

Assessment of Marine Protected Areas in the California Current



June 5, 2020

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Conservation science for a healthy planet

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EXECUTIVE SUMMARY

Background

The California Current System is one of the most productive marine environments in the world. High productivity is the result of coastal wind driven upwelling that brings deep, cold, nutrient-rich water to the surface of the ocean, thus enhancing primary production. The California Current extends from Vancouver to Baja California, and like other eastern boundary currents, it hosts biologically important species, supports important economic activities and is adjacent to increasing human populations.

Economic activities like fisheries, aquaculture, shipping and recreation impact the marine environment in which they take place. To mitigate these impacts and to protect marine biodiversity, ecosystem services and cultural values, marine managed and/or protected areas (herein Marine Protected Areas or MPAs) with specific goals have been established throughout the California Current System. There are approximately 390 MPAs along the U.S. West Coast representing varying levels of protection from fishery management areas that prevent specific fishing practices to fully protected no-take reserves.

We conducted a Marine Protected Area (MPA) assessment to understand the status of current spatial management approaches and to identify opportunities to better protect marine biodiversity in the California Current System. Our analysis focused on four main tasks, the results of which are presented in this report:

1. A spatial assessment of regulations and protections for existing MPAs.
2. A spatial analysis of how well priority species (e.g., anchovies, sardines) and habitats (e.g. kelp, seamounts) are represented in MPAs.
3. A spatial assessment of major threats impacting existing protected areas.
4. Based on the above, identification of opportunities for improving conservation.

Results

Very little of the California Current is highly protected. Most MPAs are in federal waters and are listed as uniform multiple use areas, which means in practice limited protection, usually focused on specific activities or a single type of species. Only 6% of the EEZ is protected by zoned multi-use areas (moderate protection), one half of one percent is zoned for no take areas (moderately high protection), and less than a quarter of one percent is entirely no take (high protection). State MPAs are important in the California Current. Though they cover relatively little of the total extent of the California Current, the small areas they do encompass tend to represent very high conservation value and State MPA protections offered tend to be relatively strict.

A relatively low percentage of the suitable habitat for the species we examined is well protected. On average, only 2 – 3% of a species' total suitable habitat was in MPAs with moderate or better protection. As expected, due to the limited number of MPAs in Oregon,

much less priority habitat is included there relative to California and Washington. Priority species as indicated by Elliott et al. 2019 are, in general, well-represented in existing MPAs and existing MPAs do a good job in focusing on high-quality habitat for the species we examined.

Of all the threats examined here, climate change is having the largest impacts on our oceans. MPAs in the California Current will be substantially impacted by climate change-related ocean acidification and increases in ultraviolet radiation; increases in sea surface temperature are also projected to have a major impact. Due to the global scale of climate change, management entities that exist on local and regional scales like MPAs are not likely to be effective solutions for climate impacts.

The cumulative impacts of commercial and recreational fishing are substantial in the California Current. Fishing is also the most regulated of human activities in the California Current, both through spatial restrictions and fishery-wide regulations. Recreational fishing is an area that needs additional regulation. It is a human activity that has great magnitude in terms of impact and, unlike commercial fishing, very few restrictions. Shipping is another impact of concern, with a high index of impact, yet few restrictions. Less than 5% of the Exclusive Economic Zone (EEZ) has restrictions on vessel traffic and less than a twentieth of a percent of the EEZ is closed to shipping.

Recommendations

Strengthening regulation in existing California Current MPAs would offer significant conservation benefits and is potentially more feasible than establishing new MPAs. Existing spatial regulations cover over half of the California Current, offering opportunities to increase protection in already regulated areas. Expanding the protective focus of some of these MPAs that are currently focused on single-species protection to ensure sustainable protection (e.g., the groundfish FMP) would have substantial conservation benefits.

The California Current is governed by dozens of regulations and agencies. Because of this, it is often difficult to determine the exact restrictions that apply to a given area. This is especially true in areas of overlapping jurisdictions, in which multiple MPAs govern the area. Clarifying MPA boundaries and simplifying marine governance structure would make it easier for individuals to comply with marine regulations and easier for governments to enforce them.

Expanding the nearshore area protected by MPAs would provide the greatest conservation value for the least area protected. State MPAs are important in the California Current. Though they cover relatively little area, the area they include tends to be of very high conservation value and the actual protections offered tend to be relatively strict.

Coastal MPAs are also the most vulnerable to human impacts of all MPAs examined. Nearshore impacts from human development are numerous (e.g., pollution, nutrient runoff, sedimentation, light pollution) and cumulatively have a very large impact on habitat suitability.

Increasing environmental protection in areas in and adjacent to existing nearshore MPAs would have significant conservation benefits.

Spatially, the rocky banks of the Oregon Coast would be a strategic choice for the creation of new MPAs. There is a large gap in existing MPAs from Northern California through Southern Washington. Oregon has very few MPAs in its state waters and there is a corresponding gap in federal MPAs. Moreover, this area boasts highly suitable habitat for most of the species examined in this report, and coastal Oregon consistently ranked highly in our prioritization of conservation value. In particular, the water from Heceta Bank to Cape Blanco were zoned as being of very high conservation value.

National Marine Sanctuaries in the California Current are areas of high conservation value. They are also impacted by many local human activities that could potentially be regulated. Sanctuaries are generally less impacted by land-based activity (with the notable exceptions of sediment runoff and climate change), so regulation of the sanctuaries themselves can have more influence on overall ecosystem health. Increasing the regulation of commercial fishing would have benefits for all sanctuaries, as would zoning portions of the sanctuary as no-take areas. Olympic Coast National Marine Sanctuary (NMS) would benefit from additional restrictions on commercial fishing. All sanctuaries except for Olympic Coast NMS are substantially impacted by shipping traffic, so redesigning shipping lanes and/or restricting dumping (especially from cruise ships, which have exemptions under many NMS regulations) would be helpful. Olympic Coast is less affected by human impacts and is a good candidate for preservation from future potential impacts. It is also a good candidate for expansion, as adjacent areas have a high conservation value.

Of the habitats examined, our analysis found seamounts to be of high conservation value. Seamounts, designated as Habitat Areas of Particular Concern by and for regional fisheries management, provide unique habitat for many species. They are also relatively rare habitats. While most seamounts do occur within existing MPAs, these are MPAs that do not have major restrictions on human activity vis-à-vis seamount habitats and many of the species that use them. Strengthening the protection of seamounts in the California Current would have significant conservation benefits relative to the total area protected.

INTRODUCTION

The California Current System is one of the most productive marine environments in the world. High productivity is the result of coastal wind driven upwelling that brings deep, cold, nutrient-rich water to the surface of the ocean, thus enhancing primary production. The California Current extends from Vancouver to Baja California, and like other eastern boundary currents, it hosts biologically important species, supports important economic activities, and is adjacent to increasing human populations.

Economic activities like fisheries, aquaculture, shipping and recreation impact the marine environment in which they take place. To mitigate these impacts and to protect marine biodiversity, ecosystem services and cultural values, marine managed and/or protected areas (Marine Protected Areas, or MPAs) with specific goals have been established throughout the California Current System. There are approximately 390 MPAs along the U.S. West Coast representing varying levels of protection from fishery management areas that prevent specific fishing practices to fully protected no-take reserves.

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Ocean Conservation Priorities

We synthesized 33 documents that focused on ocean research and management priorities along the U.S. West Coast. We identified the species, habitats, resources, and threats emphasized by different ocean stakeholders. Our review identified two dozen priority species and habitats for focus as well as a similar number of human threats. Please see Elliott et al. (2019) for more information.

Priority Species

The priority species identified include five fish, five invertebrates, five birds, and five marine mammals. Commercially important fish received the most frequent recognition, which included groundfishes, pelagic forage fishes, and salmonids. Our literature review involved using counts of the number of times species were mentioned as a metric of conservation importance.

Fish

The fish species highlighted the most frequently were Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon (*Oncorhynchus kisutch*), Pacific sardine (*Sardinops sagax caerulea*), California halibut (*Paralichthys californicus*), and northern anchovy (*Engraulis mordax*).

Invertebrates

There were several documents that discussed the intertidal and benthic invertebrates that are harvested by people, including various species of crabs, oysters, sea urchins, and clams. The top five species in this category include Dungeness crab (*Metacarcinus magister*), Olympia oyster (*Ostrea lurida*), red abalone (*Haliotis rufescens*), California mussel (*Mytilus californianus*), and red sea urchin (*Mesocentrotus franciscanus*).

Birds

There were several seabirds, shorebirds, and waterfowl frequently mentioned, particularly those with a protected or special status. The top five species in this category are Cassin's auklet (*Ptychoramphus aleuticus*), western snowy plover (*Charadrius alexandrinus j nivosus*), common murre (*Uria aalge*), black oystercatcher (*Haematopus bachmani*), and Brandt's cormorant (*Phalacrocorax penicillatus*).

Mammals

Mammals identified in the review included cetaceans, pinnipeds, and an otter species. The top five mammal species cited in our synthesis include blue whale (*Balaenoptera musculus*), Steller sea lion (*Eumetopias jubatus*), humpback whale (*Megaptera novaeangliae*), California sea lion (*Zalophus californianus*), and southern sea otter (*Enhydra lutris nereis*).

Plants / Biotic Habitats

Macroalgae species (e.g., kelps) and two types of sea grass were identified as important. Macroalgae provide important habitat for many marine species and some are harvested by people. Important species in this category are bull kelp (*Nereocystis* spp.), sea palm (*Postelsia palmaeformis*), and coralline algae (order Corallinales). Kelp are habitat-forming species, creating the kelp forest that is iconic to the California coast and important for ecological, recreational, and commercial reasons. Of the other plants, eelgrass (*Zostera marina*) and surf grass (*Phyllospadix* spp.) were cited most frequently. Seagrass habitat is composed of submerged aquatic flowering plants. There are 60 species of seagrass (including eelgrass). Seagrass meadows offer habitat to fish, macroalgae, microalgae, and various invertebrates.

Physical Habitats

Our review identified several priority physical habitats in addition to biological habitats provided by kelp and seagrasses. These were beaches, rocky intertidal, rocky reefs (including other benthic topography such as seamounts and marine canyons), and estuaries. Beaches provide spawning habitat for certain forage fish species, haul-out and pupping areas for pinnipeds, habitat for invertebrates, and both nesting and foraging habitat for shorebirds and seabirds. The rocky intertidal is rocky substrate found between high and low tide water levels,

and subject to wave action and temperature changes; it is home to sea palm, shorebirds (e.g., black oystercatcher), and many species of invertebrates, including the ochre sea star and California mussel.

Rocky reef habitats are submerged rocky outcrops that provide a physical structure for many species to find refuge or places to attach themselves. Estuaries offer refuge and nursery habitat to many fish species (including commercially important salmonid species), and shorebirds utilize estuaries during their migrations. In the analysis presented below, we will focus primarily on pelagic habitat due to data availability and an ability to connect priority species and habitats.

Threats

The threats to the California Current Ecosystem generally fall into two categories: direct human impacts (threats attributable to direct human activities) and indirect human impacts (threats that are largely related to climate change). For direct human impacts, we found the top threats emphasized in the literature are fishing, pollution (including urban, nonpoint, and industrial sources), and disturbance. The most important indirect human impacts that we found are changes in natural processes, ocean chemistry changes (acidification and hypoxia), sea level rise, increased temperatures (both sea surface and air), and invasive species.

The habitats enduring the most threats are shallow benthic, estuary, intertidal, and pelagic. Shallow benthic is affected by both direct and indirect human impacts, and it is connected to the most number of species groups; however, this habitat is dominated by invertebrates and may not affect different levels of the marine food web as other habitats (e.g., estuary, pelagic). Habitats closest to human populations are considered the most vulnerable and less likely to be resilient to further stressors; the marine nearshore group contains most of these habitats, and the highest priority habitats identified are seagrass beds, beaches, dunes, and rocky intertidal zones.

EXISTING REGULATIONS

The waters of the California Current are managed by a complex and overlapping set of regulations. Some of these include MPAs that pertain to specific habitats or depth contours, or that manage a specific set of species. MPAs in various forms cover a large area of the Exclusive Economic Zone (EEZ; 200 nm from the shoreline) in the California Current (Figure 1). The protection offered by each of these MPAs is varied both in the level and target of the restriction. Some protect only a single species from being seasonally fished with specific fishing gear while others are complete no-take zones.

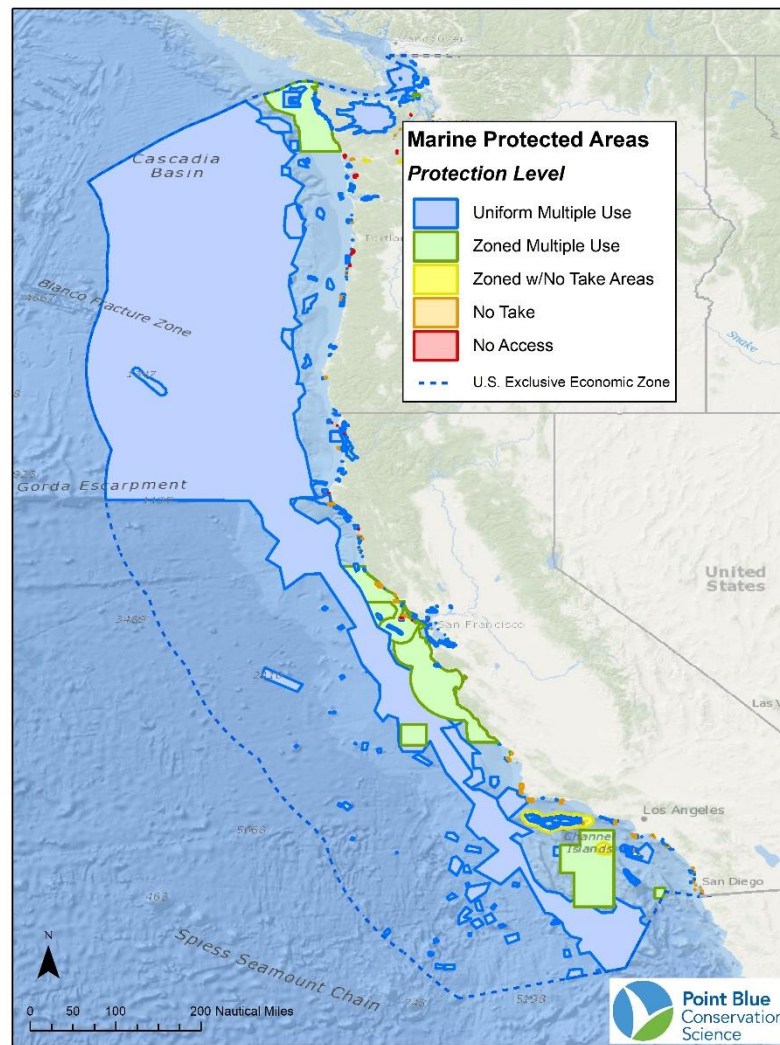


Figure 1. Marine Protected Areas in the California Current, by level of protection. Data from the Marine Protected Areas Inventory (NOAA, 2017).

Below we provide an inventory of regulations that apply to the California Current. First, there is an overview of applicable laws and management agencies that have jurisdiction over marine species and habitats. Second, there is a spatial analysis of the areas covered by different types of MPAs. This includes summaries by protection level, focus, scale, constancy, governance, jurisdiction, and a variety of other factors.

Inventory of Existing Regulations

Below we provide a general overview of federal and state regulatory authorities and jurisdictions that pertain to ocean waters (i.e. outer coast) along the Pacific Coast. We first summarize applicable laws, both federal and state, and then summarize agencies that are responsible for managing these areas.

Applicable Laws

Federal Laws

At a federal level, species-specific protection is provided by the Endangered Species Act (ESA), Magnuson-Stevens Fishery Conservation and Management Act (MSA), Marine Mammal Protection Act (MMPA), and Migratory Bird Treaty Act (MBTA). Other protection is provided by the Fish and Wildlife Coordination Act (FWCA), the Rivers and Harbors Appropriations Act (RHA), the Coastal Zone Management Act (CZMA), the National Aquatic Nuisance Prevention and Control Act (NANCPA), and Title I of the Marine Protection, Research, and Sanctuaries Act (MPRSA).

[Endangered Species Act \(ESA\), 16 U.S.C. §§ 1531-1544](#)

The ESA protects plant, fish, and wildlife species (plus their habitats) that are listed as endangered and threatened. Species are listed as endangered if found to be in danger of extinction throughout all or a significant portion of their ranges. Species are listed as threatened if they are likely to become endangered within the foreseeable future. The ESA also protects designated critical habitat for listed species, which are areas of physical or biological features essential to the conservation of the species and which may require special management considerations. The ESA requires federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS), as applicable, before initiating any action that may affect a listed species.

The ESA can protect an entire species or a geographic subset of a species. The most used subset is a Distinct Population Segment (DPS), which is a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. A second designation is used for subsets of Pacific salmon. An Evolutionarily Significant Unit (ESU) is a Pacific salmon population or group of populations that is substantially reproductively isolated from other conspecific populations and that represents an important component of the evolutionary legacy of the species.

Priority species protected by the ESA and that have critical habitat within the study area include the blue whale, humpback whale, Steller sea lion, southern sea otter, western snowy plover, Coho salmon, and Chinook salmon (Table 1).

Table 1. Protection status of priority species under the Endangered Species Act. If protection for a species is not range-wide, protected subsets may be defined as Evolutionary Significant Units (ESU) or Distinct Population Segments (DPS) by NOAA Fisheries and USFWS.

Common Name	Endangered Species Act	
	Status	Range
Coho Salmon	Endangered	Central California coast ESU
	Threatened	Lower Columbia River ESU, Oregon coast ESU, Southern Oregon & Northern California coasts ESU
Chinook Salmon	Endangered	Sacramento River winter-run, Upper Columbia River spring-run
	Threatened	California coastal, Central Valley spring-run, Lower Columbia River, Puget Sound, Snake River fall-run, Snake River spring/summer-run, Upper Willamette River
	Candidate	Upper Klamath-Trinity River
Western Snowy Plover	Threatened	Pacific Coast Population
Southern Sea Otter	Threatened	Throughout Range
Steller Sea Lion	Endangered	Western DPS
	Delisted	Eastern DPS
Blue Whale	Endangered	Throughout Range
Humpback Whale	Endangered	Central America DPS; Western North Pacific DPS
	Threatened	Mexico DPS

[Magnuson-Stevens Fishery Conservation and Management Act \(MSA\), 16 U.S.C. § 1801 et seq.](#) Under the MSA, the U.S. claimed sovereign rights and exclusive fishery management authority over all fish and Continental Shelf fishery resources within the EEZ. The MSA established a procedure for authorizing foreign fishing and prohibited unauthorized foreign fishing within the EEZ.

