Bren School
of Environmental Science & Management
UNIVERSITY OF CALIFORNIA, SANTA BARBARA

ANALYZING THE SUITABILITY OF THE SAN FRANCISCO-PACIFICA EXCLUSION AREA FOR INCORPORATION INTO THE NATIONAL MARINE SANCTUARY SYSTEM

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22 March 2013

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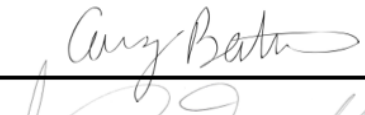

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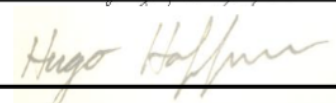

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(The faculty advisor may change this statement prior to submitting this report).

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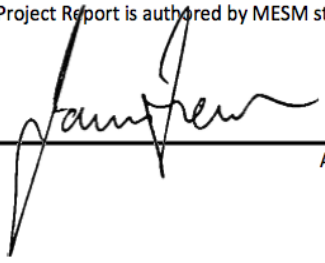
The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:



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Abstract

When Monterey Bay National Marine Sanctuary (MBNMS) was designated in 1992, a 101-square-mile area adjacent to San Francisco was omitted from the Sanctuary because three uses of the region were deemed incompatible with sanctuary status: dredging activities, wastewater discharge, and vessel traffic. This region is known as the San Francisco-Pacifica Exclusion Area. In 2012, Gulf of the Farallones National Marine Sanctuary proposed incorporating this Area into MBNMS. This project analyzes the Exclusion Area's eligibility for sanctuary status. First, we evaluate how the original reasons for exclusion have changed since 1992. We then analyze previous National Marine Sanctuary designations to help characterize how the Area qualifies as "nationally significant" under the National Marine Sanctuaries Act. Finally, we compare the proposed expansion to previous expansions of existing sanctuaries. Our analysis reveals that 1) the three reasons originally cited for omission of the Exclusion Area do not currently present barriers to the proposed Sanctuary expansion, 2) the Exclusion Area meets sanctuary designation criteria in the National Marine Sanctuaries Act, and 3) the proposed expansion is similar to previous sanctuary expansions. Based on these conclusions, we recommend that the San Francisco-Pacifica Exclusion Area be incorporated into the National Marine Sanctuary System.

Executive Summary

Introduction

Monterey Bay National Marine Sanctuary (MBNMS) was designated in 1992. It encompasses 6,094 square miles of ocean near central California, including 276 miles of coastline. During the Sanctuary's designation process, a 101-square-mile (77-square-nautical-mile) area near San Francisco was deliberately omitted from the Sanctuary. This area is now commonly referred to as the San Francisco-Pacifica Exclusion Area (or simply, the Exclusion Area). In the Federal Register notice of MBNMS's designation, three reasons were noted for the Exclusion Area's omission from the Sanctuary's boundaries: 1) the Area encompassed the anticipated discharge plume of the combined sewer overflow component of the City & County of San Francisco's sewage treatment program; 2) the Area encompassed the Main Shipping Channel (MSC), which provides access for ocean-going vessels to and from San Francisco Bay, and; 3) dredged material from the MSC was placed within the Area. These uses were deemed incompatible with sanctuary status.

Mounting public pressure to reconsider sanctuary designation for the Area prompted managers to include the issue in the 2008 Joint Management Plan Review for Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries [1]. On August 7, 2012, GFNMS published a Notice of Intent to prepare an Environmental Impact Statement (EIS) for the expansion of MBNMS into the Exclusion Area, as required by the National Environmental Policy Act.

Objectives and Methods

The primary objective of this study is to supplement, guide, and inform the EIS associated with the proposed expansion of MBNMS into the Exclusion Area. To accomplish this goal, we address two research questions:

1. **Do the three factors that resulted in the San Francisco-Pacifica Exclusion Area's omission from Monterey Bay National Marine Sanctuary currently present barriers to the proposed Sanctuary expansion?**
2. **Does the San Francisco-Pacifica Exclusion Area fulfill the sanctuary designation criteria in the National Marine Sanctuaries Act?**

We address the first research question by investigating the history and current state of dredging activities, wastewater discharge, and vessel traffic in the Exclusion Area:

- Our analysis of dredging activities addresses whether the placement of dredged material from the Main Shipping Channel is a barrier to the proposed expansion, given the nature of the dredged material and the location of deposition sites. We also compare the current dredging operations to those in existing National Marine Sanctuaries.
- Our analysis of wastewater determines whether current discharges into the Exclusion Area's coastal and offshore waters constitute a barrier to the proposed expansion, considering the relevant impacts of those discharges. We analyze trends in the number of combined sewer discharges from coastal outfalls and the number of times the region did not meet state water quality standards. We also examine the impacts to several biological and ecological factors that could be affected by offshore wastewater discharge into the Exclusion Area.

