack Mackerel			Pelagic	S/0–403												
Uraspis helvola	Cottonmouth Jack			Pelagic	10–300												
Coryphaenidae	Dolphinfishes																
Coryphaena equiselis	Pompano Dol-phinfish			Pelagic	S–50												
Coryphaena hippurus	Dolphinfish			Pelagic	S–262												
Echeneidae	Remoras																
Echeneis naucrates	Sharksucker			Pelagic	S–135												
Remora albescens	White Suckerfish			Pelagic	S–50												
Remora australis	Whalesucker			Pelagic	S–200												
Remora brachyptera	Spearfish Rem-ora			Pelagic	S–200												
Remora osteochir	Marlinsucker			Pelagic	S–200												
Remora remora	Remora			Pelagic	S–300												
Bramidae	Pomfrets																
Taractichthys stein-dachneri	Sickle Pomfret			Pelagic	9–700												
Lutjanidae	Snappers																
Lutjanus argentiventris	Amarillo Snap-per		FW	Benthic	0–94		2	2	2				1				
Lutjanus colorado	Colorado Snap-per		FW	Pelagic	S–90												
Lutjanus novemfas-ciatus	Pacific Dog Snapper		FW	Benthic	0–60		2	2					1	1			

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Lutjanus peru	Pacific Red Snapper			Benthic, WC	18–91		2	2					1				
Lobotidae	Tripletails																
Lobotes pacificus	Pacific Tripletail		FW	Pelagic	S–50												
Gerreidae	Mojarras																
Eucinostomus currani	Pacific Flagfin Mojarra		FW	Benthic	0–100		1	1									
Eucinostomus dowii	Pacific Spotfin Mojarra			Benthic	0–114		1	1									
Haemulidae	Grunts																
Anisotremus davidsonii	Sargo			Benthic	0–61	< 9	2	2					1		1	1	
Brachygenys californiensis	Salema			Benthic, WC	1–40								1	1	1	1	
Conodon serrifer	Armed Grunt			Benthic	1–72		1	1									
Haemulon flaviguttatum	Cortez Grunt			Benthic, WC	1–107								1				
Haemulopsis axillaris	Yellowstripe Grunt			Benthic	2–113		1	1									
Haemulopsis elongatus	Elongate Grunt			Benthic	0–66		1	1									
Microlepidotus inornatus	Wavyline Grunt			Benthic	1–30			1					1				
Sparidae	Porgies																
Calamus brachysomus	Pacific Porgy			Benthic, WC	0–80			1					2				
Polynemidae	Threadfins																
Polydactylus approximans	Blue Bobo		FW	Benthic	0–107		1	1									
Polydactylus opercularis	Yellow Bobo			Benthic	0–107		1	1									
Sciaenidae	Drums and Croakers																
Atractoscion nobilis	White Seabass			Benthic, WC	0–245			2					1	2	1	2	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Cheilotrema saturnum	Black Croaker			Benthic, WC	0–271	1-15							1			2	
Cynoscion parvipinnis	Shortfin Corvina			Benthic	1–101			1									
Genyonemus lineatus	White Croaker			Benthic	0–238	2-130	1	1									
Menticirrhus undulatus	California Corbina			Benthic	0–27	1-12		1									
Roncador stearnsii	Spotfin Croaker			Benthic	0–22			1					2				
Seriphus politus	Queenfish			Benthic	0–181	2-40	1	1								2	
Umbrina roncador	Yellowfin Croaker			Benthic, WC	0–46	< 12		1									
Mullidae	Goatfishes																
Pseudupeneus grandisquamis	Bigscale Goatfish			Benthic	1–67		1	1									
Kyphosidae	Sea Chubs																
Girella nigricans	Opaleye			Benthic	0–32		2	2					1		1	1	
Kyphosus azureus	Zebraperch			Benthic	0–15								1		1	1	
Kyphosus ocyurus	Bluestriped Chub			Pelagic, Benthic	0–30								1				
Kyphosus vaigiensis	Brassy Chub			Benthic, WC	S–24								1	1	1		
Medialuna californiensis	Halfmoon			Benthic, WC	0–44								1	1	1	1	
Chaetodontidae	Butterflyfishes																
Chaetodon humeralis	Threebanded Butterflyfish			Benthic	0–107		2	2					1				