The MSA also set national standards for fishery conservation and management within the EEZ. To do so, it created eight Regional Fishery Management Councils composed of state officials with fishery management responsibility, the regional administrators of NMFS, and individuals appointed by the Secretary of Commerce with relevant knowledge. (Relevant knowledge is defined as those who are knowledgeable regarding the conservation and management, the commercial or recreational harvest, of the fishery resources of the geographical area concerned.) The Councils are responsible for preparing and amending fishery management plans for each fishery under their authority that requires conservation and management.

Fishery management plans (FMPs) describe the fisheries and contain necessary and appropriate conservation and management measures, applicable to foreign vessels in U.S. waters and fishing by U.S. vessels. The plans are submitted to the Secretary of Commerce, who has delegated to the National Oceanic and Atmospheric Administration (NOAA) approval of the plans. If approved, NMFS promulgates implementing regulations. NMFS may prepare Secretarial FMPs if the appropriate Council fails to develop such a plan.

Of particular relevance to this report is the Groundfish FMP. Amendment 19 was prepared by NMFS and the Pacific Fishery Management Council (PFMC) to comply with Section 303(a)(7) of the MSA by amending the Pacific Coast Groundfish FMP to:

- Describe and identify Essential Fish Habitat (EFH) for the fishery;
- Designate Habitat Areas of Particular Concern (HAPC);
- Minimize to the extent practicable the adverse effects of fishing on EFH; and
- Identify other actions to encourage the conservation and enhancement of EFH.

On May 11, 2006, NMFS published a final rule to implement regulatory provisions of Amendment 19 to the Pacific Coast Groundfish FMP (71 FR 27408). This rule implemented management measures to minimize adverse impacts on EFH from fishing, including gear restrictions and area closures. There are two Bottom Trawl Closed Areas in the study area: Point Arena North and Point Arena South Biogenic Area. There is also a bottom trawl footprint closure that prohibits the use of bottom trawl gear in depths greater than 700 fathoms to the outer extent of groundfish EFH (3,500 m) or the seaward extent of the EEZ, preventing the expansion of the use of this gear type into areas where its historical use has been limited.

[Migratory Bird Treaty Act \(MBTA\), 16 U.S.C. § 703 et. seq.](#)

The MBTA is a federal statute that implements U.S. treaties with several countries concerning the conservation and protection of migratory birds. The number of bird species covered by the MBTA is extensive and is listed at 50 CFR 10.13. Further, the regulatory definition of a migratory bird is broad and includes any mutation or hybrid of a listed species, as well as any part, egg, or nest of such bird (50 CFR 10.12). Migratory birds are not necessarily federally listed endangered or threatened under the ESA. The MBTA, which is enforced by the USFWS, makes it unlawful “by any means or manner, to pursue, hunt, take, capture [or] kill” any migratory bird except as permitted by regulation. The applicable regulations prohibit the take, possession, import, export, transport, sale purchase, barter, or the offering of these activities, except as permitted by the implementing regulations.

[Marine Mammal Protection Act \(MMPA\), 16 U.S.C. §§ 1361-1421h](#)

The MMPA protects and conserves marine mammal species by placing a moratorium on harassing, hunting, capturing, or killing any marine mammal or attempting any of these. If a project proponent determines that an action could incidentally harass (“take”) marine mammals, the proponent must consult with either the USFWS or NMFS to determine if a permit to take a marine mammal is required. A recent redefinition of “take” of an MMPA-protected species occurred under the FY 2004 Defense Authorization Act (House Bill 1588), where an animal is “taken” if it is harassed, and where harassment is defined as “(i) any act that injures or

has the significant potential to injure a marine mammal or marine mammal stock in the wild or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered” (section 315(f) P.L. 107–314; 16 U.S.C. § 703 note).

[Fish and Wildlife Coordination Act and Implementing Regulations, 16 U.S.C. §§ 661-666c](#)

Any federal agency that proposes to control or modify any body of water must first consult with the USFWS or NMFS, as appropriate. Consultation is additionally required with the head of the appropriate state agency exercising administration over the wildlife resources of the affected state. The U.S. Army Corps of Engineers (USACE) has a memorandum of understanding with the USFWS to provide a coordination act report to assist in planning efforts.

[Rivers and Harbors Appropriations Act \(RHA\) of 1899, 33 U.S.C. §§ 401, 403](#)

Section 10 of the RHA prohibits the unauthorized obstruction or alteration of any navigable water. Navigable waters under the RHA are those “subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce” (33 CFR 3294). Typical activities requiring Section 10 permits from USACE are construction of piers, wharves, bulkheads, marinas, ramps, floats, intake structures, cable or pipeline crossings, and dredging and excavation.

[Coastal Zone Management Act \(CZMA\), 16 U.S.C. §§ 1451-1466](#)

The CZMA encourages states to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources, such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. To encourage states to participate, the CZMA makes federal financial assistance available to any coastal state or territory that is willing to develop and implement a comprehensive coastal management program. Federal agencies are required to carry out activities that affect any land or water use or natural resource of a state’s coastal zone in a manner consistent with the enforceable policies of an approved state management plan.

[National Aquatic Nuisance Prevention and Control Act \(NANCPA\) of 1990](#)

NANCPA 90 mandates ballast water management for vessels entering the Great Lakes. This law was reauthorized as the National Invasive Species Act of 1996 (NISA 96), which strengthened the 1990 law and required the development of voluntary ballast management guidelines for all other ships entering U.S. waters. The law also requires all vessels that enter U.S. territorial waters (with certain exemptions) to manage ballast water according to prescribed measures. NISA 96 also required the US Coast Guard (USCG) to evaluate the effectiveness of the voluntary ballast management program three years after implementation. In 2004, voluntary guidelines were determined to be ineffective, and thus USCG initiated mandatory ballast management for all ships entering U.S. waters from outside the EEZ of the United States. Current management strategies for preventing introductions via ballast water are limited to ballast water retention,

open ocean exchange or alternate environmentally sound methods of ballast water management approved by USCG.

[Title I of the Marine Protection, Research, and Sanctuaries Act, Ocean Dumping Act \(MPRSA\), 33, U.S.C., §§ 1401-1420](#)

The USEPA has regulatory responsibilities with regard to ocean water quality under both the Clean Water Act and Title 1 of the MPRSA (Ocean Dumping Act). Title I of the MPRSA prohibits all ocean dumping, except that allowed by permits, in any ocean waters under U.S. jurisdiction, by any U.S. vessel, or by any vessel sailing from a U.S. port. Certain materials, such as high-level radioactive waste, chemical and biological warfare agents, medical waste, sewage sludge, and industrial waste, may not be dumped in the ocean. The law regulates ocean dumping within the area extending 12 nm seaward from the U.S. baseline and regulates transport of material by U.S.-flagged vessels for dumping into ocean waters (Copeland 2010). Additional information about the types of permitted discharges allowed under the Act is in the water quality regulatory overview in Section 4.2 (Physical Resources).

State Laws

[California Endangered Species Act \(CESA\), California Fish and Game Code §§ 2050-2111.5](#)

The CESA places the responsibility for maintaining a list of threatened and endangered species with the California Department of Fish and Wildlife (CDFW). The CDFW also maintains a list of candidate species that are under review for addition to either the list of endangered species or the list of threatened species. Pursuant to the requirements of CESA, an agency reviewing a proposed project within its jurisdiction must determine whether any California-listed endangered or threatened species may be present in the project area and determine whether the proposed project will have a potentially significant impact on such species. In addition, the CDFW encourages informal consultation on any proposed project that may affect a candidate species.

[Fish and Wildlife Protection and Conservation, California Fish and Game Code §§ 1600-1616](#)

The state's authority in regulating activities in wetlands resides primarily with the CDFW and the State Water Resources Control Board (SWRCB). The State of California regulates wetlands through the CDFW, which provides comment on USACE permit actions under the Fish and Wildlife Coordination Act. The CDFW may develop mitigation measures and require the preparation of a streambed alteration agreement if a proposed project would obstruct the flow or alter the bed, channel, or bank of a river or stream in which there are fish or wildlife resources, including intermittent and ephemeral streams. The CDFW is authorized to do so by the State Fish and Game Code Sections 1600-1616.

The California legislature gave the Fish and Wildlife Commission the authority to establish State Marine Reserves, State Marine Conservation Areas State Marine Parks, State Marine Recreational Management Areas, and Special Closures as a result of the California Marine Life Protection Act of 1999. The California Fish and Wildlife Commission also has the authority to prohibit or restrict activities that may harm resources, including fishing, collecting, swimming,

boating, and public entry. The CDFW also conducts oil spill response, damage assessment, and restoration through its Office of Spill Prevention and Response.

[California Code of Regulations, Title 14 Division 1](#)

The Fish and Game Commission has broad authority under Title 14 to establish regulations that restrict both sport and commercial fishing and otherwise afford protection to marine organisms and habitats. Of particular relevance to this DEIS are the eleven existing MPAs in the study area (Title 14, Section 632). MPAs in the study area have been in effect since May 1, 2010.

[California Coastal Act \(CCA\), California Public Resources Code § 30000 et seq.](#)

The CCA defines the “coastal zone” as the area of the state that extends 3 miles seaward and generally about 1,000 yards (910 meters) inland. Almost all development within the coastal zone, which contains many wetlands, requires a coastal development permit from either the California Coastal Commission or a local government with a certified Local Coastal Program. Additional details are provided in the regulatory overview of Section 4.6 (Socioeconomic Resources, Human Uses, and Environmental Justice).

[California Marine Invasive Species Act \(CMISA\), Cal. Pub.Res. Code § 71200 et seq.](#)

The California Marine Invasive Species Act (CMISA) was passed in 1999. It allows California to regulate vessels entering California ports in order to control the introduction of invasive species. Of particular note is Title 2, Division 3, Chapter 1, Article 4.6 of the California Code of Regulations detailed below.

[California Code of Regulations, Title 2, Division 3, Chapter 1, Article 4.6](#)

Article 4.6 was designed to move the state toward elimination of the discharge of nonindigenous species into the waters of the state or into waters that may impact the waters of the state, based on the best available technology economically achievable. The provisions of Article 4.6 apply to all vessels arriving at a California port or place from another port or place within the Pacific Coast Region. All such vessels shall exchange ballast water in near-coastal waters (more than 50 nm from land).

[Managing Agencies](#)

Federal

[NOAA Office of National Marine Sanctuaries \(ONMS\)](#)

There are five National Marine Sanctuaries (NMS) off the U.S. West Coast: Channel Island NMS, Monterey Bay NMS, Greater Farallones NMS, Cordell Bank NMS, and Olympic Coast NMS. Four are located along the California coast; the Olympic Coast NMS is in Washington. Regulatory authority established by the National Marine Sanctuary Act (NMSA), 16 U.S.C. § 1431. They have both common regulations amongst the sites (i.e. prohibited activities) and site-specific regulations. Prohibitions include oil, gas, and mineral exploration or development, dredging or otherwise disturbing the seabed, anchoring in seagrass, and disturbing or hunting marine mammals, sea turtles and birds. Restrictions cover vessel-based discharges and pollutants,

locations for vessel traffic, and transport of invasive species. Fishing is generally allowed. Full information on regulatory restrictions can be found at 15 CFR Part 922. Sanctuary sites whose boundaries touch land also overlap with state waters (i.e. which extend 3 nm from shore) including State MPAs.

[NOAA National Marine Fisheries Service \(NOAA Fisheries; NMFS\)](#)

NOAA Fisheries has jurisdiction over all federal waters and overlaps with state waters. Regulatory authority for these areas is taken from Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1801 et seq. Authority is also taken from the Marine Mammal Protection Act (MMPA), which protects and conserves marine mammal species by placing a moratorium on harassing, hunting, capturing, or killing any marine mammal or attempting any of these. If a project proponent determines that an action could incidentally harass (“take”) marine mammals, the proponent must consult with either the USFWS or NMFS to determine if a permit to take a marine mammal is required.

NMFS establishes and manages designated areas for Essential Fish Habitat (EFH) under Section 7 of the ESA. Proponents of proposed projects that may have an impact on any of these designated habitat types must consult NOAA Fisheries.

NMFS works with Regional Fishery Management Councils to prepare fishery management plans for each fishery under their authority that requires conservation and management. As determined by the Magnuson-Stevens Act (described above), this includes all fish Continental Shelf fishery resources within the Exclusive Economic Zone (EEZ) (within 230 miles [200 nm] of the shoreline). Fishery management plans (FMPs) describe the fisheries and contain necessary and appropriate conservation and management measures, applicable to foreign vessels in U.S. waters and fishing by U.S. vessels. The plans are submitted to the Secretary of Commerce, who has delegated to NOAA approval of the plans. If approved, NMFS promulgates implementing regulations. Under Section 303(a)(7) of the MSA NOAA Fisheries is tasked with identifying and protecting EFH, and Designate Habitat Areas of Particular Concern (HAPC).

[National Park Service \(NPS\)](#)

The NPS has aquatic jurisdiction in areas specifically created as marine national parks / monuments or where land-based National Parks / Monuments extend into the ocean. In California, this includes Point Reyes National Seashore and the Golden Gate National Recreation Area, both of which have boundaries extend ¼ mile offshore from landside park areas in most cases. The NPS also establishes Wilderness areas, which protects federally managed lands that are of a pristine condition, established by the Wilderness Act (Public Law 88-577) in 1964.

[U.S. Environmental Protection Agency \(EPA\)](#)

EPA jurisdiction includes all waters of the U.S. and overlaps with ONMS, USACE, NOAA Fisheries, and State agency jurisdictions (i.e. state waters). The EPA is involved in the implementation of numerous laws and regulatory programs and issues a variety of permits and/or plays a review role for various activities. The EPA’s Section 404 Program (under the federal Clean Water Act (CWA)) regulates the discharge of dredged or fill material into waters

of the United States under the CWA. The EPA implements sections of the Marine Protection, Research, and Sanctuaries Act (MPRSA) (aka Ocean Dumping Act) when it comes to regulating the disposal of dredged material in designated ocean disposal sites (e.g. SF Deep Ocean Disposal Site (SF-DODS)). USEPA also regulates vessel ocean discharges and has established “No Discharge” zones in certain areas. Full EPA regulations can be found under Title 40, Code of Federal Regulations (40 C.F.R.).

[U.S. Army Corps of Engineers \(USACE\)](#)

USACE jurisdiction under Rivers and Harbors Act includes all navigable waters of the U.S. and overlaps with ONMS, USACE, NOAA Fisheries, and State agency jurisdictions (i.e. state waters). Regulatory authority is taken from the Clean Water Act and the Rivers and Harbors Act of 1899. Under the CWA the USACE issues permits for the discharge of dredged and fill material into waters of the United States, including adjacent wetlands. Divided into eight divisions nationally; South Pacific division covers entire CA coastline. Within each division there are several Districts, established by watershed. Full regulations found in Title 33 (33 C.F.R), the portion of the Code of Federal Regulations that governs Navigation and Navigable Waters within the United States.

[U.S. Fish and Wildlife Service \(USFWS\)](#)

The USFWS established and oversees national Wildlife Refuge System. The USFWS’s goal is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats. Twenty refuges exist along the west coast in our study area. Regulatory authority is taken from the ESA, Migratory Bird Treaty Act (MBTA), and the federal Airborne Hunting Act. Restrictions and regulations vary widely from refuge to refuge, but most limit extractive and large-scale disturbances. Proponents of proposed projects that may have an impact on any of these designated habitat types must consult USFWS, as must any take of marine mammals (MMPA).

[State Agencies](#)

[California State Water Resources Control Board \(SWRCB\)](#)

The SWRCB adopts statewide water quality control plans and policies, such as the Ocean Plan, the Thermal Plan, and the State Implementation Policy. The SWRCB has established a system of 34 Areas of Special Biological Significance (ASBS). These areas are designated for special protection from undesirable alteration in natural water quality. These areas are often created overlap with federally-managed units.

[California Coastal Commission \(CCC\)](#)

The CCC takes authority from the California Coastal Act and federal Coastal Zone Management Act (CZMA). It has jurisdiction over entire coastal zone including up into watershed and out to marine state waters (i.e. 3 nm offshore). The CCC is responsible for reviewing and permitting most activities in marine state waters, including resource extraction.

[California State Lands Commission \(SLC\)](#)

California’s SLC is responsible for management and protection of natural and cultural resources, as well as public access rights, on some of California's publicly owned lands. It reviews projects

and issues leases. Often CEQA lead on proposed projects. CSLC Manages 4 million acres of tide and submerged lands and the beds of navigable rivers, streams, lakes, bays, estuaries, inlets, and straits. Jurisdiction is limited to state waters (i.e. 3 nm offshore). Regulatory authority was established by State Lands Act.

[California Department of Fish and Wildlife \(CDFW\) \(under CA Natural Resources Agency\)](#)

The CDFW divides the State of California into seven management regions whose boundaries mostly correspond to county borders (excepting Sacramento, Yolo, and San Joaquin counties). Jurisdiction is primarily within state waters (i.e. 3 nm offshore) but CDFW enforcement program patrols beyond that. Regulatory authority from the California Endangered Species Act (CESA). Pursuant to the requirements of CESA, CDFW must be consulted for any proposed project within its jurisdiction in which a California-listed endangered or threatened species may be present in the project area to determine whether the proposed project will have a potentially significant impact on such species.

The CDFW manages fishing activities in state waters. CDFW is overseen by the Fish and Game Commission, and is therefore responsible for applying and enforcing their directives as well as providing biological data and expertise to inform the Commission's decision making process. The CDFW also manages California's network of State MPAs. MPAs are named, discrete geographic marine or estuarine areas designed to protect or conserve marine life and habitat. There are different marine managed areas classifications used in California's MPA network. This includes three MPA designations (State Marine Reserve, State Marine Conservation Area, State Marine Park), a marine recreational management area (State Marine Recreational Management Area), and special closures.