- Our analysis of vessel traffic considers whether this activity presents a barrier to the proposed expansion, given the intensity of vessel traffic along the Main Shipping Channel in the Exclusion Area compared with vessel traffic in existing National Marine Sanctuaries.

To address our second research question, we analyze whether the Exclusion Area meets the sanctuary designation standards outlined in the National Marine Sanctuaries Act (NMSA).

According to the NMSA, a candidate sanctuary site must have "special national significance due to its conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities; the communities of living marine resources it harbors; or its resource or human-use values" [1]. Additionally, candidate sites can only be designated as sanctuaries if "existing State and Federal authorities are inadequate or should be supplemented to ensure coordinated and comprehensive conservation and management of the area" and if "the area is of a size and nature that will permit comprehensive and coordinated conservation and management" [1].

Therefore, we describe the characteristics of the Exclusion Area that meet each criterion listed in the NMSA. We focus on those subjects most commonly addressed in sanctuary designation documents as well as subjects that are specifically relevant to the Exclusion Area itself.

Next, we determine whether the Exclusion Area's characteristics can be considered "of special national significance" under the NMSA. Since "special national significance" has never been clearly defined by Congress or by the Office of National Marine Sanctuaries, we operationalize the phrase through an analysis of how the NMSA has been interpreted and implemented over the 40-year history of the National Marine Sanctuary System. We analyze the characteristics of the thirteen existing National Marine Sanctuaries and identify specific qualitative and quantitative thresholds that have emerged over time as standards for sanctuary status. For the purposes of this report, we call these thresholds "emergent sanctuary designation criteria." We then compare the characteristics of the Exclusion Area to these emergent criteria to determine if the Area's characteristics could be deemed nationally significant, and thus whether the Area meets the requirements of the NMSA.

Results

Our analysis reveals that dredging activities, wastewater discharge, and vessel traffic do not currently present barriers to the proposed sanctuary expansion:

- Dredging and the placement of dredged material should not be considered a barrier to the proposed sanctuary expansion because current operations are designed to minimize environmental impact, and similar operations occur in existing National Marine Sanctuaries.
- Discharges from the City & County of San Francisco's combined sewer system have not been found to cause significant impacts to the Exclusion Area. Additionally, the number of times that state water quality standards were not met has declined significantly since MBNMS designation, coinciding with wastewater infrastructure updates.
- Vessel traffic in the Exclusion Area is comparable to the level of traffic in existing sanctuaries.

We also find that a substantial majority of the Exclusion Area's characteristics should be considered nationally significant when compared to our emergent sanctuary designation criteria, and thus the Area fulfills the requirements of the NMSA. The following table summarizes the emergent criteria the Exclusion Area meets for each subject listed in the NMSA. Green check marks indicate emergent criteria met by the Exclusion Area, and red x's indicate emergent criteria not met by the Exclusion Area.

Table 1: Applying Emergent Sanctuary Designation Criteria to the Exclusion Area.

	Emergent Criteria
Ecological Significance	✓ Seasonal upwelling and high productivity ✓ Habitat and feeding grounds for a significant number of marine mammals and seabirds (some threatened or endangered) ✓ High abundance of fish X Confluence of major biogeographic regions, or unique topographic feature X Unusually high habitat diversity X Exceptionally high diversity of benthic organisms
Educational Significance	✓ Educational facilities currently have programs in this area
Scientific Significance	✓ Current research projects conducted in the area ✓ Major research facilities nearby ✓ High research potential X No major research facilities in the area
Human Use Significance	X Fishing in the area contributes a small amount to regional catch
Recreational Significance	✓ More than nine recreational uses ✓ More than two pre-existing recreation areas ✓ Recreational fishing exists ✓ Human activity intensity increasing ✓ Accessible to an urban population
Historical, Cultural, and Archaeological Significance	✓ Contains historical resources
Adequacy of Existing Management	✓ Many agencies dedicated to individual characteristics, but overall comprehensive management is inadequate and requires coordination ✓ Two existing government recognitions of the value of the area
Area's Size and Nature Requirement	✓ Smaller than other sanctuaries and other expansions ✓ Adjacent to three existing sanctuaries ✓ Would remove gap in management

We also evaluated previous sanctuary expansions and found that the proposed expansion is supported by the same justifications as previous sanctuary expansions, as shown in the following table.