Prognathodes falcifer	Scythe Butterflyfish			Benthic	3–270							1	1				
Embiotocidae	Surfperches																
Amphistichus argenteus	Barred Surfperch			Benthic	0–80			1					2			1	
Amphistichus koelzi	Calico Surfperch			Benthic	0–9			1								2	
Brachyistius frenatus	Kelp Perch			WC	0–76	1-15		2				2	2	1	1	2	
Cymatogaster aggregata	Shiner Perch		FW	Benthic	0–310	1-90		2					2			1	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Embiotoca caryi	Rainbow Seap-erch			Benthic	0–50			1			1		1	1	1		
Embiotoca jacksoni	Black Perch			Benthic, Pelagic	0–73	1-24		1			1		1	1	1	1	
Embiotoca lateralis	Striped Seaperch			Benthic, Pelagic	0–111	< 30		2					1	1	1	1	
Hyperprosopon argen-teum	Walleye Surf-perch			Benthic, Midwa-ter	0–182	0-20		1					1		1	1	
Hyperprosopon ellip-ticum	Silver Surfperch			Benthic	0–110	1-4							1		1	1	
Hypocritichthys analis	Spotfin Surf-perch			Benthic	0–101	< 35	2	1							2		
Micrometrus aurora	Reef Perch			Benthic	0–6	0-2							1	1		1	
Micrometrus minimus	Dwarf Perch			Benthic	0–20	1-4							1	1		1	
Phanerodon atripes	Sharpnose Sea-perch			Benthic	12–229	< 80							1		1	1	
Phanerodon furcatus	White Seaperch			Benthic, WC	0–104	1-50		1					1		1	1	
Phanerodon vacca	Pile Perch			Benthic, WC	0–132	2–55		2					1		1	1	
Rhacochilus toxotes	Rubberlip Sea-perch			Benthic, Pelagic	0–91	2–50		2			1		1		1	1	
Zalembius rosaceus	Pink Seaperch			Benthic	0–276	50-150	1	1			1		2				
Pomacentridae	Damselfishes																
Abudefduf troschelii	Panamic Ser-geant Major			Benthic	0–15								1				
Azurina hirundo	Swallow Dam-selfish			Benthic, WC	5–30								1				
Chromis alta	Silverstripe Chromis			Benthic	1–200								1				
Chromis punctipinnis	Blacksmith			Benthic, WC	2–67	< 40							1		1	1	
Hypsypops rubicundus	Garibaldi			Benthic	0–39	2–25							1		1	1	
Stegastes leucorus	Whitetail Dam-selfish			Benthic	0–18								1				
Labridae	Wrasses																

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Bodianus pulcher	California Sheep-head			Benthic, Pelagic	0–150	2–55	2	2			1		1	1	1	2	1
Decodon melasma	Blackspot Wrasse			Benthic	15–300			1	1				2				
Halichoeres californi-cus	Señorita			Benthic, Pelagic	0–101	5-50							1		1	1	
Halichoeres semicinc-tus	Rock Wrasse			Benthic	0–79	2–15		2			1	1	1		1	1	
Nicholsina denticulata	Loosetooth Par-rotfish			Benthic	1–30								1			2	
Bathymasteridae	Ronquils																
Rathbunella hypo-plecta	Bluebanded Ronquil			Benthic	3–178			1					2				
Ronquilus jordani	Northern Ron-quil			Benthic	3–337	< 150		1					1				
Zoarcidae	Eelpouts																
Bothrocara molle	Soft Eelpout			Benthic	60–2688		1	1									
Eucryphycus califor-nicus	Persimmon Eelpout			Benthic	60–545		2	2						1	1	1	
Lycenchelys crotalinus	Snakehead Eelpout			Benthic	63–2816		1										
Lycodes cortezianus	Bigfin Eelpout			Benthic	18–1280	70-400	1	1									
Lycodes diapterus	Black Eelpout			Benthic	24–1472	146-844	1	1									
Lycodes pacificus	Blackbelly Eel-pout			Benthic	7–1036	50–400	1										
Lyconema barbatum	Bearded Eelpout			Benthic	45–472		1	2									
Stichaeidae	Pricklebacks																
Anoplarchus pur-purescens	High Cockscomb			Benthic	0–35					1	1		1	1	1	1	
Cebidichthys violaceus	Monkeyface Prickleback			Benthic	0–24	0-3							1	1	1		
Chirolophis nugator	Mosshead War-bonnet			Benthic	0–80	1-30				1			1		2		
Esselenichthys carli	Threeline Prick-leback			Benthic	1–29			1					1	1	1		