[Oregon Department of Fish and Wildlife \(ODFW\)](#)

The ODFW is responsible for sustainably managing fish and wildlife in Oregon, including fishing and shellfishing. The ODFW manages five sites in the state waters of Oregon that are dedicated to conservation and scientific research. These sites are Cape Falcon, Cascade Head, Otter Rock, Cape Perpetua, and Redfish Rocks Marine Reserves. Jurisdiction is limited to within state waters and enforcement is carried out by the State Police rather than separate wardens. ODFW is overseen by the State Fish and Wildlife Commission which consists of seven members appointed by the governor (O.L.1975, ch. 253).

[Washington Department of Fish and Wildlife \(WDFW\)](#)

The WDFW is responsible for sustainably managing fish and wildlife in Washington, including fishing and shellfishing. The agency is overseen by the Washington Fish and Wildlife Commission which consists of nine members appointed by the governor. Jurisdiction and enforcement authority are generally limited to within state-owned land, although game wardens are usually deputized to act as law enforcement officials in the entire county in which they operate.

Washington Department of Natural Resources (WDNR)

The WDNR is responsible for managing all state-owned conservation lands in Washington. This includes seven marine aquatic reserves, all of which are located in Puget Sound (none are along the outer coast).

Analysis of Spatial Regulations

There are 391 U.S. MPAs in the outer coast area of the California Current as identified by NOAA's Marine Protected Area Inventory (NOAA 2017). Below we summarize the management regimes of these MPAs according to their jurisdiction and level of protection. For each category, we summarize the percentage of the U.S. Pacific EEZ and total area covered as well as the median area and the count of MPAs in that category. This allowed us to show trends in how the U.S. uses MPAs on the Pacific coast. Overall, the federal government is responsible for over 95% of the area within MPAs (Table 2). Oregon's state waters are far less protected than California's and Washington's (Table 3). Most MPAs are managed by NOAA Fisheries (Table 4). Less than a quarter of one percent of the EEZ is covered by highly protective MPAs (no take/impact/access; Table 5). This highly protected area tends to be concentrated in small state MPAs.

Jurisdiction

Government Level

Over half of the California Current's federal waters are within an MPA and the federal government is responsible for over 95% of the area within MPAs (Table 2). This is due primarily to the extremely large Groundfish Conservation Area which has specific restrictions to protect overfished groundfish species. Most MPAs are very small, and state MPAs are much smaller than federal MPAs, with over half of federal MPAs under 90 km² and half of state MPAs under 3.5 km² in size.

Table 2. Government level of Marine Protected Areas in the California Current (U.S. EEZ)

Government Level	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Local	<0.05%	1.3	0.1	8
Partnership	0.1%	572.6	0.3	13
State	0.9%	7,156.8	3.4	268
Federal	52.5%	433,049.4	89.7	102

Location

Oregon's state waters are far less protected (< 0.05 % in MPAs) than California's (0.6% in MPAs) and Washington's (0.3% in MPAs; Table 3). While California has six times more MPAs than Oregon and four times more MPAs than Washington, most of them are likely too small to be effective.

Table 3. Location of Marine Protected Areas in the California Current (U.S. EEZ)

Location	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
California	0.6%	4,630.5	4.3	198
Oregon	<0.05%	307.1	0.6	30
Washington	0.3%	2,221.4	0.7	55
Federal	52.5%	433,621.2	85.6	108

Type

The National Marine Fisheries Service is responsible for managing the vast majority of area within California Current MPAs (Table 4). National Marine Sanctuaries account for approximately 5% of the EEZ and all other types account for less than 2%. California manages by far the most MPAs (198).

Table 4. Types of Marine Protected Areas in the California Current (U.S. EEZ)

Types	Percentage of area of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
National Marine Fisheries Service	46.9%	387,480.2	164.1	69
National Marine Sanctuaries	4.8%	39,788.7	8,258.6	5
National Wildlife Refuge System	<0.05%	390.5	4.6	20
National Park Service	0.7%	5,850.7	317.9	7
Marine National Monuments	<0.05%	7.7	3.9	2
National Estuarine Research Reserve System	<0.05%	103.4	15.1	5
Washington State	0.3%	2,221.4	0.7	55
Oregon State	<0.05%	307.1	0.6	30
California State	0.6%	4,630.5	4.3	198

Protection

The Marine Protected Areas Inventory classifies the protection offered by MPAs in the U.S. in five categories. These are the overall protection level (e.g., multiple-use vs no take), the focus of the protected area (e.g., sustainable production vs natural heritage), the scale of the protection (focal resource vs ecosystem), the constancy (seasonality) of protection, and the permanence of protection. We also analyze several further classifications, including IUCN designation as an alternative classification for overall protection, level of fishing restrictions, vessel traffic, and anchoring. Overall, less than a quarter of one percent of the EEZ is covered by highly protected MPAs (no take/impact/access; Table 5).

Protection Level

This classification identifies the general level at which activities are permitted in the MPA. There are six levels: uniform multiple-use, zoned multiple-use, zoned multiple-use with no take areas, no take, no impact, and no access. Overall, less than a quarter of one percent of the EEZ is covered by highly protective MPAs (no take/impact/access; Table 5). These highly protective MPAs are disproportionately state MPAs.

Table 5. Protection Level of Marine Protected Areas in the California Current (U.S. EEZ)

Protection Level	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Uniform Multiple Use	46.7%	385,225.3	9.2	257
Zoned Multiple Use	6.0%	49,840.6	8,258.6	7
Zoned w/No Take Areas	0.5%	3,845.8	10.9	5
No Take	0.2%	1,815.6	9.4	92
No Impact	0.0%	0.0	0.0	0
No Access	<0.05%	52.9	0.4	30

Protection Focus

This category classifies the focus of the MPA as protecting cultural heritage (e.g., shipwrecks), ensuring sustainable production (e.g., a fishery), or preserving natural heritage (e.g., biodiversity). The vast majority of area within MPAs is for ensuring sustainable production whereas the vast majority of MPAs were created to protect the natural environment (Table 6). MPAs designated for natural heritage are much smaller, on average, than those for sustainable production (median area: 181.4 vs 3.8 km²). Only one California Current MPA has the primary focus of protecting cultural heritage (San Juan Island National Historical Park).

Table 6. Focus of Marine Protected Areas in the California Current (U.S. EEZ)

Focus	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Cultural Heritage	<0.05%	7.0	7.0	1
Sustainable Production	46.9%	387,239.2	181.4	64
Natural Heritage	6.5%	53,534.0	3.8	326

Scale

This category identifies whether the MPA was created to protect a specific focal resource (e.g., fishery or endangered species) or an ecosystem as a whole. Focal resource MPAs cover the majority of area whereas ecosystem MPAs make up the majority of number (Table 7). Interestingly, ecosystem-scale MPAs tend to be much smaller than focal resource MPAs, indicating that this classification may not be matching the actual benefit of the MPA well.

Table 7. Scale of Marine Protected Areas in the California Current (U.S. EEZ)

Scale	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Focal Resource	46.9%	387,287.3	40.8	108
Ecosystem	6.5%	53,492.9	6.4	283

Constancy and Permanence

The final two classifications refer to the temporal duration of an MPA. Constancy is whether an MPA provides protection year-round or for only some part of a year (e.g., seasonal). All but six MPAs in the California Current provide year-round protection. Permanence is whether an MPA is permanent or only in place until certain conditions are met. All of the MPAs in the California Current provide permanent protection. Conditional marine protection is not provided spatially in the U.S. California Current.

Fishing Restrictions

The level of fishing permitted in an MPA varies widely. Most MPAs, by area majority and count plurality, have some form of commercial fishing restriction (Table 8). About one-third of MPAs prohibit commercial fishing but this represents only 0.3% of the EEZ. Note that the ‘Restricted’ category is very broad, covering everything from limits on a single species or equipment type to a near ban.

Table 8. Commercial Fishing Regulations of Marine Protected Areas in the California Current (U.S. EEZ)

Commercial Fishing Regulations	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Restrictions Unknown	<0.05%	221.4	22.7	6
No Site Restrictions	3.8%	31,379.2	6.2	70
Restricted	49.3%	407,083.2	22.9	163
Prohibited	0.3%	2,096.3	2.9	152

Recreational fishing is less regulated than commercial fishing. The majority of MPAs by area have no recreational restrictions, a plurality by count have some recreation restrictions (4% of area), and only 0.2% of the EEZ is off-limits to recreational fishing (Table 9). Again note that the ‘Restricted’ category is very broad.

Table 9. Recreational Fishing Regulations of Marine Protected Areas in the California Current (U.S. EEZ)

Recreational Fishing Regulations	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Restrictions Unknown	<0.05%	221.4	22.7	6
No Site Restrictions	49.3%	406,822.5	56.5	118
Restricted	3.9%	31,846.9	3.8	143
Prohibited	0.2%	1,889.4	3.5	124

Vessel Restrictions

The vast majority of MPAs have no restrictions on vessel traffic or anchoring. Less than 5% of the EEZ has vessel restrictions (29 MPAs) and less than 0.05% is closed to vessel traffic (28 MPAs; Table 10). Anchoring is even less restricted, with less than half of one percent either restricted (0.4%, 14 MPAs) or prohibited (<0.05%, 28 MPAs; Table 11).

Table 10. Vessel Traffic Regulations of Marine Protected Areas in the California Current (U.S. EEZ).

Vessel Traffic Regulations	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Unknown	1.1%	9,084.5	3.8	181
Unrestricted	47.5%	392,013.9	27.4	153
Restricted	4.8%	39,650.6	3.7	29
Prohibited	<0.05%	31.2	0.3	28

Table 11. Anchoring Regulations of Marine Protected Areas in the California Current (U.S. EEZ).

Anchoring Regulations	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
Unknown	1.1%	9,464.4	3.8	222
Unrestricted	51.9%	428,163.1	39.1	133
Restricted	0.4%	2,998.4	2.8	14
Prohibited	<0.05%	154.4	0.6	22

Management Plan Type

The vast majority of MPAs in the California Current are managed with non-MPA programmatic fisheries management plans (Table 12). This primarily includes all areas managed by the National Marine Fisheries Service. Approximately 5% of the EEZ is managed by site-specific management plans, most notably including most of the National Marine Sanctuaries. Approximately 1% of the EEZ is managed by non-MPA programmatic habitat plans. Less than 1% of the EEZ is managed by MPA programmatic management plans; this includes most state MPAs.

Table 12. Management Plan Type of Marine Protected Areas in the California Current (U.S. EEZ).

Management Plan Type	Percentage of EEZ	Total Area (km ²)	Median Area (km ²)	Number of MPAs
No Management Plan	<0.05%	55.0	0.3	21
Non-MPA Programmatic Fisheries Management Plan	46.9%	387,577.7	88.6	83
Non-MPA Programmatic Species Management Plan	<0.05%	17.7	1.7	4
Non-MPA Programmatic Habitat Management Plan	1.0%	8,569.5	1.5	8
MPA Programmatic Management Plan	0.8%	6,541.6	4.3	219
Site-Specific Management Plan	4.6%	38,018.8	10.8	56

Combined Index of Protection

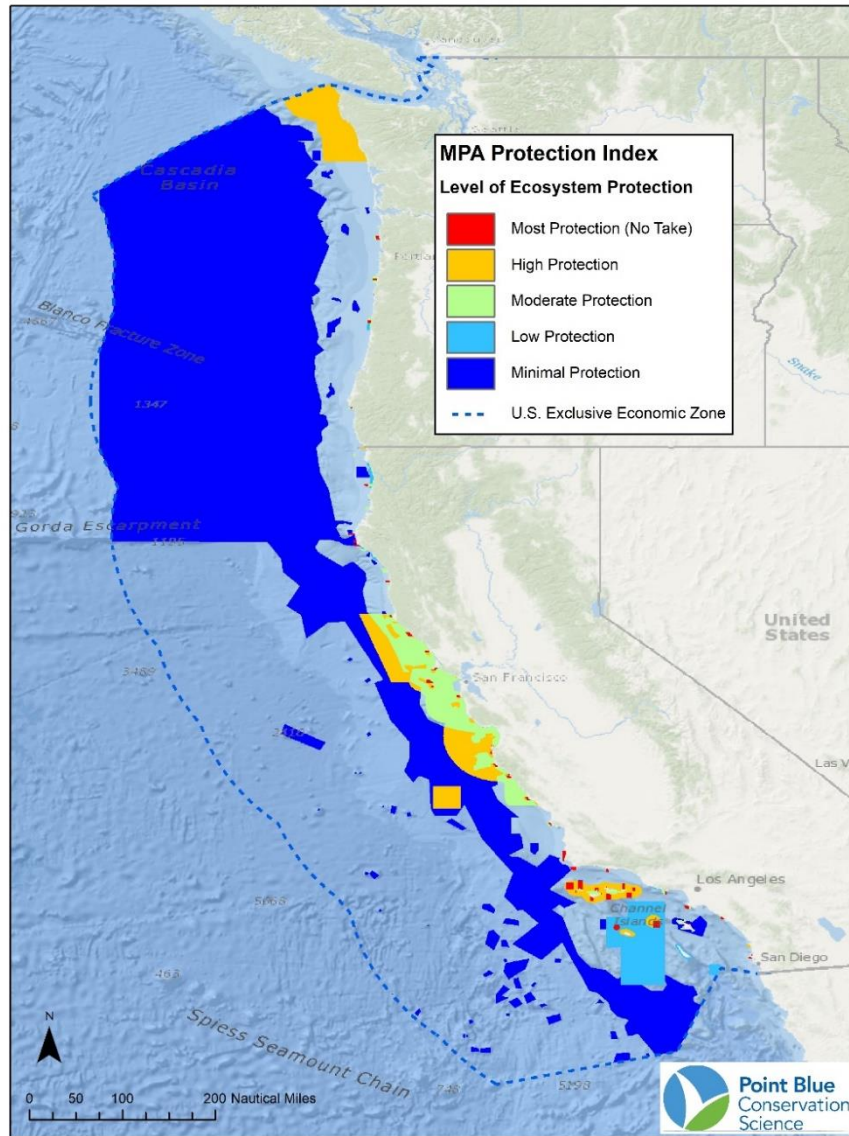


Figure 2. Protection index of Marine Protected Areas in the California Current (U.S. EEZ). The index is based on a cumulative score of the above protection metrics. High values (oranges and reds) are more protective, moderate values (greens and light blue) are moderately protective, low values (dark blue) are minimally protective, and uncolored areas are outside current MPA boundaries. Note that ‘protection’ refers to cumulative protection of an ecosystem as a whole; some MPAs shown as minimally protective have nonetheless been extremely important at targeted conservation (e.g., the Groundfish FMP).

Protection by State

To quantify the level of protection in the state waters for each state, we performed a separate analysis looking only at MPAs within 3nm from shore. This analysis used the combined protection index as described above. As was likely obvious from the map above (Figure 2), there is a noticeable gap in MPAs between central Washington and northern California. This is reflected in the results of our analysis, showing that Oregon protects substantially less of its state waters than California or Washington (11% vs. 56% and 48%, respectively; Table 13). Moreover, MPAs in Oregon are, on average, much less protective than MPAs in California or Washington (average protection index of 0.3 vs 1.5 and 1.3, respectively). California, by virtue of its larger size, as well as higher percent of area protected and the level of protection, has a much higher protection value than both other states.

Table 13. Summary of Marine Protected Area coverage, protection level, and conservation value by state-owned waters.

State	Protected Area (km ²)	Percent of State Waters Protected	Average Protection Index	Conservation Value Index
California	4798	56%	1.5	7233
Oregon	281	11%	0.3	94
Washington	1277	48%	1.3	1702

PRIORITY SPECIES & HABITATS

We collected data on all 20 species and 11 habitats identified as ocean conservation priorities during our review and expert survey. We obtained range-wide estimates of habitat suitability for all species except for Snowy Plover and Black Oystercatcher which are excluded from subsequent analyses. Bird data layers were from Nur et al. (2011) and all other layers were from AquaMaps (Kaschner et al. 2016). These layers are rasterized heatmaps that score the suitability of each portion of the California Current for each species on a scale of 0 (totally unsuitable) to 1 (highly suitable).

We used these heatmaps to calculate the relative amount of suitable habitat for each species and habitat that was protected within MPAs by jurisdiction (i.e. agency and state). This was done by overlaying the species and habitat layers with the MPA boundaries and summarizing the values therein. By comparing the distribution of habitat suitability included within different levels of MPA protection, we were able to determine how representative the protected habitat is of the species' total habitat.

Species

We estimated the total percentage of suitable habitat for each species included in MPAs across the entire EEZ. To account for varying suitability across the range of a species, we calculated a suitability-weighted habitat area. For each species, each portion of their range (raster cell) was scored from 0 (least suitable) to 1 (most suitable). We then multiplied the area of each subsection by the suitability of that subsection. Summing these values across the range of the species gave us a suitability-weighted habitat value. This was done to ensure that more suitable habitat was ranked highly in our analysis: a small patch of highly suitable habitat would be scored similarly to a large area of moderately suitable habitat.

To analyze species' habitat suitability by different jurisdictions, we divided the suitability-weighted area within MPAs (grouped by agency and/or state) by the total suitability-weighted area in a species' range. All species but red sea urchin have the majority of their suitable habitat occurring within MPAs (Table 14). Note that this table does not directly examine the level of protection offered by inclusion in an MPA, so simply having habitat within any MPA does not necessarily mean that species is well protected there. Generally speaking, the table is ordered from jurisdictions that are less restrictive of human activities (NMFS) towards more restrictive (state MPAs).

The National Marine Fisheries Service manages a large area and number of MPAs with suitable habitat for all species, followed closely by National Marine Sanctuaries. National Marine Sanctuaries protect a lower percentage of suitable habitat for Cassin's auklet, California sea lion, blue whale, and humpback whale than all other species examined. Areas managed as National Wildlife Refuges (NWR), National Parks (NPS), or Marine National Monuments (MNM) protect very little suitable habitat, mostly due to lack of size.