Table 2: Comparing the proposed expansion to previous National Marine Sanctuary expansions.

Primary Justification	Secondary Justifications	Exclusion Area Characteristics
Area is Unique	Rare/Special Species	Endangered: brown pelican, humpback whale, leatherback sea turtle Threatened: Western snowy plover, Steller sea lion Special: Harbor porpoise, sevengill shark, white shark
	Unique Geologic Features	Within the widest stretch of shallow, flat continental shelf off California
	Sensitive Habitat Types	Essential Fish Habitat for groundfish, Coho Salmon, and Chinook Salmon
	Seabird Foraging Area	Birds that use the Area for foraging include Clark's grebes, common murre, sooty and black-vented shearwater, white-winged and surf scoters, brown pelican, three species of cormorants, six species of gulls, and two species of terns.
	Cultural and Historical Resources	Native American cultural history of Coast Miwok and Ohlone Over 60 known shipwrecks within the Exclusion Area
	(New criterion)	The Exclusion Area also has a unique oceanographic characteristic of significant upwelling.

Protection Against Increasing Threats	Improved Access to the Area	The GGNRA can host up to 14 million visitors a year Ocean Beach visitation alone is about 300,000 people per year Populations in adjacent counties are growing
	Increased Fishing Pressure	Commercial catch of Dungeness crab and California halibut, is increasing Number of Commercial Passenger Fishing Vessel anglers is increasing
	Ensure Long Term Protection of Sanctuary Resources	Additional oversight of shipwrecks and cultural resources Additional protection for species and habitats within the Area Increase extent of continuous regional protection for marine areas Further coordinate sediment management and water quality issues to protect recreational resources
Facilitate Comprehensive and Coordinated Management	Complement an Existing Network	Located near CBNMS, GFNMS, and MBNMS
	Provide More Continuous Protection	Would remove gap between existing Sanctuaries
	Support Sustainable Fisheries Management	While NOAA currently defers fisheries management to California Department of Fish and Wildlife, sanctuary managers could increase oversight for protection of marine species if necessary
	Improved Cooperation with Other Agencies	Opportunity to work with USACE, EPA, SFPUC, NPS, DFW, and a variety of other agencies on many activities that could influence conditions in the Exclusion Area and in existing sanctuaries in the region
	Straight Sanctuary Boundary Lines	Gap between MBNMS, GFNMS, and CBNMS would be removed to create more continuous boundaries
Increase Opportunities for Research, Education, and Outreach	Foster Stewardship and Education	Opportunities to expand educational programs within the Area Opportunity to increase outreach to a large metropolitan area Increased sense of stewardship for local communities as Sanctuary boundaries are brought to shore
	Provide Increased Research Opportunities	Opportunities to increase research activities within the Exclusion Area

Conclusions and Implications

We conclude that the three original reasons for omitting the Exclusion Area from MBNMS do not currently constitute barriers to the proposed expansion, and the Exclusion Area fulfills the requirements outlined in the NMSA. The proposed expansion is also similar to past sanctuary expansions. Therefore, we recommend that the San Francisco-Pacifica Exclusion Area be incorporated into MBNMS.

While our analysis supports the proposed expansion, it also reveals several subjects that will require special attention from sanctuary managers. These activities include dredging activities, wastewater treatment, coastal erosion management, vessel discharges, and climate change adaptation measures related to sea level rise. To address these management issues, GFNMS will need to alter existing sanctuary regulations or institute adaptive zonal management approaches in the Exclusion Area. In the event that NOAA moves forward with the proposed expansion, we recommend that GFNMS work with regional stakeholders to develop management approaches and regulations that will balance ongoing essential human activities in the region with conservation of sanctuary resources.