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Esselenichthys laurae	Twoline Prickleback			Benthic	11–46		1	1					2				
Lumpenopsis clitella	Saddled Prickleback			Benthic	54–130								1				
Phytichthys chirus	Ribbon Prickleback			Benthic	0–12								1	1	1	1	1
Plectobranchus evides	Bluebarred Prickleback			Benthic	57–368		1	1									
Poroclinus rothrocki	Whitebarred Prickleback			Benthic	35–350		2	2		1			1				
Xiphister atropurpureus	Black Prickleback			Benthic	0–27				1		1	1	1	1			
Xiphister mucosus	Rock Prickleback			Benthic	0–18						1	1	1	1			
Pholidae	Gunnels																
Apodichthys flavidus	Penpoint Gunnel			Benthic	0–11	0-2	1	1	1		1	1	1	1		1	
Apodichthys fucorum	Rockweed Gunnel			Benthic	0–9	0-6							1	1		1	
Pholis ornata	Saddleback Gunnel			Benthic	0–60		1	1					1	1		1	
Ulvicola sanctaerosae	Kelp Gunnel			WC	0–12										1		
Anarhichadidae	Wolffishes																
Anarrhichthys ocellatus	Wolf-Eel			Benthic, Pelagic	0–417	> 50							1	2	2		
Ammodytidae	Sand Lances																
Ammodytes personatus	Pacific Sand Lance			Benthic, WC	0–272	0-80		1	1								
Uranoscopidae	Stargazers																
Astroscopus zephyreus	Pacific Stargazer			Benthic	1–385			1									
Kathetostoma averruncus	Smooth Stargazer			Benthic	13–600		1	1									
Blenniidae	Combtooth Blennies																
Hypsoblennius gentilis	Bay Blenny			Benthic	0–24	0-10					2		1	1		1	1
Hypsoblennius gilberti	Rockpool Blenny			Benthic	0–18	0-5							1				
Hypsoblennius jenkinsi	Mussel Blenny			Benthic	0–40	0-10							1			1	1