Table 14. Percentage of suitable habitat (suitability-weighted area) occurring within different jurisdictions of MPAs. The second column (Total) is the percent falling within any MPA. NMFS: National Marine Fisheries Service, NMS: National Marine Sanctuary, NWR: National Wildlife Refuge, MNM: Marine National Monument, WA: Washington State or sub-state, OR: Oregon State or sub-state; CA: California State or sub-state.

Species	Total	NMFS	NMS	NWR	NPS	MNM	WA	OR	CA
Red Abalone	62.0%	29.3%	25.6%	0.1%	0.9%	<0.05%	0.0%	0.1%	6.1%
Red Sea Urchin	46.7%	18.8%	21.0%	0.9%	0.1%	0.0%	5.4%	0.5%	0.1%
Dungeness Crab	59.0%	34.9%	20.3%	0.2%	0.2%	<0.05%	1.1%	0.3%	1.8%
California Mussel	55.8%	25.4%	24.4%	0.2%	0.6%	<0.05%	1.1%	0.4%	3.8%
Olympia Oyster	51.2%	19.0%	25.1%	0.3%	0.6%	<0.05%	1.7%	0.4%	4.0%
Coho Salmon	55.8%	32.5%	18.6%	0.3%	0.4%	<0.05%	1.4%	0.3%	2.4%
Chinook Salmon	61.3%	38.3%	19.5%	0.2%	0.2%	<0.05%	1.1%	0.3%	1.7%
Northern Anchovy	62.3%	40.5%	18.2%	0.1%	0.4%	<0.05%	0.2%	0.2%	2.7%
Pacific Sardine	57.6%	34.8%	18.3%	0.1%	0.5%	<0.05%	0.1%	0.2%	3.6%
Halibut	62.8%	38.1%	20.4%	0.6%	<0.05%	0.0%	3.5%	0.1%	0.0%
Brandt's Cormorant	50.9%	28.7%	18.9%	<0.05%	0.4%	0.0%	0.0%	0.1%	2.8%
Common Murre	61.8%	46.1%	14.2%	<0.05%	0.2%	0.0%	0.0%	0.1%	1.4%
Cassin's Auklet	51.5%	43.6%	7.2%	0.0%	0.1%	0.0%	0.0%	0.0%	0.7%
Sea Otter	53.9%	31.4%	18.0%	0.2%	0.4%	0.0%	1.1%	0.3%	2.4%
Steller Sea Lion	53.8%	29.5%	19.7%	0.3%	0.3%	0.0%	1.4%	0.4%	2.2%
California Sea Lion	64.7%	57.4%	6.1%	0.0%	0.1%	<0.05%	<0.05%	<0.05%	0.9%
Blue Whale	55.8%	53.0%	2.5%	0.0%	<0.05%	0.0%	<0.05%	0.0%	0.3%
Humpback Whale	55.8%	50.6%	4.4%	0.0%	0.1%	0.0%	0.2%	<0.05%	0.6%
Giant Kelp	53.0%	23.9%	23.1%	0.1%	0.7%	<0.05%	0.3%	0.4%	4.6%

States also protect a relatively small percentage of the total suitable habitat for most species. This is due to the relatively small area protected by state MPAs, as state MPAs are limited to occurring within 3nm from shore, which is a small portion of the overall EEZ (200 nm). Species with a higher portion of their suitable range within nearshore waters (e.g., red abalone, Olympia oyster, and giant kelp) have a correspondingly higher percentage of their suitable habitat protected by state MPAs. For most species, California protects a much higher percentage of suitable habitat than Washington and Oregon. For a similar analysis restricted to state waters, see [Table 15](#).

Performing the above analysis but limiting the extent to state waters gives a more accurate representation of state protection. As expected due to the limited number of MPAs in Oregon, less suitable habitat is protected in Oregon than in California and Washington (average of ~10% vs 68% and 82%; [Table 15](#)). Despite having less protected area than California, Washington MPAs generally protect higher quality habitat. Priority species are generally protected at similar relative levels across states. Notable under-protected exceptions are red sea urchins in California and both red abalone and blue whale in Oregon.

Table 15. Index and percentage of suitable habitat (suitability-weighted area) occurring within MPAs in state waters of the California Current.

Common Name	Suitable Habitat in Outer Coast State Waters Protected by MPAs					
	California		Oregon		Washington	
	Value	Percent	Value	Percent	Value	Percent
Red Abalone	6758	58.1%	14	1.8%	0	NA
Red Sea Urchin	64	27.3%	126	10.7%	1118	93.2%
Dungeness Crab	3198	58.3%	302	9.7%	1263	72.6%
California Mussel	6262	56.6%	316	10.2%	1266	69.0%
Olympia Oyster	6121	56.2%	318	9.6%	1266	68.8%
Coho Salmon	4374	56.5%	278	9.8%	1239	75.7%
Chinook Salmon	2598	58.7%	217	9.8%	1106	80.4%
Northern Anchovy	5947	55.7%	271	9.7%	1003	78.4%
Pacific Sardine	6555	57.0%	213	9.0%	552	76.4%
Halibut	0	NA	12	7.9%	365	98.9%
Brand's Cormorant	4411	58.0%	114	9.3%	678	60.3%
Common Murre	4975	61.1%	117	9.1%	719	61.7%
Cassin's Auklet	5200	61.9%	108	9.1%	702	61.5%
Sea Otter	3537	55.2%	252	10.1%	1193	79.0%
Steller Sea Lion	3160	55.9%	290	10.1%	1251	75.4%
California Sea Lion	5527	56.2%	137	8.6%	537	86.1%
Blue Whale	2762	64.9%	23	6.0%	106	85.3%
Humpback Whale	6131	58.7%	251	9.5%	1032	73.0%
Giant Kelp	6249	55.3%	273	9.8%	993	76.6%

Breaking this down further, we compared habitat suitability for each species between MPAs that offered different levels of protection. If the quality of a species' habitat was lower in high protection MPAs (namely state MPAs) than in the EEZ as a whole, we determined that species to be underrepresented in MPAs. That is an indication that previous efforts have not focused on creating MPAs for the protection of that particular species as only a small fraction of their best habitat is protected.

Conversely, if the quality of a species' habitat was higher in high protection MPAs than in the EEZ as a whole, this is an indication that conservation efforts have been focused on that species and that it is currently overrepresented relative to other species in current MPAs. (Note that overrepresentation is not a bad thing in and of itself; that depends on the relative conservation values and targets set).

Our analysis found that seven species are underrepresented in conservation-focused MPAs across the EEZ as a whole: Dungeness crab, Coho salmon, Chinook salmon, common murre, Cassin's auklet, blue whale, and humpback whale (Table 16). However, when we only consider the area that overlaps with the native range of Coho and Chinook salmon, these species drop off the list, leaving five species whose high-quality habitat is underrepresented in the MPAs.

Table 16. How well high-quality priority species habitat is represented in high protection Marine Protected Areas in the California Current (U.S. EEZ). *Coho and Chinook salmon are not underrepresented in MPAs in their naturally occurring range.

Common Name	Scientific Name	Representativeness
Red Abalone	<i>Haliotis rufescens</i>	↑ Overrepresented
Red Sea Urchin	<i>Mesocentrotus franciscanus</i>	↑ Well Represented
Dungeness Crab	<i>Metacarcinus magister</i>	↓ Underrepresented
California Mussel	<i>Mytilus californianus</i>	↑ Well Represented
Olympia Oyster	<i>Ostrea lurida</i>	↑ Well Represented
Coho Salmon	<i>Oncorhynchus kisutch</i>	↓ Underrepresented*
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	↓ Underrepresented*
Northern Anchovy	<i>Engraulis mordax</i>	↑ Overrepresented
Pacific Sardine	<i>Sardinops sagax</i>	↑ Overrepresented
Halibut	<i>Hippoglossus stenolepis</i>	↑ Well Represented
Brandt's Cormorant	<i>Phalacrocorax penicillatus</i>	↑ Well Represented
Common Murre	<i>Uria aalge</i>	↓ Underrepresented
Cassin's Auklet	<i>Ptychoramphus aleuticus</i>	↓ Underrepresented
Sea Otter	<i>Enhydra lutris</i>	↑ Well Represented
Steller Sea Lion	<i>Eumetopias jubatus</i>	↑ Well Represented
California Sea Lion	<i>Zalophus californianus</i>	↑ Overrepresented
Blue Whale	<i>Balaenoptera musculus</i>	↓ Underrepresented
Humpback Whale	<i>Megaptera novaengliae</i>	↑ Well Represented
Giant Kelp	<i>Macrocystis pyrifera</i>	↑ Overrepresented

THREATS

The California Current Ecosystem is threatened both by direct and indirect human activities. In the direct human impacts, we found the top threats emphasized are fishing, pollution (including urban, nonpoint, and industrial sources), and disturbance. The most important indirect human impacts that we found are changes in natural processes, ocean chemistry changes (acidification and hypoxia), sea level rise, and increased temperatures (both sea surface and air).

We collected data on 25 threats identified in the literature as being of potential concern to the California Current Ecosystem (Elliott et al. 2019; Halpern et al. 2009). These include data on fishing (e.g., recreational and different types of commercial fishing), land-based pollution (e.g., sedimentation and runoff), ocean-based pollution (e.g., vessel traffic and oil extraction), and climate change (e.g., ocean acidification and temperature change). Please see Elliott et al. (2019) for a detailed listing of identified threats. This information (from Halpern et al. 2009) was used to estimate the relative potential impact of each identified threat on Pacific coast MPAs. This was done by overlaying the threat index layers with the MPA layers and calculating the mean threat index within each MPA.

Cumulative Human Impact

The cumulative human impact on the California Current is greater in deep waters off Washington and Oregon, as well as along the shoreline particularly in areas adjacent to major population centers (Figure 3). While it is difficult to observe in Figure 3 given the scale, there is a thin band immediately along the coast of extremely high human impact due to shore based activities and pollution. Nearshore waters tend to be relatively less disturbed, due to greater restrictions within state's territorial jurisdictions.

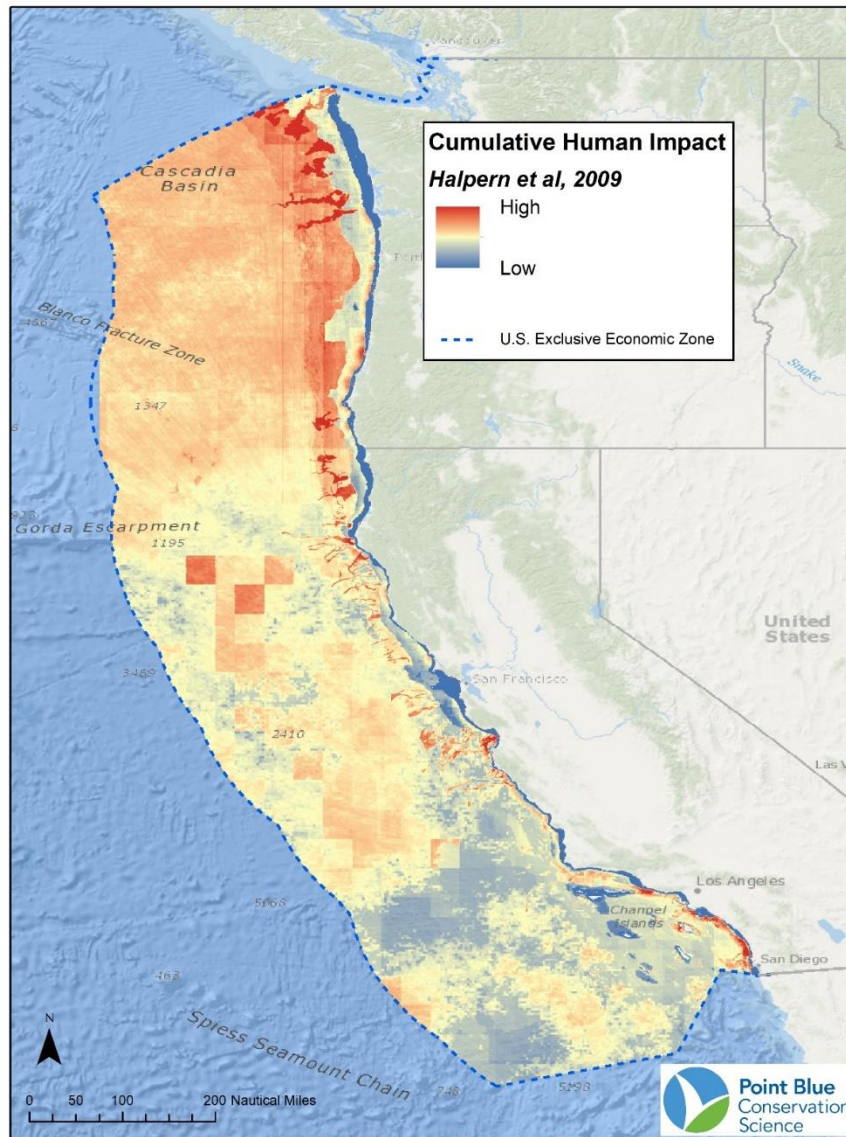


Figure 3. Cumulative impact of human activities, both direct and indirect, on the California Current (U.S. EEZ). Data from Halpern et al. (2009).

Individual Impacts

Our analysis identifies climate change-related threats as having the most potential impact on existing MPAs in the California Current (Table 17). Of these, the threats posed by ocean acidification and changes in ultraviolet radiation are projected to have the largest impact, followed by changes in sea surface temperature. Spatially, climate change impacts tend to be more concentrated in the northern part of the U.S. EEZ (Figure 4 and Figure 5). Our analysis identifies ocean deposition, increased sedimentation, recreational fishing, shipping, and ocean-based pollution as the top five non-climate threats.

Table 17. Average magnitude of human impact on MPAs in the California Current (U.S. EEZ) by impact type. Index of impact is on a scale of 0 – 1 (from Halpern et al., 2009) and averaged across all regions identified by the MPA Inventory (NOAA, 2017).

Impact Category	Impact Name	Index of Impact
Climate Change	Ocean Acidification	0.81
	Ultraviolet Radiation Change	0.77
	Sea Surface Temperature Change	0.36
Fishing	Fishing: Recreational	0.32
	Fishing: Demersal Non-Destructive Low-Bycatch	0.17
	Fishing: Demersal Destructive	0.06
	Fishing: Pelagic Low-Bycatch	0.04
	Fishing: Demersal Non-Destructive High-Bycatch	0.03
	Fishing: Pelagic High-Bycatch	0.01
Land-based Pollution	Sediment Runoff, Increase	0.49
	Sediment Runoff, Decrease	0.18
	Light Pollution	0.18
	Organic Pollution	0.17
	Nutrient Runoff	0.15
	Coastal Waste	0.11
	Inorganic Pollution	0.08
	Power Plants	0.01
Other Land-based	Invasive Species	0.25
	Beach Access	0.08
	Coastal Engineering	0.05
Other Ocean-based	Ocean Deposition	0.49
	Shipping	0.3
	Ocean Based Pollution	0.28
	Ocean Engineering	0
	Fish Farming	0

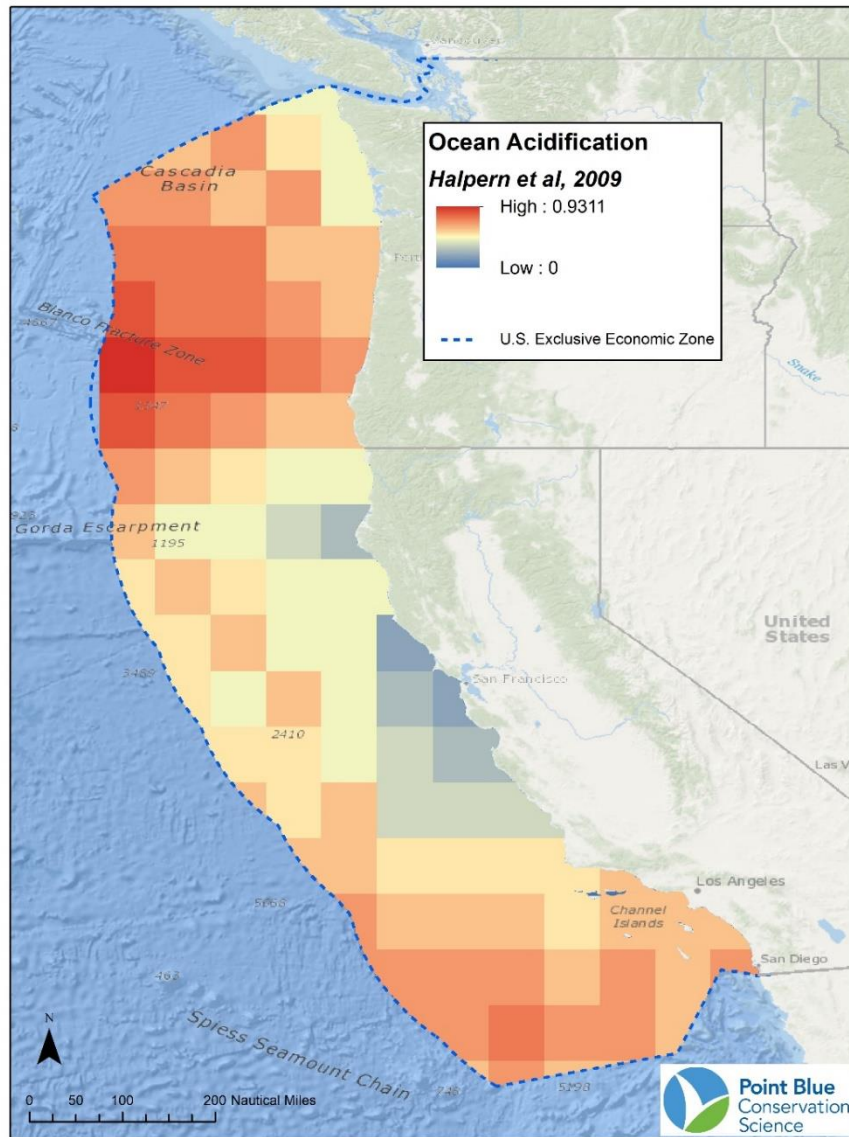


Figure 4. Relative impact of projected changes in ocean pH (ocean acidification) on the California Current (U.S. EEZ). Ocean acidification is the impact of largest total projected magnitude. Data from Halpern et al. (2009).