Our analysis also reveals several subjects that could be further researched to improve sanctuary management. First, the emergent sanctuary designation criteria identified in this study could be employed as a framework with which to assess future sanctuary designations and expansions. Second, further study of the human uses of the area such as the potential of dredged material deposition sites to serve as beneficial reuse sites, the effects of climate change on wastewater infrastructure, and the precise locations of commercial fish catch within the Area, could refine current management.

List of Acronyms

Common Acronyms	
EIS	Environmental Impact Statement
GFNMS	Gulf of the Farallones National Marine Sanctuary
MBNMS	Monterey Bay National Marine Sanctuary
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NMSA	National Marine Sanctuaries Act
ONMS	Office of National Marine Sanctuaries

Other Acronyms	
ASNMS	American Samoa National Marine Sanctuary
BACIP	Before-After Control-Impact Paired Analysis
BGA	Biogeographic Assessment
BOEM	Bureau of Ocean Energy Management
CARB	California Air Resources Board
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CFU	Colony Forming Units
CINMS	Channel Islands National Marine Sanctuary
CPFV	Commercial Passenger Fishing Vessel
CSD	Combined Sewer Discharge
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DDT	dichlorodiphenyltrichloroethane
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index
FGBNMS	Flower Garden Banks National Marine Sanctuary
FKNMS	Florida Keys National Marine Sanctuary
FONSI	Finding of No Significant Impact
GGCR	Golden Gate Cetacean Research
GGNRA	Golden Gate National Recreation Area
IMO	International Maritime Organization
IUCN	International Union for Conservation of Nature
JMPR	Joint Management Plan Review
LCP	Local Coastal Program
LiMPETS	Long-term Monitoring Program and Experiential Training for Students
MBDS	Massachusetts Bay Disposal Site
MGD	Million gallons per day (unit)
MLPA	Marine Life Protection Act
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MPN	Most probable number (unit)

MSC	Main Shipping Channel
nm	Nautical mile (unit)
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PFMC	Pacific Fisheries Management Council
SAC	Sanctuary Advisory Council
SBNMS	Stellwagen Bank National Marine Sanctuary
SFPUC	San Francisco Public Utilities Commission
SLC	State Lands Commission
SWOO	Southwest Ocean Outfall
SWRCB	State Water Resources Control Board
TBNMS	Thunder Bay National Marine Sanctuary
TOC	Total Organic Carbon
TSS	Traffic Separation Scheme
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WPCP	Water Pollution Control Plant
WWF	Wet Weather Facility

Project Objectives and Significance

The primary objective of this project is to provide an impartial scientific analysis of whether the San Francisco-Pacifica Exclusion Area should be incorporated into the National Marine Sanctuary System. The 101-square-mile Exclusion Area lies at the mouth of San Francisco Bay, stretching from Point Bonita in Marin County to Point San Pedro in San Mateo County (Figure 1).