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Ophioblennius steindachneri	Panamic Fanged Blenny			Benthic	0–20							1	1				
Plagiotremus azaleus	Sabertooth Blenny			Benthic	1–37								1				1
Clinidae	Kelp Blennies																
Gibbonsia elegans	Spotted Kelpfish			Benthic	0–56	0-30							1	1	1	1	
Gibbonsia metzi	Striped Kelpfish			Benthic	0–18	> 2							1	1	1	1	
Gibbonsia montereyensis	Crevice Kelpfish			Benthic	0–49	0-8							1	1	1	1	
Heterostichus rostratus	Giant Kelpfish			Benthic, WC	0–40	5-25							1	1	1	1	
Labrisomidae	Labrisomid Blennies																
Alloclinus holderi	Island Kelpfish			Benthic	0–91					1			1			2	
Cryptotrema corallinum	Deepwater Blenny			Benthic	15–195	55-95		1		1			1				
Labrisomus xanti	Largemouth Blenny			Benthic	0–21								1	1			
Paraclinus integripinnis	Reef Finspot			Benthic	0–15	0-10							1	1		1	
Chaenopsidae	Tube Blennies																
Chaenopsis alepidota	Orangethroat Pikeblenny			Benthic	0–27		1	1									1
Neoclinus blanchardi	Sarcastic Fringehead			Benthic	3-83		1			1			1				1
Neoclinus stephensae	Yellowfin Fringehead			Benthic	0–30		1			1			1				1
Neoclinus uninotatus	Onespot Fringehead			Benthic	0–55		1			1			1				1
Icosteidae	Ragfishes																
Icosteus aenigmaticus	Ragfish			Pelagic, Benthic	0–1420												
Gobiesocidae	Clingfishes																
Gobiesox eugrammus	Lined Clingfish			Benthic	9–82								1				1
Gobiesox maeandricus	Northern Clingfish			Benthic	0–18	< 10					2		1	2	2	2	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Gobiesox papillifer	Bearded Clingfish			Benthic	0–5			1					1				
Gobiesox rhessodon	California Clingfish			Benthic	0–11						1		1				
Rimicola cabrilloi	Channel Islands Clingfish			Benthic	0–3								1				
Rimicola dimorpha	Southern Clingfish			Benthic	0–10								1				
Rimicola eigenmanni	Slender Clingfish			Benthic	0–15						1		1				
Rimicola muscarum	Kelp Clingfish			WC	0–5								2	1	1	1	
Callionymidae	Dragonets																
Synchiropus atrilabiatus	Blacklip Dragonet			Benthic	3–235		1	1			2		2				
Eleotridae	Sleepers																
Dormitator latifrons	Pacific Fat Sleeper		FW	Benthic	0–2		1	1									
Gobiidae	Gobies																
Acanthogobius flavimanus	Yellowfin Goby	X	FW	Benthic	0–14		1									1	
Bollmannia stigmatura	Tailspot Goby			Benthic	20–150		1										
Clevelandia ios	Arrow Goby		FW	Benthic	0–45	0-10	1	1								1	
Ctenogobius sagittula	Longtail Goby		FW	Benthic	0–5		1	1									
Eucyclogobius kristinae	Southern Tidewater Goby			Benthic	0–5		2	1									
Eucyclogobius newberryi	Northern Tidewater Goby		FW	Benthic	0–15		1	1						2		2	
Gillichthys mirabilis	Longjaw Mudsucker			Benthic	0–5		1							2		2	
Ilypnus gilberti	Cheekspot Goby			Benthic	0–24		1	1								2	
Lepidogobius lepidus	Bay Goby			Benthic	0–305	< 70	1	1								1	
Lethops connectens	Halfblind Goby			Benthic, WC	0–21								1		1		
Lythrypnus dalli	Bluebanded Goby			Benthic	0–76	> 3				1			1				1
Lythrypnus zebra	Zebra Goby			Benthic	0–97					1			1				1

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Quietula y-cauda	Shadow Goby			Benthic	0–6		1								2	2	
Rhinogobiops nicholsii	Blackeye Goby			Benthic	0–195	< 80	1	1	1				1		2	2	2
Tridentiger trigono-cephalus	Chameleon Goby	X	FW	Benthic	0–15		1			2			2				
Typhlogobius californ-iensis	Blind Goby			Benthic	0–15		1	1					2				2
Ephippidae	Spadefishes																
Chaetodipterus zona-tus	Pacific Spadefish			Benthic	1–107			1			1		1				
Acanthuridae	Surgeonfishes																
Acanthurus xantho-pterus	Yellowfin Sur-geonfish			Benthic, WC	0–148			1					1				
Sphyraenidae	Barracudas																
Sphyraena argentea	Pacific Barra-cuda			Pelagic	S/0–383												
Sphyraena ensis	Mexican Barra-cuda			Pelagic	3–25												
Scombridae	Mackerels																
Auxis rochei	Bullet Tuna			Pelagic	S–200												
Auxis thazard	Frigate Tuna			Pelagic	S–200												
Euthynnus affinis	Kawakawa			Pelagic	S–73												
Euthynnus lineatus	Black Skipjack			Pelagic	S–73												
Sarda chiliensis	Pacific Bonito			Pelagic	S–110												
Scomber japonicus	Pacific Chub Mackerel			Pelagic	S/0-300												
Scomberomorus con-color	Gulf Sierra			Pelagic	S–15												
Scomberomorus sierra	Pacific Sierra			Pelagic	S–15												
Stromateidae	Butterfishes																
Peprilus simillimus	Pacific Pompano			Benthic, Pelagic	0–302	3–70		1									
PLEURONECTIFORMES	FLATFISHES																
Paralichthyidae	Sand Flounders																
Citharichthys fragilis	Gulf Sanddab			Benthic	18–347			1									
Citharichthys sordidus	Pacific Sanddab			Benthic	0–581	< 150	1	1		1						2	