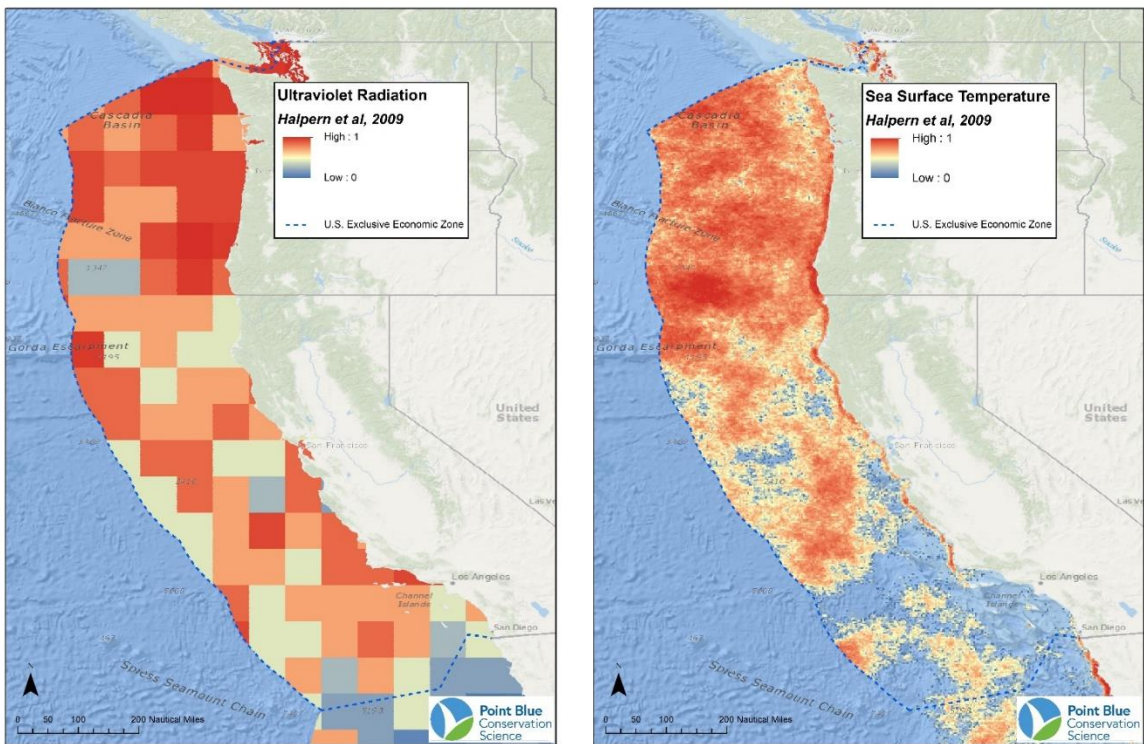


Figure 5. Relative impact of projected changes in ultraviolet radiation and sea surface temperature on the California Current (U.S. EEZ). Data from Halpern et al. (2009).

Performing the same analysis for each jurisdiction type reveals spatial patterns in the threats facing California Current MPAs (Table 18). Climate change impacts threaten all MPAs in similar amounts. State MPAs, being located closer to shore, show a much greater impact from land-based threats such as coastal waste, nutrient runoff, and light pollution.

It is important to note that certain practices, such as demersal destructive fishing, are widely restricted in MPAs, resulting in a much lower index of impact than would otherwise be the case. When looking at areas that are less protected, such as Oregon’s MPAs, the impacts of demersal fishing increase substantially (Table 18).

Table 18. Average magnitude of human impact on MPAs in the California Current (U.S. EEZ) by impact type and MPA jurisdiction. Index of impact is on a scale of 0 – 1 (from Halpern et al. 2009) and averaged across all regions identified by the MPA Inventory (NOAA, 2017). Washington State has no state managed MPAs along the Outer Coast and so is not included.

	Impact	NMFS	NMS	NWR	NPS	MNM	OR	CA
Climate Change	Ocean Acidification	0.81	0.85	0.83	0.83	0.62	0.81	0.8
	Sea Surface Temperature Change	0.36	0.35	0.42	0.67	0.21	0.74	0.3
	Ultraviolet Radiation Change	0.77	0.82	0.82	0.75	0.6	0.8	0.75
Fishing	Demersal Destructive	0.06	0.02	0.07	0.07	0.04	0.14	0.06
	Demersal Non-Destructive, High-Bycatch	0.03	0.03	0.03	0.01	0.02	0.03	0.04
	Demersal Non-Destructive, Low-Bycatch	0.17	0.19	0.14	0.19	0.09	0.38	0.13
	Pelagic, High-Bycatch	0.01	0.01	0.01	0	0.07	0	0.02
	Pelagic, Low-Bycatch	0.04	0.04	0.03	0.02	0.02	0.04	0.05
	Recreational	0.32	0.23	0.26	0.47	0.26	0.39	0.34
Land-based Pollution	Coastal Waste	0.11	0	0	0	0.22	0	0.18
	Inorganic Pollution	0.08	0	0.01	0.05	0.08	0.1	0.11
	Light Pollution	0.18	0	0.01	0.06	0.12	0.22	0.26
	Nutrient Runoff	0.15	0.04	0.04	0.14	0.21	0.18	0.2
	Organic Pollution	0.17	0.02	0.04	0.18	0.22	0.23	0.23
	Power Plants	0.01	0	0	0	0	0	0.02
	Sediment Runoff, Decrease	0.18	0.06	0.05	0.07	0.26	0.16	0.24
	Sediment Runoff, Increase	0.49	0.15	0.21	0.41	0.49	0.71	0.61
Other Land-based	Beach Access	0.08	0	0	0	0.09	0.26	0.08
	Coastal Engineering	0.05	0	0	0	0.02	0	0.08
	Invasive Species	0.25	0.07	0.08	0.45	0.22	0.35	0.31
Other Ocean-based	Fish Farming	0	0	0	0	0	0	0
	Ocean Based Pollution	0.28	0.17	0.19	0.42	0.24	0.32	0.33
	Ocean Deposition	0.49	0.58	0.53	0.55	0.4	0.68	0.42
	Ocean Engineering	0	0	0	0	0	0	0
	Shipping	0.3	0.42	0.43	0.22	0.22	0.11	0.29

We performed a similar analysis looking specifically at impacts on National Marine Sanctuaries (Table 19). As noted above, climate change impacts are large across all sanctuaries, but these challenges probably cannot be addressed at an MPA level. Changes in sea surface temperature are the only climate change impact projected to have significant spatial variation, with Cordell Bank somewhat less affected and Channel Islands only minimally affected.

Recreational fishing has a moderate to major impact for all sanctuaries, and the largest relative fishing impact on all sanctuaries but Olympic. Olympic is most impacted by commercial fishing,

a relatively minor human disturbance for the other sanctuaries. The two types of fishing causing the most harm in Olympic are both demersal in nature, targeting groundfish and impacting the sea floor. The impacts of demersal non-destructive, low-bycatch fishing and demersal destructive fishing are four times higher in Olympic than the other sanctuaries. The impact of pelagic fishing is most felt in Olympic but relatively minor across all sanctuaries relative to other types of fishing.

Sediment runoff and ocean deposition have major impacts on all sanctuaries, with the exception of sedimentation in Cordell Bank. Other land-originating impacts (e.g., light pollution and nutrient runoff) are largest for Monterey Bay and Greater Farallones while minimal for Olympic and Cordell Bank, as expected due to relative proximity to shorelines and population centers. Invasive species are a relatively minor concern for the sanctuaries overall, with Monterey Bay and Channel Islands more vulnerable than the northern sanctuaries.

Shipping has a major impact on all sanctuaries in the California Current. When looking at non-climate change impacts, shipping is in the top three for all sanctuaries but Olympic, which is only moderately impacted. Aquaculture, petroleum extraction, and other ocean engineering projects are tightly regulated and not currently having a discernable impact on the outer coast portions of California Current sanctuaries.

Table 19. Average magnitude of human impact within National Marine Sanctuaries in the California Current (U.S. EEZ). Index of impact is on a scale of 0 – 1 (from Halpern et al., 2009).

Impact Category	Impact Name	All NMS	Olympic Coast	Greater Farallones	Cordell Bank	Monterey Bay	Channel Islands
Climate Change	Ocean Acidification	0.83	0.84	0.81	0.81	0.81	0.86
	Ultraviolet Radiation Change	0.82	0.9	0.79	0.78	0.81	0.81
	Sea Surface Temperature Change	0.42	0.59	0.53	0.57	0.32	0.09
Fishing	Fishing: Recreational	0.26	0.24	0.22	0.12	0.31	0.4
	Fishing: Demersal Non-Destructive Low-Bycatch	0.14	0.37	0.08	0.08	0.07	0.11
	Fishing: Demersal Destructive	0.07	0.2	0.05	0.04	0.03	0.01
	Fishing: Demersal Non-Destructive High-Bycatch	0.03	0.03	0.02	0.03	0.03	0.03

Impact Category	Impact Name	All NMS	Olympic Coast	Greater Farallones	Cordell Bank	Monterey Bay	Channel Islands
	Fishing: Pelagic Low-Bycatch	0.03	0.07	0.02	0.02	0.02	0.03
	Fishing: Pelagic High-Bycatch	0.01	0	0.01	0	0.01	0.03
Land-based Pollution	Sediment Runoff, Increase	0.21	0.2	0.23	0.04	0.24	0.33
	Sediment Runoff, Decrease	0.05	0	0.07	0.04	0.09	0.04
	Nutrient Runoff	0.04	0.04	0.04	0.01	0.07	0.04
	Organic Pollution	0.04	0.05	0.06	0	0.06	0.01
	Inorganic Pollution	0.01	0	0.01	0	0.02	0
	Light Pollution	0.01	0	0.01	0	0.03	0.01
	Power Plants	0	0	0	0	0	0
	Coastal Waste	0	0	0.01	0	0.01	0
Other Land-based	Invasive Species	0.08	0.08	0.07	0.04	0.12	0.12
	Beach Access	0	0	0	0	0	0
	Coastal Engineering	0	0	0	0	0	0
Other Ocean-based	Ocean Deposition	0.53	0.96	0.43	0.43	0.33	0.51
	Shipping	0.43	0.27	0.46	0.5	0.46	0.45
	Ocean Based Pollution	0.19	0.14	0.18	0.17	0.23	0.22
	Ocean Engineering	0	0	0	0	0	0
	Fish Farming	0	0	0	0	0	0

OPPORTUNITIES FOR CONSERVATION

We synthesized the information collected and analyzed for Tasks 1 – 3 above to identify areas of high conservation value. Areas of high conservation value outside existing MPAs are candidates for new MPAs, and areas of high conservation value within existing MPAs are candidates for regulatory enhancement. We broke these areas down further into two subcategories based on the level of human impact: areas of high impact had the most potential benefit but also the highest potential cost, whereas areas of low human impact had less potential benefit now but also lower barriers to establishment.

We estimated conservation value using the Zonation spatial prioritization framework and software (Lehtomäki & Moilanen 2013). Given a set of inputs (e.g., the priority species suitability and priority habitat layers used above), Zonation calculates the relative conservation value of a set area (in our case, a 1 km² pixel). The conservation value for a given area depends on the species-specific suitability values and the proportion of the distribution of each species remaining across the landscape. The program iteratively removes area (cells) from the landscape and critically, the conservation value of every remaining area is then recalculated to factor in the habitat previously knocked out, serving to prioritize habitat for species that have less habitat remaining.

There are different cell removal rules that can be implemented in Zonation. We focused on two main methods: Core Area Zonation (CAZ) and the Additive Benefit Function (ABF). Broadly speaking, the difference between the two can be equated as a focus on rare species vs a focus on species richness. More technically, CAZ iteratively removes the cells with the lowest individual maximum of inputs. This maximizes value for any single species that has the lowest proportion of its original habitat remaining at each cell removal iteration. By prioritizing conservation of the species with the least habitat remaining at each cell removal iteration, the algorithm ensures protection of all species for as long as possible while habitat is removed. On the other hand, ABF iteratively removes the cells with the lowest summed value of inputs. This maximizes value for all species in a cell and prioritizes cells with mediocre habitat for many species over high quality habitat for one species. We present the results of both methods for each analysis to visually compare the different outcomes of both approaches.

As the species suitability layers we used were of environmental suitability rather than measured suitability, we decided to include a spatial measure of cumulative human impact (Figure 6). This discounted areas of high human impact, as they would not be able to support as many organisms as their environmental characteristics alone would predict. We derived this habitat condition layer from the cumulative human impact index of Halpern et al. (2009). By comparing the Zonation results with and without human impacts, we can find areas that are disproportionately affected by current human activity.

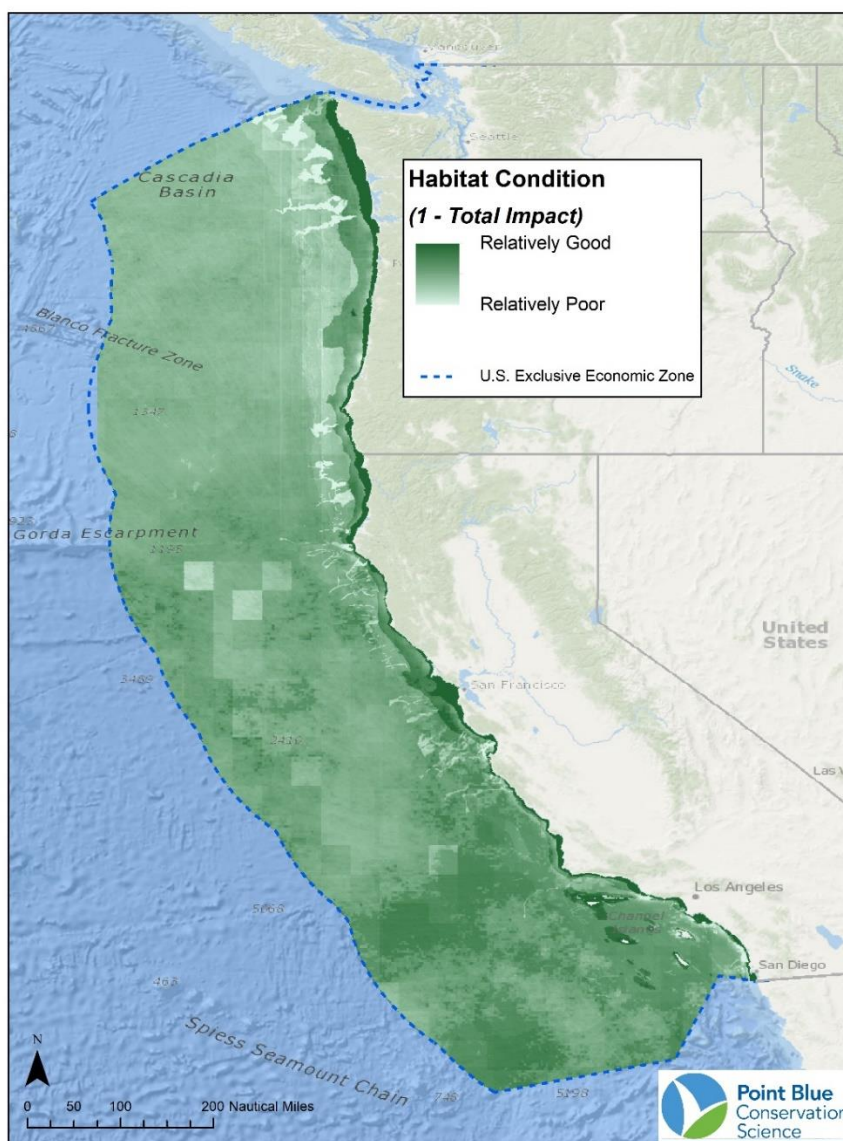


Figure 6. Relative habitat condition of waters within the California Current (U.S. EEZ). Darker green areas are in relatively better condition due to being relatively less disturbed. Layer derived from cumulative human impact of Halpern et al. (2009).

Finally, when looking at areas to propose new MPAs, we locked in current high protection MPAs. This allows the Zonation algorithm to take into account areas that are currently protected in its prioritization.

Overall Conservation Value

A zonation analysis of the entire EEZ reveals hotspots for conservation value (Figure 7). Notable areas include the Olympic Peninsula in Washington, Cape Blanco, rocky reefs and banks off the

Oregon Coast, Cape Mendocino to Point Arena in Northern California, the Channel Islands in Southern California, and several seamounts. The ABF approach heavily prioritizes areas off of Oregon’s coast due to high productivity, whereas the CAZ approach considers these areas less important due to these species also being found elsewhere. Seamounts, listed as habitat areas of particular concern, are prioritized more heavily by the rarity metric (CAZ) given the relative scarcity of seamount habitat as a portion of the EEZ as a whole.

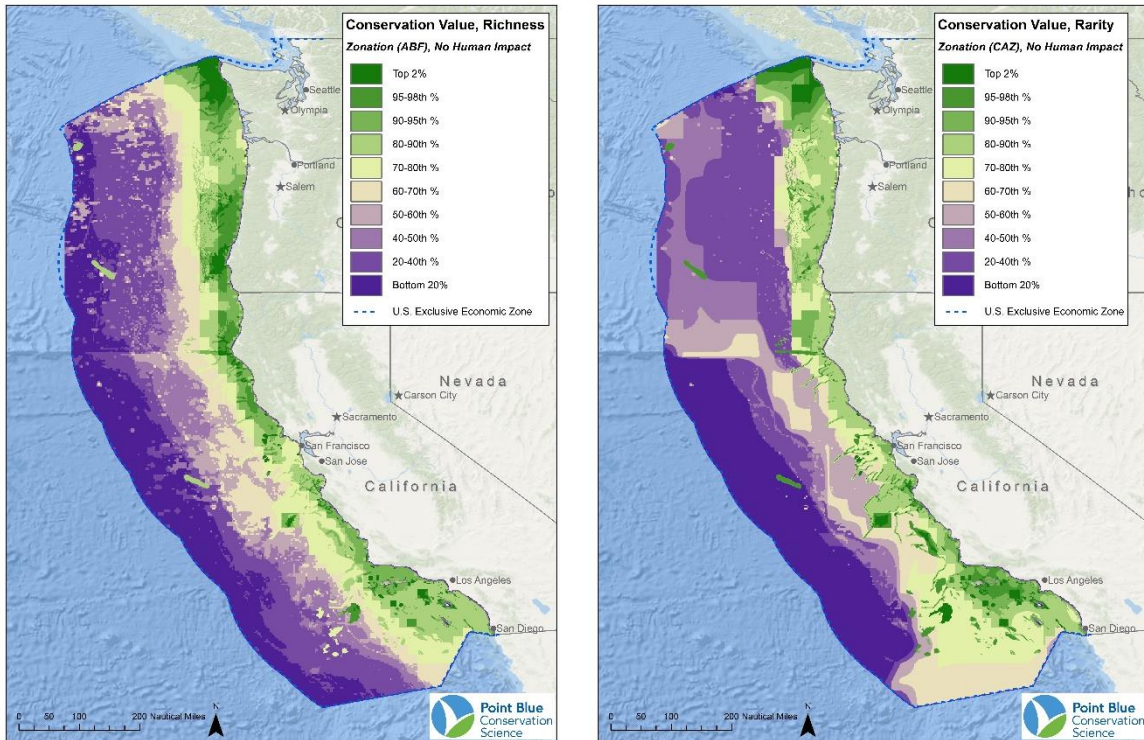


Figure 7. Relative conservation value of areas in the California Current (U.S. EEZ) using two different zonation metrics. These assume no human impact and do take into account current high-protection MPAs. The two metrics produce similar but distinct results.