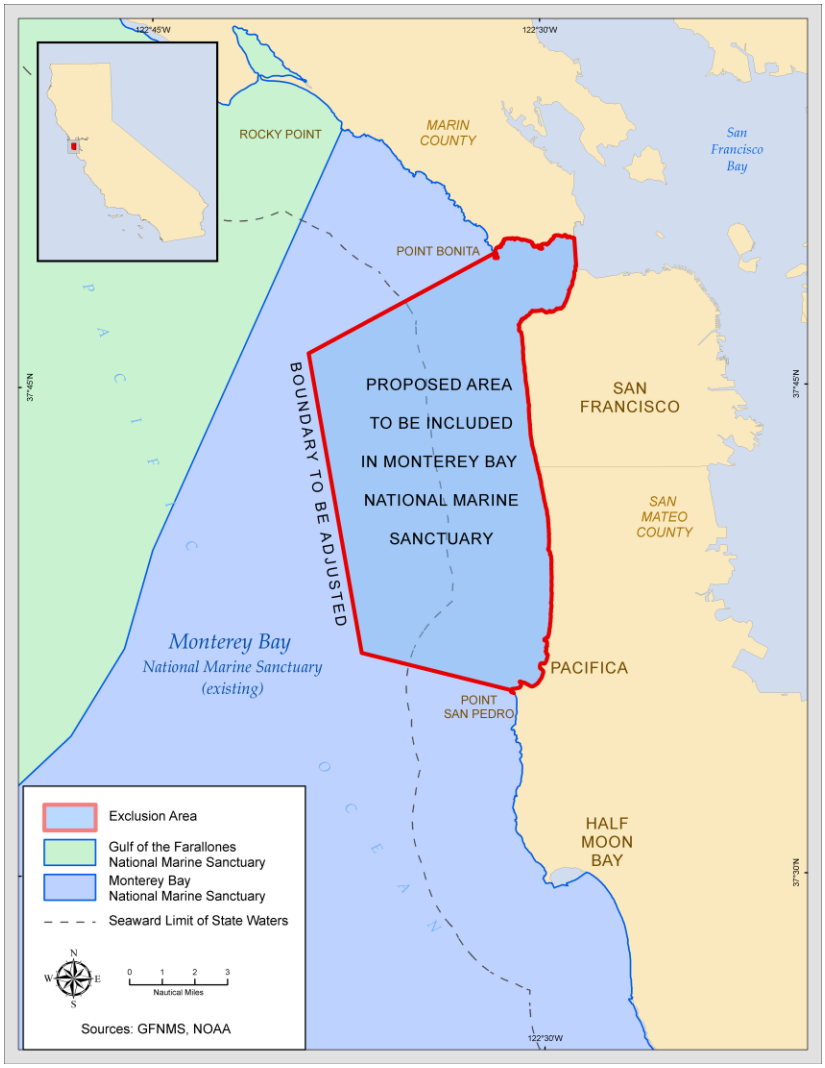

Figure 1: The Exclusion Area.

In 1992, the Area was deliberately omitted from Monterey Bay National Marine Sanctuary (MBNMS) because several activities occurring within the Area were deemed incompatible with sanctuary status [2]. However, mounting public pressure to reconsider sanctuary designation for the region prompted managers to include a plan to address the issue in the 2008 Joint Management Plan Review for Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries [3]. On August 7, 2012, the Gulf of the Farallones National Marine Sanctuary (GFNMS) published a Notice of Intent to prepare a

Draft Environmental Impact Statement (EIS) for the expansion of MBNMS into the Exclusion Area, as required by the National Environmental Policy Act (NEPA).

This project seeks to supplement, guide, and inform the Draft EIS by accomplishing two main goals:

1. Determine whether the original reasons cited for the omission of the Exclusion Area from MBNMS in 1992 currently present barriers to the proposed sanctuary expansion.
2. Determine whether the Exclusion Area fulfills the sanctuary designation criteria in the National Marine Sanctuaries Act.

It is important to note that the NEPA process associated with the designation or expansion of a National Marine Sanctuary is a highly political process. This report represents just one of many steps that must take place in the attempt to expand MBNMS to include the Exclusion Area. Our report serves as the impartial scientific analysis of the suitability of the Area for sanctuary status. It will inform and supplement the Draft EIS, after which public comment and the preparation of a Final EIS and Management Plan will occur. We expect our report will serve as a tool for the decision-makers responsible for continuing the NEPA process beyond the Draft EIS stage.

More specifically, the project has the following objectives.

- **Provide an impartial scientific analysis of whether the Exclusion Area should be incorporated into the National Marine Sanctuary System.** This report will inform and supplement GFNMS's Draft EIS. The managers and decision-makers responsible for responding to public comments on the Draft EIS and creating the Final EIS and Management Plan associated with the proposed sanctuary expansion will likely consult this report.
- **Document the history of the Exclusion Area.** Very little published information regarding the omission of the Exclusion Area from MBNMS currently exists. The subject is briefly mentioned in a 1992 Federal Register Notice regarding the establishment of MBNMS, but little explanatory information is included. However, the political history of this debate is relevant to the National Marine Sanctuary System as a whole because it illustrates the interaction between sanctuaries and their stakeholders. This project will summarize and clarify the reasons for the Exclusion Area's omission from MBNMS in 1992 and the political forces that led to the current, renewed interest in giving the Exclusion Area sanctuary status. This information could serve as a reference for future sanctuary expansions.
- **Determine if the original reasons cited for the omission of the Exclusion Area from MBNMS in 1992 currently present barriers to the proposed sanctuary expansion.** In 1992, three reasons were cited for the omission of the Exclusion Area from MBNMS: discharges into the Area from the City & County of San Francisco's combined sewer system, the placement of dredged material in the Area, and the presence of San Francisco Bay's Main Shipping Channel [2]. These three activities are essential uses of the region, and they are common in many marine environments. We seek to determine whether each of these activities is currently compatible with sanctuary status.