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cobble	Boulder	Rock	Algae	Kelp	Seagrass	SFMI
Citharichthys stigmaeus	Speckled Sanddab			Benthic	0–366	< 60	1	1							2	2	
Citharichthys xanthostigma	Longfin Sanddab			Benthic	2–298		2	1									
Hippoglossina stomata	Bigmouth Sole			Benthic	2–478	20-140	2	1									
Paralichthys californicus	California Halibut			Benthic	0–317	1-60	1	1									
Xystreurys liolepis	Fantail Sole			Benthic	0–136	6-50	1	1					2		2	2	
Pleuronectidae	Righteye Flounders																
Atheresthes stomias	Arrowtooth Flounder			Benthic	9–1186	100–500	1	1	2				2				
Eopsetta jordani	Petrale Sole			Benthic	0–640	55-457	1	1	2		2						
Glyptocephalus zachirus	Rex Sole			Benthic	0–1237	100–500	1	2			2		2				
Hippoglossus stenolepis	Pacific Halibut			Benthic, Midwater	2–2000	27-274	1	1				2	2			2	
Isopsetta isolepis	Butter Sole			Benthic	2–425		1										
Lepidopsetta bilineata	Southern Rock Sole			Benthic	1–476			1	1								
Lyopsetta exilis	Slender Sole			Benthic	9–1258	90-350	1						2				
Microstomus bathybius	Deepsea Sole			Benthic	41–1743	500-1400	1	1			1	1	1				
Microstomus pacificus	Dover Sole			Benthic	2–1400		1	2					2				
Parophrys vetulus	English Sole			Benthic	0–608	< 200	1	1								1	
Platichthys stellatus	Starry Flounder		FW	Benthic, Pelagic	0–660	< 100	1	1	1					2		1	
Pleuronichthys coenosus	C-O Sole			Benthic	0–350	5-30	1	1					1			1	
Pleuronichthys decurrens	Curlfin Sole			Benthic	0–440	18-70	1	1					2				
Pleuronichthys guttulatus	Diamond Turbot			Benthic	0–46	< 20	1	1								1	
Pleuronichthys ritteri	Spotted Turbot			Benthic	1–219	< 30	1	1									

Taxon	Common Name	Exotic	FW	Vertical Zonation	Min-Max (m)	Common (m)	Mud	Sand	Gravel	Shell	Cob-ble	Boul-der	Rock	Algae	Kelp	Sea-grass	SFMI
Pleuronichthys verticalis	Hornyhead Turbot			Benthic	5–496	10-100	1	1									
Psettichthys melanostictus	Sand Sole			Benthic	0–325	< 50		1								2	
Reinhardtius hippoglossoides	Greenland Halibut			Benthic, Pelagic	10–2000	50-1000	1	1									
Bothidae	Lefteye Flounders																
Engyophrys sanctilaurentii	Speckledtail Flounder			Benthic	15–1369		1	1		1	1						
Cynoglossidae	Tonguefishes																
Symphurus atricauda	California Tonguefish			Benthic	0–463	5-140	1	1								1	
TETRADONTIFORMES	PUFFERFISHES AND RELATIVES																
Balistidae	Triggerfishes																
Balistes polylepis	Finescale Triggerfish			Benthic	2–512	< 30		2			2		1	2			
Ostraciidae	Boxfishes																
Lactoria diaphana	Spiny Boxfish			Benthic, Pelagic	20-171								1				
Tetraodontidae	Puffers																
Sphoeroides annulatus	Bullseye Puffer			Benthic, WC	0–105	20-40		1					1	2			
Diodontidae	Porcupinefishes																
Chilomycterus reticulatus	Spotfin Burrfish			Benthic	1–141			2					1				
Diodon holocanthus	Balloonfish			Benthic	1–100			2					1				
Diodon hystrix	Porcupinefish			Benthic	0–135		1	1				1	1	1			1