Looking more closely at the northern portion of the California Current, the area in and around Olympic Coast National Marine Sanctuary (NMS) is of very high conservation value in both metrics (Figure 8). The waters of northern Washington state are productive and include highly suitable habitat for many of the species in our analysis, especially salmon. Both metrics describe the majority of Olympic Coast NMS as being in the top 2% of important habitat. This MPA would also be a good candidate for expansion, given the abundance of adjacent high-value habitat.

The Oregon coast is also important using both metrics. The areas of highest value and most agreement include Heceta Bank to Cape Blanco, particularly at about 30 nautical miles off the coast of Oregon. The Oregon coast is also home to many rocky reefs, a Habitat Area of Particular Concern. This analysis agrees with prior work suggesting a conservation gap off the coast of Oregon (e.g., Nur et al. 2011).

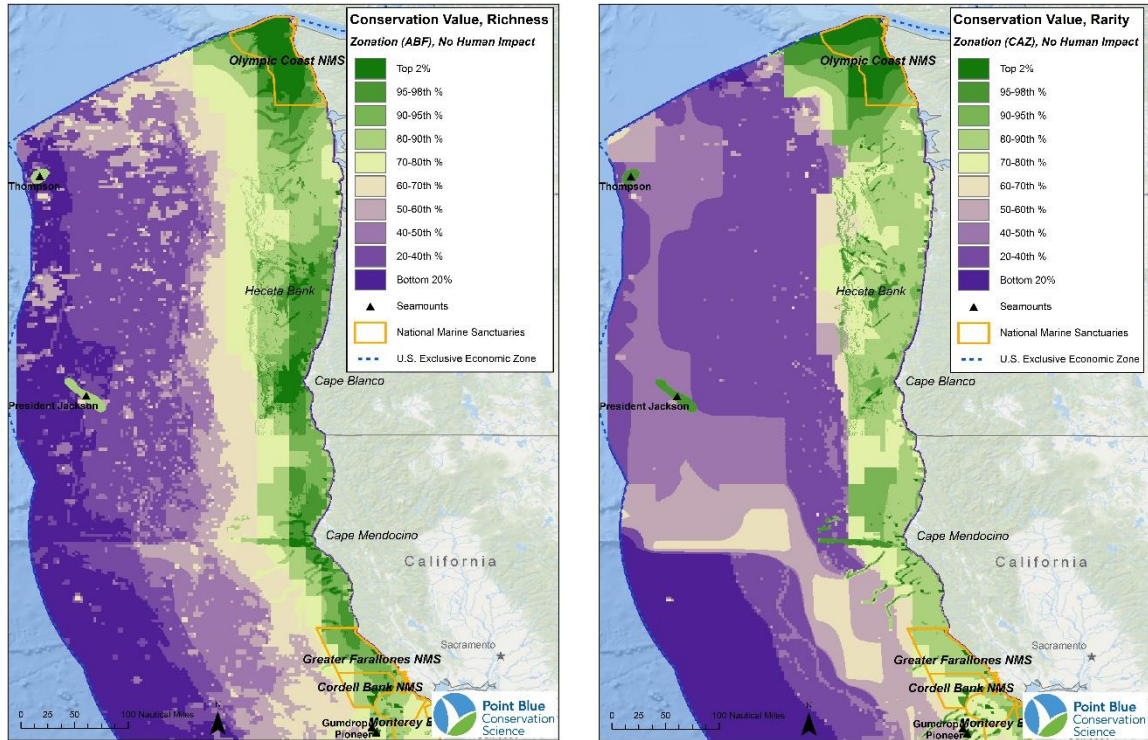


Figure 8. Relative conservation value of areas in the northern portion of California Current (U.S. EEZ) using two different zonation metrics. These assume no human impact and do take into account current high-protection MPAs. The two metrics produce similar but distinct results.

Along the Northern California coast, the waters in vicinity of Cape Mendocino and south to Point Arena stand out as an area of conservation value (Figure 9). Dramatic changes in bathymetry off Cape Mendocino cause nutrient-rich upwelling and serve as a hotspot for many of the species we examined in this report, especially seabirds. This conclusion supports (and is supported by) the independent designation of Mendocino Ridge as a Habitat Area of Particular Concern.

Existing National Marine Sanctuaries include pockets of extremely valuable habitat and all protect habitat that is in the top 30% of available habitat for the species we examined. As discussed above, seamounts are shown as more important if the primary goal is to protect rare habitats and species. This is especially the case with President Jackson Seamount (west of Cape Blanco) and Taney Seamount (west of Monterey Bay NMS), where they are ranked 10 – 15% higher when using the CAZ metric instead of the ABF metric.

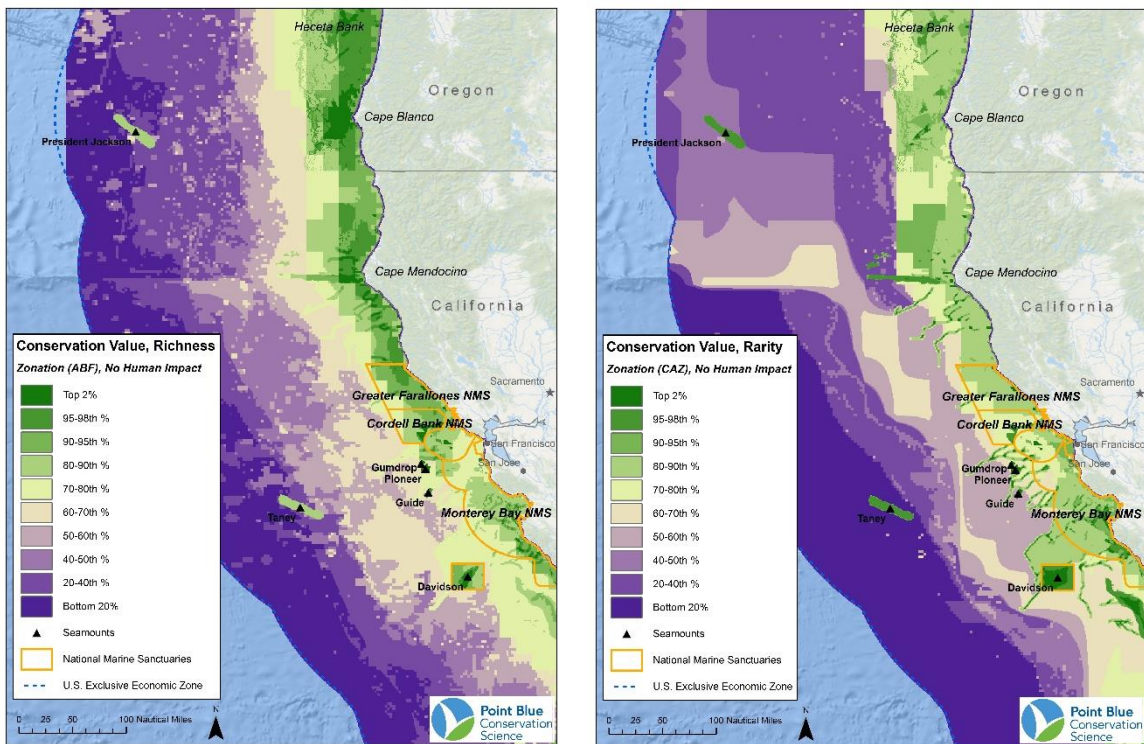


Figure 9. Relative conservation value of areas in the middle portion of California Current (U.S. EEZ) using two different zonation metrics. These assume no human impact and do not take into account current high-protection MPAs. The two metrics produce similar but distinct results.

Along the Southern California coast, the waters around the Channel Islands stand out as being highly valuable habitat (Figure 10). Channel Islands National Marine Sanctuary protects the core of this area and would be a good candidate for expansion given the prevalence of adjacent waters of high conservation value.

Davidson and San Juan Seamounts are also highlighted due to their importance as Habitat Areas of Particular Concern, presence of rocky reefs, and rich foraging waters. These two seamounts are unique in our analysis as being very highly ranked by both metrics. While the rarity metric (CAZ) considers all seamounts as highly valuable to protect given their scarcity (top 10%), only Davidson and San Juan are ranked in the top 10% by the richness metric (ABF) as well.

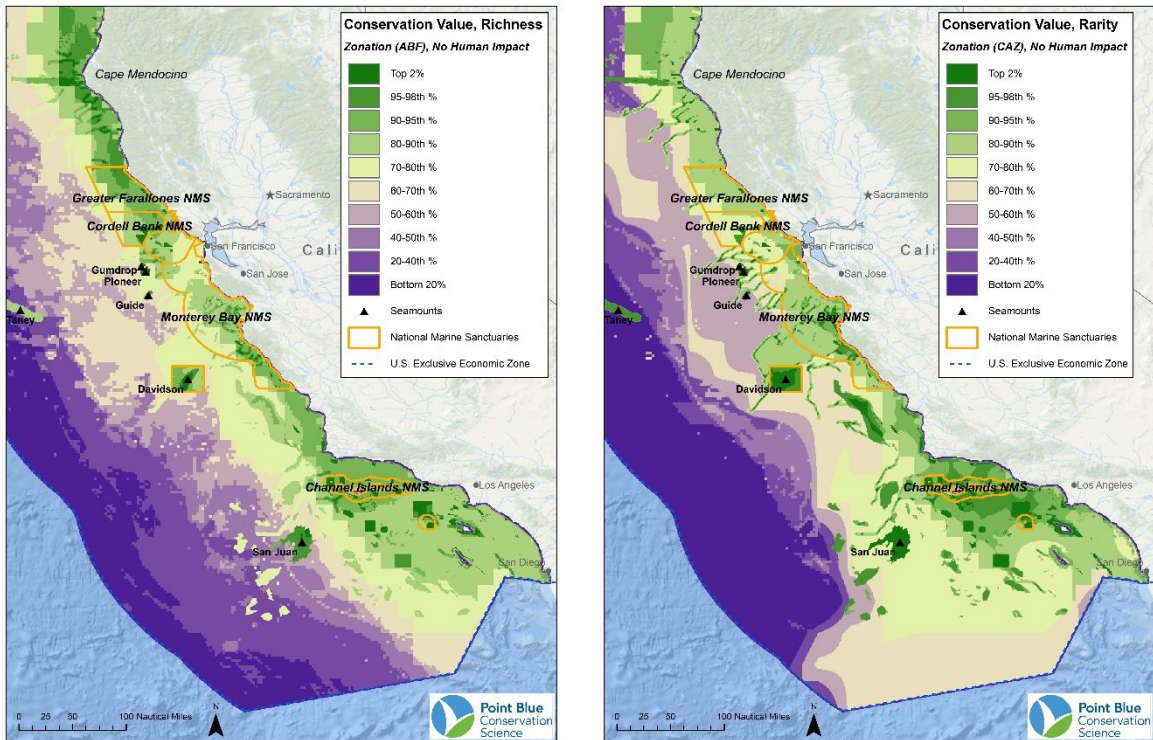


Figure 10. Relative conservation value of areas in the southern portion of California Current (U.S. EEZ) using two different zonation metrics. These assume no human impact and do take into account current high-protection MPAs. The two metrics produce similar but distinct results.

Best Places for New MPAs: 30% by 2030

The IUCN recently called for 30% of the world's oceans to be protected by 2030. To see what this might look like in the California Current, we focus in on the top 30% of habitat as ranked by each Zonation analysis (Figure 11). This makes it much easier to identify areas of agreement and disagreement between the two metrics.

Overall, the footprint of the recommended area to protect is very similar between the two metrics. The main difference in footprint is that the rarity metric (CAZ) prioritizes more area off the coast of Southern California whereas the richness metric prioritizes more area off the coasts of Washington and Oregon.

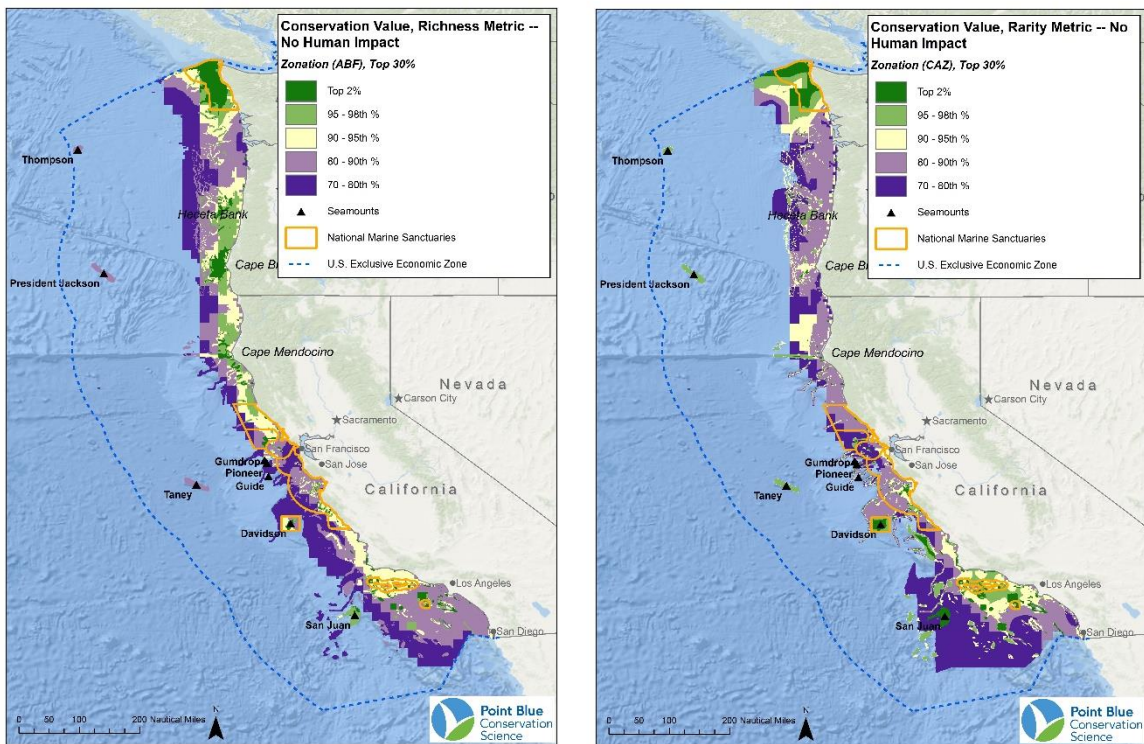


Figure 11. Relative conservation value of areas in the California Current (U.S. EEZ) using two different zonation metrics. The analysis is restricted to the top 30% as measured by each metric to ease comparison.

In terms of priority, both metrics agree that waters off the Olympic Coast and around the Channel Islands are in the top 2% of value for the species and habitats examined in this study. Both metrics also highly prioritize protection of Heceta Bank, the Mendocino Ridge, Davidson Seamount, and San Juan Seamount.

Major differences in priority can be seen along the coast of Oregon and for the seamounts located farther offshore (Thompson, President Jackson, and Taney). The rarity metric places much more weight (10 – 15%) on the offshore seamounts given their relative rarity. They are listed as Habitat Areas of Particular Concern. The richness metric places much more weight (10 – 15%) on waters from Heceta Bank to Cape Blanco. These areas are incredibly productive, supporting a wide range of species in abundance.

Best Places to Strengthen Regulation

The above maps have all excluded human impact, assuming that a highly protective MPA would be able to mitigate most human impacts. We now present the same analysis including human impacts. By comparing the two results, we can find the areas that are most impacted by human use that would benefit most from additional protection. This analysis also identifies less-impacted areas that might be technically and/or politically easier to protect.

Looking first at Zonation’s richness metric (ABF), the changes are relatively minor (Figure 12). Areas of high conservation value when ignoring human impacts (i.e., the Olympic coast, Heceta Bank to Cape Blanco, Cape Mendocino to Point Arena, and Channel Islands) are still of high conservation value when including the degradation caused by human activity. The results suggest that human impacts are not substantially degrading conservation values based on species richness in these areas.