- **Determine whether the Exclusion Area fulfills the National Marine Sanctuaries Act's sanctuary designation criteria.** Candidate sanctuaries must fulfill the NMSA's sanctuary designation criteria to legally receive sanctuary status. To determine whether the Exclusion Area fulfills these criteria, we characterize the Area's nationally significant conservation, recreational, ecological, historical, scientific, cultural, archaeological, and educational qualities; the communities of living marine resources it harbors; its resource and human-use values; the adequacy of its existing managerial authorities; and its manageability [1].
- **Clarify the meaning of the phrase "special national significance" in the National Marine Sanctuaries Act's sanctuary designation criteria.** The NMSA's sanctuary designation criteria stipulate that a marine area must have characteristics that can be considered of "special national significance" to be designated as a National Marine Sanctuary. However, what constitutes "special national significance" has never been clarified by Congress or by the Office of National Marine Sanctuaries, leaving this language open to interpretation [4]. We operationalize the phrase "special national significance" through a unique analysis of how the NMSA has been interpreted and implemented over the 40-year history of the National Marine Sanctuary System. We analyze the characteristics of the thirteen existing National Marine Sanctuaries and identify specific qualitative and quantitative thresholds that have emerged over time as standards for sanctuary status. For the purposes of this project, we call these thresholds "emergent sanctuary designation criteria." We then compare the characteristics of the Exclusion Area to these emergent criteria to determine if the Area's characteristics could be deemed nationally significant. We believe these "emergent sanctuary designation criteria" could serve as a framework against which future sites could be evaluated for sanctuary designation and expansion. These criteria could also guide future interpretations of "special national significance" in the context of the NMSA.
- **Compare the proposed expansion to previous sanctuary boundary expansions.** We review the Environmental Impact Statements for the seven previous sanctuary boundary expansions and identify justifications for expansions to determine precedent. We then compare the proposed expansion to these justifications.
- **Provide material that will inform and supplement the expansion EIS.** Our characterization of the Exclusion Area includes an extensive written description of the Exclusion Area's ecological and cultural characteristics as well as human uses. This material could supplement the Draft and Final EISs for the sanctuary expansion.

More broadly, this project is significant because the Exclusion Area is located near the densely populated San Francisco Bay Area, so the potential incorporation of the Exclusion Area into MBNMS could impact many stakeholders. Sanctuaries provide comprehensive and coordinated management that regulate multiple uses of the marine environment, including conservation, preservation of cultural resources, and human activities. They have the ability to bring together users, stakeholders, and regulatory agencies to coordinate and balance the many uses of marine environments while ensuring the protection of natural resources. The proposed expansion of MBNMS would bring these benefits to the Exclusion Area, potentially affecting the future of the Area's natural resources and human uses in a significant way.

Background

History of the National Marine Sanctuaries

Congress established the National Marine Sanctuary Program, a branch of the National Oceanic and Atmospheric Administration (NOAA), on October 23, 1972 with the passage of the Marine Protection, Research and Sanctuaries Act. In 1992, Title III of this Act was renamed the National Marine Sanctuaries Act (NMSA). The NMSA allows the Secretary of Commerce to designate marine sanctuaries in areas that are considered "nationally significant [1]." In 2000, an amendment to the Act required that all Sanctuaries be managed collectively in a system known as the "National Marine Sanctuary System [1]." The Office of National Marine Sanctuaries (ONMS), provides authority to manage these marine areas in a comprehensive and coordinated manner; protect and restore the natural biological communities; enhance public awareness; support, promote, and coordinate scientific research on site; and facilitate compatible public and private uses of the marine resources [5]. Consequently, the National Marine Sanctuary System is known for its focus on multiple uses of sanctuary waters. Sanctuaries seek to balance preservation with human activities, protecting natural and cultural features of special marine environments while allowing people to use them in a sustainable way [6].

National Marine Sanctuary Designation Criteria

For an area to be designated as a National Marine Sanctuary (NMS), it must meet certain criteria outlined in the NMSA. These standards have changed somewhat throughout the legislative history of the Act. This section will describe how these designation criteria evolved into their current form and describe an important characteristic of the designation criteria: their flexibility.