APPENDIX 13

Proposed CMECS Classifications

Component	Unit Code	Origin / Setting	Class	Subclass	Group	Subgroup / Community
Substrate	1.2.1.2.7p	Geologic Substrate	Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravel Mixes	Cobble Mix
Substrate	1.2.1.2.8p	Geologic Substrate	Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravel Mixes	Muddy Sandy Cobble Mix
Substrate	1.2.1.2.9p	Geologic Substrate	Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravel Mixes	Sandy Cobble Mix
Substrate	1.2.1.2.10p	Geologic Substrate	Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravel Mixes	Sandy Gravel Mix
Substrate	1.2.1.3.5p	Geologic Substrate	Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravelly	Cobbley Sandy Mud
Substrate	1.2.1.3.6p	Geologic Substrate	Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravelly	Sandy Cobbles
Substrate	1.2.1.3.7p	Geologic Substrate	Unconsolidated Mineral Substrate	Coarse Unconsolidated Substrate	Gravelly	Sandy Cobbles
Substrate	1.2.2.1.6p	Geologic Substrate	Unconsolidated Mineral Substrate	Fine Unconsolidated Substrate	Slightly Gravelly	Slightly Cobbley Sand
Biotic	2.2.1.24.3p	Benthic/Attached Biota	Faunal Bed	Attached Fauna	Attached Sea Urchins	Attached Strongylocentrotus franciscanus
Biotic	2.2.2.14.2p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Macoma Bed
Biotic	2.2.2.14.5p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Mya Bed
Biotic	2.2.2.14.11p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Clinocardium Bed
Biotic	2.2.2.14.12p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Cryptomya Bed
Biotic	2.2.2.14.13p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Leukoma Bed
Biotic	2.2.2.14.14p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Nuttallia Bed
Biotic	2.2.2.14.15p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Saxidomus Bed
Biotic	2.2.2.14.16p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Tresus Bed
Biotic	2.2.2.14.17p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Venerupis Bed
Biotic	2.2.2.14.18p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Protothaca Bed

Component	Unit Code	Origin / Setting	Class	Subclass	Group	Subgroup / Community
Biotic	2.2.2.14.19p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Tivela Bed
Biotic	2.2.2.14.20p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Chione Bed
Biotic	2.2.2.14.21p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Panopea Bed
Biotic	2.2.2.14.22p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Clam Bed	Siliqua Bed
Biotic	2.2.2.25.3p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Scallop Bed	Crassodoma Bed
Biotic	2.2.2.25.4p	Benthic/Attached Biota	Faunal Bed	Soft Sediment Fauna	Scallop Bed	Chlamys Bed
Biotic	2.5.2.1.17p	Benthic/Attached Biota	Aquatic Vegetation Bed	Aquatic Vascular Vegetation	Seagrass Bed	Zostera japonica
Biotic	2.5.2.1.18p	Benthic/Attached Biota	Aquatic Vegetation Bed	Aquatic Vascular Vegetation	Seagrass Bed	Eelgrass bed (Zostera spp.)
Biotic	2.5.2.1.19p	Benthic/Attached Biota	Aquatic Vegetation Bed	Aquatic Vascular Vegetation	Seagrass Bed	Zostera pacifica
Biotic	2.5.2.1.20p	Benthic/Attached Biota	Aquatic Vegetation Bed	Aquatic Vascular Vegetation	Seagrass Bed	Surfgrass (Phyllospadix spp.)