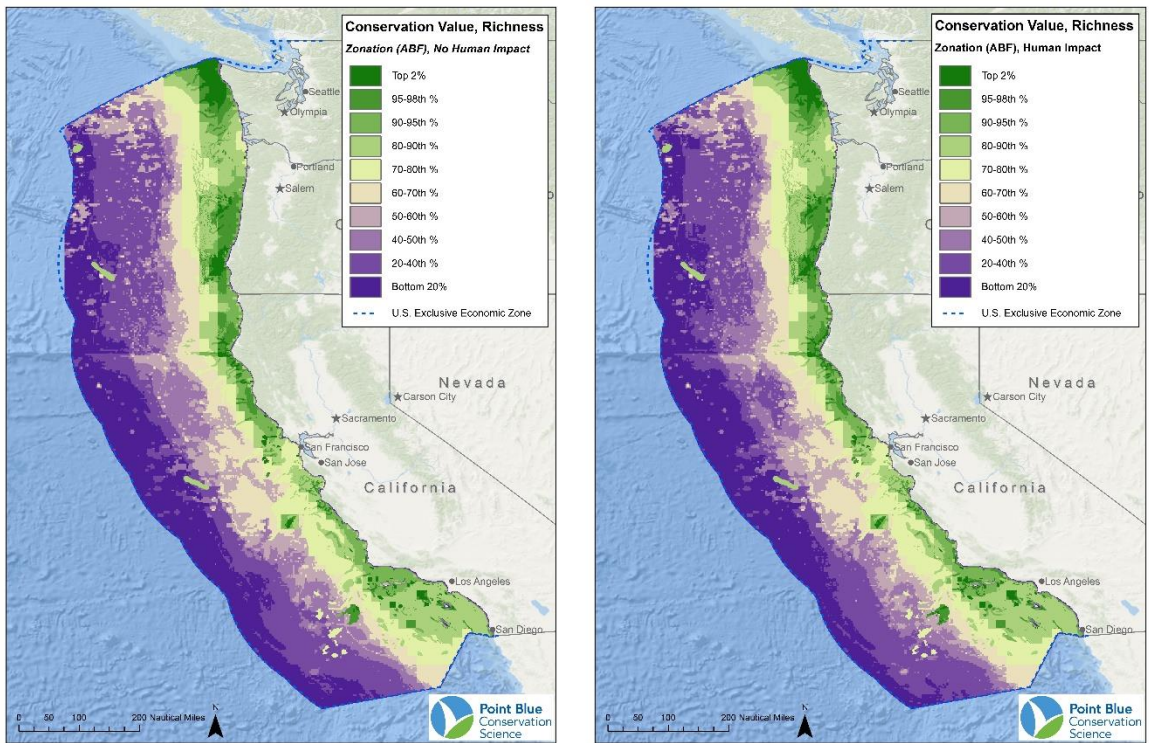


Figure 12. Relative conservation value of areas in the California Current (U.S. EEZ) using the Zonation richness metric (ABF) when assuming no anthropogenic impacts (left) and including human-caused habitat degradation (right).

The changes are more pronounced using Zonation’s rarity metric (CAZ) (Figure 13). There is a pronounced shift along the coast, where highly-impacted areas immediately adjacent to shore are deprioritized. The waters around the Channel Islands, relatively highly impacted by human activities, are also prioritized less. Notable areas of high conservation value persist across analyses, including waters off the Olympic coast, Heceta Bank to Cape Blanco, Cape Mendocino to Point Arena, Davidson and San Juan Seamounts, and waters immediately adjacent to the Channel Islands.

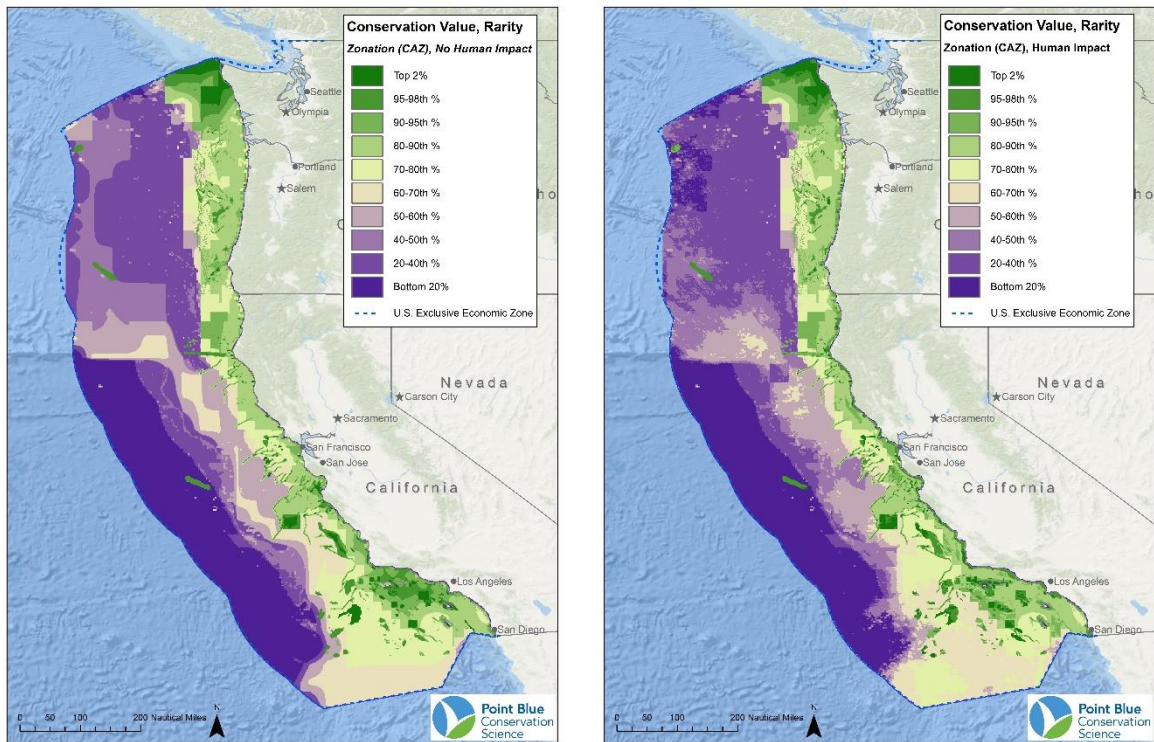


Figure 13. Relative conservation value of areas in the California Current (U.S. EEZ) using the Zonation rarity metric (CAZ) when assuming no anthropogenic impacts (left) and including human-caused habitat degradation (right).

Computing the difference between the Zonation results with and without human impacts offers another way to examine the data (Figure 14). This allows us to very clearly see where the two metrics show the most impact from human activity within higher priority conservation areas.

Both metrics show substantial loss of conservation value in areas immediately adjacent to shore, most notably at this scale in Southern California. The richness metric shows more of an effect from human activity in the waters 10 – 50 nautical miles off the coast of Washington, Oregon and northern California, whereas the rarity metric shows the most impact in the waters shoreward and seaward of the Channel Islands.

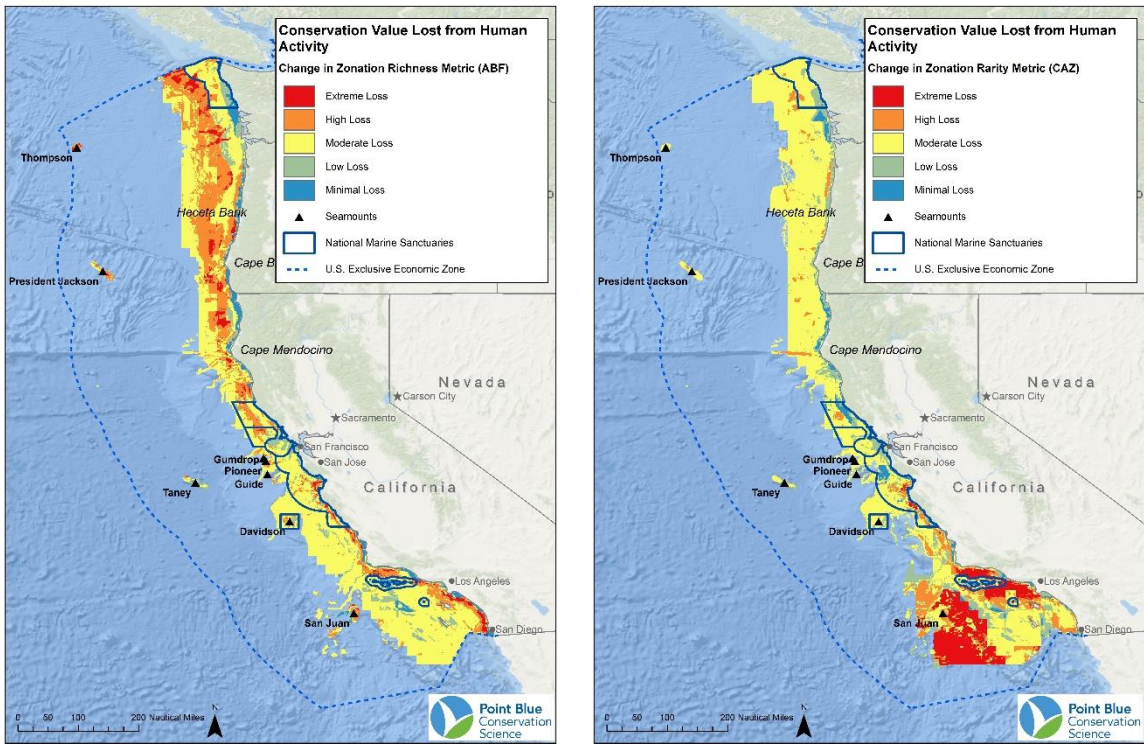


Figure 14. Relative conservation value lost by current human activity in high-value areas (top 30% conservation value) of the U.S. EEZ. Values are the difference between the zonation rank (ABF on the left and CAZ on the right) with and without human impacts.

We overlaid the results from the difference maps presented in Figure 14 by individual MPAs to assess where conservation value within existing MPAs is most affected by human impacts. We summed the difference in Zonation scores with and without impacts within each MPA to use as an index of potential loss of conservation value. We report on the 20 MPAs where we found the highest index values.

Table 20. Index of conservation value lost from Zonation analyses using the richness index (ABF). Index values are the summed differences of Zonation ranks with and without human impacts within each MPA. Higher values indicate greater potential loss of conservation value. We present the 20 MPAs with greatest index values. Agencies include National Marine Fisheries Service (NMFS), National Marine Sanctuaries (NMS) and the State of California. MPAs in italics were selected in the top 20 also using the rarity index (CAZ) (See Table 21 below).

MPA	Agency	Conservation Value Lost Index
<i>Seaward of the 700 fm to 1094 fm Essential Fish Habitat Conservation Area (1280m to 3500 m depth contour)</i>	NMFS	3152.1
<i>Biogenic 1 Essential Fish Habitat Conservation Area</i>	NMFS	18.5
<i>Monterey Bay/Canyon Essential Fish Habitat Conservation Area</i>	NMFS	8.7
<i>Astoria Canyon Essential Fish Habitat Conservation Area</i>	NMFS	9.6
<i>Rogue Canyon Essential Fish Habitat Conservation Area</i>	NMFS	7.5
<i>Thompson Seamount Essential Fish Habitat Conservation Area</i>	NMFS	6.5
<i>President Jackson Seamount Essential Fish Habitat Conservation Area</i>	NMFS	5.6
<i>Catalina Island Essential Fish Habitat Conservation Area</i>	NMFS	5
<i>Deepwater off Coos Bay Essential Fish Habitat Conservation Area</i>	NMFS	3.4
<i>Biogenic 2 Essential Fish Habitat Conservation Area</i>	NMFS	2.3
<i>Siletz Deepwater Essential Fish Habitat Conservation Area</i>	NMFS	2.5
<i>Cordell Bank National Marine Sanctuary</i>	NMS	2.4
<i>Olympic 2 Essential Fish Habitat Conservation Area</i>	NMFS	1.8
<i>North Coast Recreational Yelloweye Rockfish Conservation Area</i>	NMFS	1.8
<i>Eel River Canyon Essential Fish Habitat Conservation Area</i>	NMFS	1.8
<i>Gray's Canyon Essential Fish Habitat Conservation Area</i>	NMFS	1.2
<i>Biogenic 3 Essential Fish Habitat Conservation Area</i>	NMFS	1.1
<i>Bandon High Spot Essential Fish Habitat Conservation Area</i>	NMFS	0.7
<i>Point Arena South Essential Fish Habitat Conservation Area</i>	NMFS	0.6
<i>Point Vicente State Marine Conservation Area</i>	State of California	0.5

We found that MPAs managed by the National Marine Fisheries Service had the greatest loss in value with both the richness (ABF) and rarity (CAZ) Zonation indices (Table 20 and Table 21). In addition, the Seaward of the 700 fm to 1094 fm Essential Fish Habitat Conservation Area (1280m to 3500 m depth contour) MPA had by far the highest conservation loss from human impacts than any other MPA in both analyses (Table 20 and Table 21). Ten MPAs were selected in both Zonation analyses of top 20 MPAs with human impacts to conservation (Table 20 and Table 21). These results indicate where regulations or other management actions to reduce impact within existing MPAs could substantially increase the conservation value of the MPA.

Table 21. Index of conservation value lost from Zonation analyses using the rarity index (CAZ). Index values are the summed differences of Zonation ranks with and without human impacts within each MPA. Higher values indicate greater potential loss of conservation value. We present the 20 MPAs with greatest index values. Agencies include National Marine Fisheries Service (NMFS) and the State of California. MPAs in italics were selected in the top 20 also using the richness index (ABF) (See Table 20 above).

MPA	Agency	Conservation Value Loss Index
<i>Seaward of the 700 fm to 1094 fm Essential Fish Habitat Conservation Area (1280m to 3500 m depth contour)</i>	NMFS	5802.2
Channel Islands National Marine Sanctuary	NMFS	94.8
Western and Eastern Cowcod Conservation Areas	NMFS	82.1
<i>Monterey Bay/Canyon Essential Fish Habitat Conservation Area</i>	NMFS	44.3
<i>Catalina Island Essential Fish Habitat Conservation Area</i>	NMFS	30.6
Point Conception Essential Fish Habitat Conservation Area	NMFS	10.4
Hidden Reef/Kidney Bank Essential Fish Habitat Conservation Area	NMFS	9.7
Footprint Essential Fish Habitat Conservation Area	NMFS	8.4
<i>Rogue Canyon Essential Fish Habitat Conservation Area</i>	NMFS	8.3
<i>President Jackson Seamount Essential Fish Habitat Conservation Area</i>	NMFS	7.2
Footprint (Anacapa Channel) Federal Marine Reserve	NMFS	6.9
<i>Biogenic 1 Essential Fish Habitat Conservation Area</i>	NMFS	6.8
Gull Island Essential Fish Habitat Conservation Area	NMFS	6.3
<i>Siletz Deepwater Essential Fish Habitat Conservation Area</i>	NMFS	6.7
<i>Astoria Canyon Essential Fish Habitat Conservation Area</i>	NMFS	6.7
<i>Thompson Seamount Essential Fish Habitat Conservation Area</i>	NMFS	5.6
<i>Biogenic 2 Essential Fish Habitat Conservation Area</i>	NMFS	3.8
Gull Island (Santa Cruz Island) Federal Marine Reserve	NMFS	3.4
Harris Point (San Miguel Island) Federal Marine Reserve	NMFS	3.1
Gull Island (Santa Cruz Island) State Marine Reserve	State of California	2.9

One final way to examine this difference is to combine the total conservation value metrics with the percentage lost due to human activity (Figure 15). This analysis operates under the assumption that the same relative loss of conservation value is more concerning to a parcel of high potential conservation value as opposed to the same loss of value to a parcel of lesser potential conservation value. In other words, it lets us identify high-value areas that are also highly impacted by human activity. This allows us to see not only which areas suffer the greatest impact but also which of those areas have the most potential conservation value if impacts can be ameliorated. Such areas are good targets for regulatory enhancement.

To calculate this, we binned the top 30% of all habitat as measured by our zonation analyses (Figure 11) into four categories (70 – 80, 80 – 90, 90 – 95, and 95- 100). Separately, the conservation value lost (Figure 14), as calculated by subtracting the zonation ranking with human impacts from the zonation ranking without human impacts, was binned into categories of major loss (> 20% drop in ranking from human impacts), moderate loss (10 – 20% drop in rank), or minor loss (< 10% drop in rank). Finally, we overlaid these results to produce the categorical maps of conservation value lost (Figure 15).

Starting with areas of agreement, both areas show substantial losses of conservation value in patches 20 – 40 nm off the coasts of Washington, Oregon, and Northern California. The CAZ metric shows a substantial loss of conservation value around and inshore of the Channel Islands. The loss seaward of the Channel Islands is of habitat in the 70th percentile in the CAZ analysis, and so though the loss is high, it is less important for the species we examined.

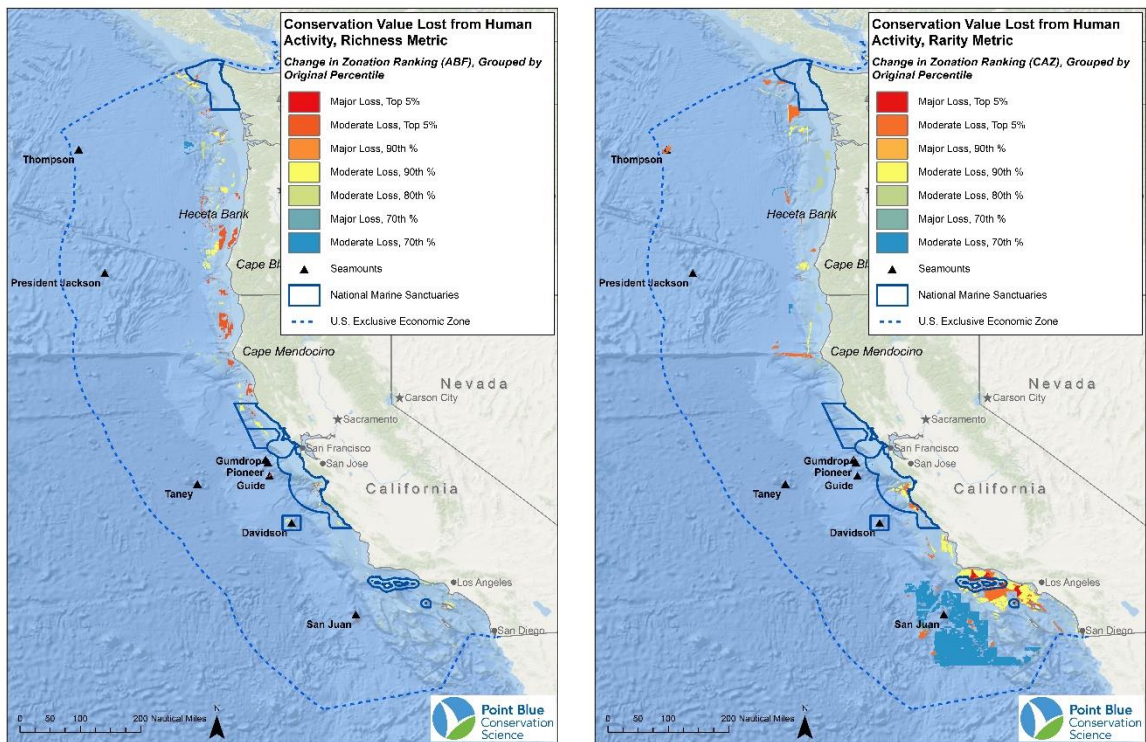


Figure 15. Areas with high relative conservation value lost because of current human activity in the Pacific U.S. EEZ. Values are categorized as major loss (drop of > 20%) or moderate loss (10 – 20 %) and grouped by original percentile. Conservation value lost was calculated as the difference between the zonation rank (ABF on the left and CAZ on the right) with and without human impacts.