In the Act's 1972 form, the Secretary of Commerce could "designate as marine sanctuaries those areas of the oceans, coastal, and other waters, as far seaward as the outer edge of the Continental Shelf… which he determines necessary for the purpose of preserving or restoring such areas for their conservation, recreational, ecological, or esthetic values [7]." This language allowed the Secretary of Commerce to designate sanctuaries where he or she personally deemed them necessary, thus introducing subjectivity into the sanctuary designation process. Additionally, the "or" statement in the legislation allowed decision-makers to cite a broad range of reasons for sanctuary designation.

In 1992, the NMSA was amended to add nationally significant cultural resources to the list of characteristics that could justify sanctuary designation [7]. The amendment also made designation contingent on the Secretary determining that the area's existing management was not comprehensive. Additional amendments in 2000 added biodiversity, and archeological and historical importance, as factors that could be considered in the sanctuary designation process [4]. These amendments further broadened the range of possible characteristics that could potentially justify sanctuary designation.

Today, the NMSA sanctuary designation criteria read as follows [1]:

> "Section 303
> (a) The Secretary may designate any discrete area of the marine environment as a national marine sanctuary and promulgate regulations implementing the designation if the Secretary determines that—
> (1) the designation will fulfill the purposes and policies of this Act;
> (2) the area is of special national significance due to—
> (A) its conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities;
> (B) the communities of living marine resources it harbors; or
> (C) its resource or human-use values;
> (3) existing State and Federal authorities are inadequate or should be supplemented to ensure coordinated and comprehensive conservation and management of the area, including resource protection, scientific research, and public education;
> (4) designation of the area as a national marine sanctuary will facilitate the objectives stated in paragraph (3); and
> (5) the area is of a size and nature that will permit comprehensive and coordinated conservation and management."

In summary, any of the following characteristics may justify sanctuary designation if it is considered nationally significant: the area's conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities; the area's living marine resources; or the area's resource or human-use values. In addition to at least one of these prerequisites, the existing managerial authorities must be inadequate, and the area must be of an easily manageable size and nature.

"Special national significance" is a particularly subjective phrase in the NMSA sanctuary designation criteria. This phrase has never been defined or clarified by Congress, leaving its interpretation up to the Secretary of Commerce and other parties involved in the sanctuary designation process [4], [8]. This characteristic of the sanctuary designation criteria is addressed in the Methodology chapter of this report.

History of MBNMS and the San Francisco-Pacifica Exclusion Area

This section will discuss why the Exclusion Area was omitted from MBNMS in 1992 and why it is currently being considered for incorporation into MBNMS.

Background

In the 1980s, there was public concern about potential oil and gas drilling in the waters surrounding the San Francisco Bay Area [9]. These concerns were heightened by the *Exxon Valdez* tanker spill off the coast of Alaska in 1989 and the *American Trader* tanker spill off Huntington Beach, California in 1990 [10]. Congressman Leon Panetta worked to ease some of these worries by championing the designation

of Monterey Bay National Marine Sanctuary (MBNMS), which would prohibit oil and gas exploration in Monterey Bay and the adjacent coastline [11].

After congressional approval for a marine sanctuary near the San Francisco Bay Area was obtained, the federal government began to consider boundary options for the new Sanctuary. The Environmental Working Group was in favor of protecting an area stretching from Cambria in San Luis Obispo County, to Point Reyes in Marin County [10].

Although there was public and congressional support for the establishment of MBNMS, the designation of the Sanctuary was delayed until 1992. The Gulf War in the early 1990s heightened the public's anxiety about the domestic oil supply and made the possibility of locking up a potential source of U.S. oil off California's coast unpopular. Additionally, limited NOAA personnel were assigned to working on the project, further delaying the designation process [10].

After these delays, environmentalists reasoned that if the Sanctuary was not approved by the 1992 election, much of the support for the designation of MBNMS would disappear [12]. There was speculation that President George H.W. Bush's support for the Sanctuary, and the 1992 moratorium on oil and gas drilling in California, were simply political moves to gain votes for the upcoming 1992 presidential election against Bill Clinton and Ross Perot [9], [12]. This political climate spurred renewed interest in the timely designation of the proposed National Marine Sanctuary.