Looking more closely at the northern portions of the California Current, the coast of Oregon and northern California are of concern (Figure 16). Particularly in the richness metric (ABF), but also the rarity metric (CAZ), areas from Heceta Bank to Cape Blanco, and south to Cape Mendocino have a high initial conservation value (top 5 or 10%) and show a significant loss of

conservation value (10 – 20 %) due to human activities. Other areas of concern include seaward of the Olympic Coast Peninsula, the Mendocino Ridge, and north and south of the Big Sur Peninsula when using the CAZ metric.

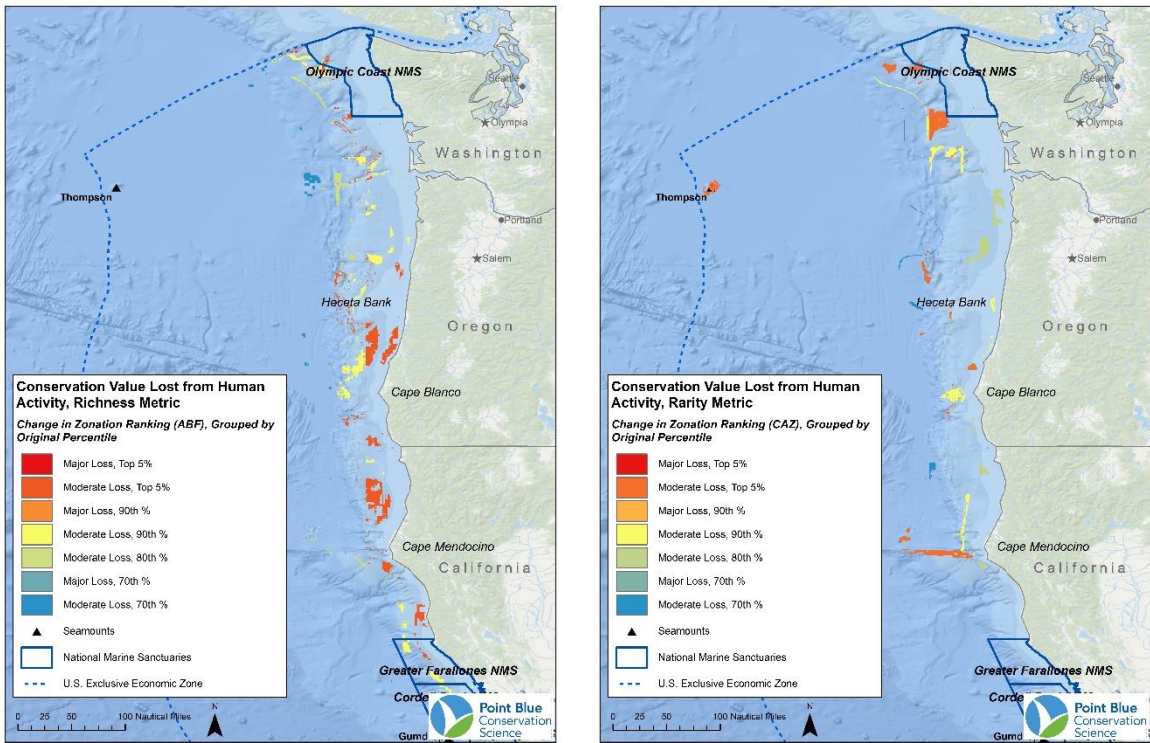


Figure 16. Areas with high relative conservation value lost because of current human activity in the northern portion of the Pacific U.S. EEZ. Values are categorized as major loss (drop of > 20%) or moderate loss (10 – 20 %) and grouped by original percentile. Conservation value lost was calculated as the difference between the zonation rank (ABF on the left and CAZ on the right) with and without human impacts.

CONCLUSIONS

Existing Regulations and Protections

Strengthening regulation in existing California Current MPAs would offer significant conservation benefits and is potentially more feasible than establishing new MPAs. Existing spatial regulations cover 52% of the California Current, offering opportunities to increase protection in already regulated areas. Our conservation prioritization analysis identifies 30 MPAs that could increase conservation value by implementing regulations that reduce human impacts (Table 20 and Table 21).

The majority of MPAs in the California Current are limited in their protective focus. Most MPAs are in federal waters and are listed as uniform multiple use areas, which means in practice little to no protection beyond the specific species or activities they were created to regulate. Only 6% of the EEZ is protected by zoned multi-use areas (moderate protection), one half of one percent is zoned with no take areas (moderately high protection), and less than a quarter of one percent is no take (high protection).

In general, state MPAs offer a much higher level of protection than do federal MPAs. Unfortunately, state MPAs are also much smaller and are restricted to occurring within 3 nm of shore. While State MPAs tend to protect high value habitat, their overall conservation value is limited by their smaller size. As State MPAs tend to be closer to shore, they could be more vulnerable to human activities. However, only two state MPAs were selected for high potential of loss in conservation value due to human activities. Therefore, focusing efforts on strengthening regulations within existing State MPAs may have limited benefits.

The California Current is governed by dozens of regulations and agencies. Because of this, it is often difficult to determine the exact restrictions that apply to a given area. Even a map does not always make things clear. This is especially true in areas of overlapping jurisdictions, in which multiple MPAs govern the area. The most egregious example is the Channel Islands. Over a dozen separate MPAs cover parts of the Channel Islands Area, and some areas of the islands are covered by up to seven different sets of spatial regulations at the same time. Clarifying MPA boundaries and simplifying marine governance structure would make it easier for individuals to comply with marine regulations and easier for governments to enforce them.

A relatively low percentage of the high quality habitat for the species we examined is well protected. On average, only 2 – 3% of a species' total suitable habitat was in MPAs with moderate or better protection. As expected due to the limited number of MPAs in Oregon, much less priority habitat is included in Oregon than in California and Washington (average of ~10% vs 68% and 82%; Table 16). Despite having less protected area than California, Washington MPAs generally protect higher quality habitat. Priority species are generally protected at similar relative levels across states. Notable under-protected exceptions are red sea urchins in California and both red abalone and blue whale in Oregon.

However, our priority species are, in general, well-represented in existing MPAs. Existing MPAs do a good job in focusing on high-quality habitat for the species we examined. Only five species are under-represented in existing MPAs relative to their entire range: Dungeness crab, common murre, Cassin's Auklet, blue whale, and humpback whale. Note that this is not to say that all other species are sufficiently protected, merely that existing MPAs have done a good job in focusing their protection on the majority of species that we examined.

Threats

Of all the threats examined here, climate change is having the largest impacts on our oceans. MPAs in the California Current will be substantially impacted by ocean acidification and increases in ultraviolet radiation; increases in sea surface temperature are also projected to have a major impact. As climate change has both global causes and global effects, MPAs are much less effective in dealing with its impacts. Larger MPAs are more beneficial than smaller ones in mitigating direct human threats like fishing, pollution and disturbance, and the nature of the threat is such that adaptive management is needed.

Cumulatively, fishing is having a substantial impact on the California Current. It is also the most regulated of human activities in the California Current, both through spatial restrictions and fishery-wide regulations. A focus on restricting high-bycatch fishing has borne fruit, as according to our data, high-bycatch fishing is less of a concern in the California Current than either recreational or low-bycatch fishing.

Recreational fishing is an area that needs additional regulation. It is a human activity that has great magnitude and virtually no restrictions. Whereas commercial fishing is spatially restricted in over half of the EEZ, only 4% of the EEZ is subject to restrictions on recreational fishing and it is prohibited in less than a quarter of one percent of the EEZ.

Shipping is another impact of concern, with a high index of impact, yet few restrictions. Less than 5% of the EEZ has restrictions on vessel traffic and less than a twentieth of a percent of the EEZ is closed to shipping.

Opportunities for Conservation

State MPAs are incredibly important in the California Current. Though they cover relatively little area, the area they include tends to be of very high conservation value and the actual protections offered tend to be relatively strict. Nearshore waters are very productive and provide highly suitable habitat for many of the priority species we examined. Expanding the nearshore area protected by MPAs would provide the greatest conservation value for the least area protected.

Coastal MPAs are also the most vulnerable to human impacts of all MPAs examined. Nearshore impacts from human development are numerous (e.g., pollution, nutrient runoff, sedimentation, light pollution) and cumulatively have a very large impact on habitat suitability. Some climate impacts are also exacerbated in shallower waters. Despite high levels of protection within these MPAs, they are impacted by threats from outside their borders. As a result, the waters closest to shore have substantial losses of conservation value. Increasing the environmental protection in areas in and adjacent to existing nearshore MPAs would have significant conservation benefits.

Spatially, the rocky banks of the Oregon Coast would be a good place for the creation of new MPAs, as there is a large gap in existing MPAs here. Oregon has very few MPAs in its state waters and there is a corresponding gap in federal MPAs. Moreover, this area boasts highly suitable habitat for most of the species examined in this report, and coastal Oregon consistently ranked highly in our prioritization of conservation value. In particular, the waters in, between, and around Heceta Bank and Cape Mendocino were zoned as being of very high conservation value.

National Marine Sanctuaries in the California Current are areas of high conservation value. They are also impacted by many local human activities that could potentially be regulated. Sanctuaries are generally less impacted by land-based activity (with the notable exceptions of sediment runoff and climate change), so regulation of the sanctuaries themselves can have more influence on overall ecosystem health. Increasing the regulation of commercial fishing would have benefits for all sanctuaries as well as zoning portions of the sanctuary as no-take areas. Olympic Coast NMS would benefit from additional restrictions on commercial fishing. All sanctuaries except for Olympic Coast NMS are substantially impacted by shipping traffic, so redesigning shipping lanes and/or restricting dumping (especially from cruise ships, which have exemptions under many NMS regulations) would be helpful. Olympic Coast is less affected by human impacts and is a good candidate for preservation from future potential impacts. It is also a good candidate for expansion, as adjacent areas have a high conservation value.

Of the habitats examined, our analysis found seamounts to be of high conservation value. Seamounts, designated as Habitat Areas of Particular Concern by and for regional fisheries management, provide unique habitat for many species. They are also relatively rare habitats. While most seamounts do occur within existing MPAs, these are MPAs that do not have major restrictions on human activity vis-à-vis seamount habitats and many of the species that use them. Strengthening the protection of seamounts in the California Current would have significant conservation benefits relative to the total area protected.

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ADDITIONAL TABLES

Table A. Types of Marine Protected Areas in the California Current (U.S. EEZ)

Types	Percentage of EEZ	Total Area (km²)	Median Area (km²)	Number of MPAs
National Marine Fisheries Service	46.9%	387,480.2	164.1	69
National Marine Sanctuaries	4.8%	39,788.7	8,258.6	5
National Wildlife Refuge System	<0.05%	390.5	4.6	20
National Park Service	0.7%	5,850.7	317.9	7
Marine National Monuments	<0.05%	7.7	3.9	2
National Estuarine Research Reserve System	<0.05%	103.4	15.1	5
Washington	0.3%	2,221.4	0.7	55
Oregon	<0.05%	307.1	0.6	30
California	0.6%	4,630.5	4.3	198

Table B. Fishing Regulations of Marine Protected Areas in the California Current (U.S. EEZ)

Fishing Regulations	Percentage of EEZ	Total Area (km²)	Median Area (km²)	Number of MPAs
Restrictions Unknown	<0.05%	221.4	22.7	6
No Site Restrictions	3.7%	30,679.6	7.1	55
Recreational Fishing Restricted	0.1%	697.9	4.2	14
Recreational Fishing Prohibited	<0.05%	1.7	1.7	1
Commercial Fishing Restricted	45.6%	376,124.7	180.6	61
Commercial and Recreational Fishing Restricted	3.7%	30,929.5	6.7	100
Commercial Fishing Restricted and Recreational Fishing Prohibited	<0.05%	29.0	14.5	2
Commercial Fishing Prohibited	<0.05%	18.1	9.1	2
Commercial Fishing Prohibited and Recreational Fishing Restricted	<0.05%	219.4	2.1	29
Commercial and Recreational Fishing Prohibited	0.2%	1,858.7	3.8	121

Table C. Management Plan Type of Marine Protected Areas in the California Current (U.S. EEZ)

Management Plan Type	Percentage of EEZ	Total Area (km²)	Median Area (km²)	Number of MPAs
No Management Plan	<0.05%	55.0	0.3	21
Non-MPA Programmatic Fisheries Management Plan	46.9%	387,577.7	88.6	83
Non-MPA Programmatic Species Management Plan	<0.05%	17.7	1.7	4
Non-MPA Programmatic Habitat Management Plan	1.0%	8,569.5	1.5	8
MPA Programmatic Management Plan	0.8%	6,541.6	4.3	219
Site-Specific Management Plan	4.6%	38,018.8	10.8	56

Table D. Managing Agencies of Marine Protected Areas in the California Current (U.S. EEZ)

Managing Agencies	Percentage of EEZ	Total Area (km²)	Median Area (km²)	Number of MPAs
University of California Natural Reserve Manager, University of California San Diego	<0.05%	0.4	0.4	1
San Francisco State University Romberg Tiburon Center & National Oceanic and Atmospheric Administration	<0.05%	15.1	15.1	1
City of Edmonds	<0.05%	0.2	0.2	1
City of Seattle	<0.05%	0.4	0.1	6
Washington Clallam County Parks and Fair Department	<0.05%	0.7	0.7	1
Washington Metropolitan Park District of Tacoma	<0.05%	0.2	0.2	1
University of Washington Friday Harbor Laboratories	0.2%	1,656.9	1,656.9	1
California Department of Fish and Wildlife	0.3%	2,291.1	4.8	163
California State Water Resources Control Board	0.3%	2,339.1	3.7	34
California Department of Fish and Wildlife & National	<0.05%	5.9	5.9	1

Managing Agencies	Percentage of EEZ	Total Area (km²)	Median Area (km²)	Number of MPAs
Oceanic and Atmospheric Administration				
California Department of Parks and Recreation & National Oceanic and Atmospheric Administration	<0.05%	9.4	9.4	1
Oregon Bureau of Land Management	<0.05%	0.3	0.3	1
Oregon Department of Fish and Wildlife	<0.05%	306.8	0.6	29
Oregon Department of State Lands & National Oceanic and Atmospheric Administration	<0.05%	19.4	19.4	1
Washington Department of Fish and Wildlife	<0.05%	119.7	0.3	21
Washington Department of Natural Resources	<0.05%	399.6	10.7	15
Washington State Department of Natural Resources	<0.05%	15.0	15.0	1
Washington State Parks & Recreation Commission	<0.05%	28.7	1.5	8
Washington State Department of Ecology & National Oceanic and Atmospheric Administration	<0.05%	53.6	53.6	1
Bureau Of Land Management	<0.05%	7.1	7.1	1
National Marine Fisheries Service	46.9%	387,480.2	164.1	69
National Marine Sanctuaries	4.8%	39,788.7	8,258.6	5
National Park Service	0.7%	5,851.4	304.6	8
U.S. Fish and Wildlife Service	<0.05%	390.5	4.6	20

Table E. Design of Marine Protected Areas in the California Current (U.S. EEZ)

Design	Percentage of EEZ	Total Area (km²)	Median Area (km²)	Number of MPAs
Aquatic Reserve	<0.05%	366.8	24.5	7
Coastal Reserve	<0.05%	0.4	0.4	1
Conservation Area	<0.05%	4.5	0.1	9
Essential Fish Habitat Conservation Area	45.1%	372,102.6	219.0	51
Fishery Management Area	1.7%	14,322.0	54.2	5
Game Refuge	<0.05%	46.2	46.2	1
Habitat Refuge	<0.05%	0.1	0.1	1
Marine Biological Preserve	0.2%	1,656.9	1,656.9	1
Marine Conservation Area	<0.05%	6.1	6.1	1
Marine Garden	<0.05%	1.2	0.2	7
Marine Life Refuge	<0.05%	7.8	0.5	12
Marine Life Sanctuary	<0.05%	0.7	0.7	1
Marine Preserve	<0.05%	6.8	0.2	15
Marine Protected Area	<0.05%	199.1	19.4	9
Marine Reserve	0.1%	493.1	28.6	14
National Estuarine Research Reserve	<0.05%	103.4	15.1	5
National Historical Park	<0.05%	7.0	7.0	1
National Historical Reserve	<0.05%	72.2	72.2	1
National Marine Sanctuary	4.8%	39,788.7	8,258.6	5
National Monument	<0.05%	7.7	3.9	2
National Park	0.6%	5,162.4	996.8	3
National Recreation Area	<0.05%	317.9	317.9	1
National Seashore	<0.05%	291.3	291.3	1
National Wildlife Refuge	<0.05%	390.5	4.6	20
Natural Area Preserve	<0.05%	29.9	2.4	7
Natural Resources Conservation Area	<0.05%	15.0	15.0	1
Research Reserve	<0.05%	2.4	0.2	6
Rockfish Conservation Area	0.1%	755.5	31.0	6
Seabird Sanctuary	<0.05%	0.1	0.1	1
Shellfish Preserve	<0.05%	0.8	0.4	2
Shoreline Sanctuary Conservation Area	<0.05%	0.2	0.2	1
Special Closure	<0.05%	8.2	0.1	17
State Marine Conservation Area	0.1%	997.5	7.2	72
State Marine Park	0.0%	0.0	0.0	0

Design	Percentage of EEZ	Total Area (km²)	Median Area (km²)	Number of MPAs
State Marine Recreational Management Area	<0.05%	11.5	0.9	5
State Marine Reserve	0.1%	1,202.4	21.5	48
State Water Quality Protection Area	0.3%	2,339.1	3.7	34
Underwater Park	<0.05%	28.9	1.1	9
Wildlife Area	<0.05%	16.5	16.5	1
State Marine Park	<0.05%	17.1	1.7	7