Just before the Sanctuary's designation in 1992, concerns surfaced about potentially conflicting uses of Sanctuary waters. San Francisco city leaders were worried about the city's aging sewer system. They believed the city would be threatened with fines and violations for releasing inadequately treated sewage into proposed Sanctuary waters off of Ocean Beach [12]. The combined sewer overflow component of the City of San Francisco's sewage treatment program made the likelihood of such violations especially high during rainy periods [13]. In addition, dredged material from San Francisco Bay's Main Shipping Channel was being placed just outside San Francisco Bay [2], [10]. This activity would be impacted by sanctuary regulations if the area received sanctuary status [12]. High vessel traffic in the area was also of concern, and, at the last minute, the urban waters of San Francisco, Daly City, and Pacifica were deemed incompatible with sanctuary regulations and were excluded from MBNMS designation [13].

Combined sewer outflows from the City of San Francisco, the placement of dredged material in the region, and high vessel traffic were cited in the Federal Register (v.57, no. 182, September 18, 1992) as reasons for the omission of the 101-square-mile region now known as the San Francisco-Pacifica Exclusion Area. Figure 2 shows the Exclusion Area in relation to the surrounding sanctuaries.

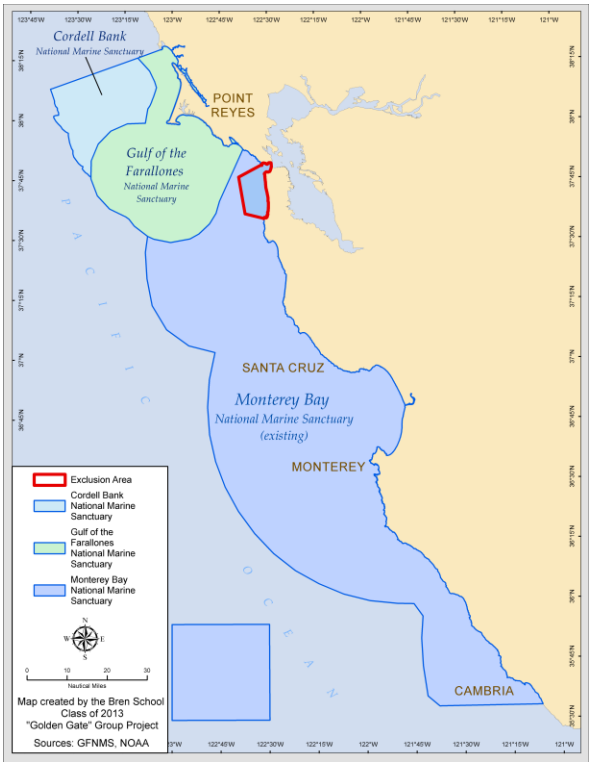

Figure 2: The San Francisco-Pacifica Exclusion Area and Surrounding Sanctuaries.

Renewed Interest in the Exclusion Area

In the early 2000s, various stakeholders began suggesting that the Exclusion Area be reconsidered for incorporation into MBNMS. Gulf of the Farallones National Marine Sanctuary (GFNMS), which manages the northern region of MBNMS, discussed the idea at various Sanctuary Advisory Council (SAC) meetings. The incorporation of the Exclusion Area was also addressed at the Joint Management Plan Review (JMPR) of Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries that took place between 2001 and 2008 [14], [15].

At the July 2005 SAC meeting, Irina Kogan, GFNMS Resource Protection Specialist, detailed the steps needed to analyze the Exclusion Area for possible inclusion into the Sanctuary [16]. These steps included research on current dredge disposal and wastewater treatment practices, in addition to the organization of a working group to analyze the significance of the Exclusion Area [17]. This working group was led by Brenda Donald who presented to the SAC in January 2006 on how the three reasons cited for exclusion had changed since the 1992 designation of MBNMS. Donald presented for a final time at the April 2009 SAC meeting. Here she reaffirmed the support the Sanctuary had received for the incorporation of the Exclusion Area into MBNMS waters and recommended that committees and stakeholders continue to research and advise on the issue and commit to reaching a final resolution [18], [19].

In addition to the discussions at various GFNMS SAC meetings, the Exclusion Area received attention during the JMPR process. A public scoping process identified important issues for each sanctuary, and

working groups developed management recommendations. In response to these recommendations, a stipulation to consider the incorporation of the Exclusion Area into MBNMS was included in the Final Management Plan for GFNMS [20].

Why Inclusion is Being Considered Today

There are three main reasons why the addition of the Exclusion Area into Sanctuary waters is being considered today:

1. Several stakeholders have suggested that the conditions originally cited as precluding the Exclusion Area from incorporation into MBNMS have been resolved over the last twenty years.
2. The 2008 JMPR update requires an analysis of this issue within five years (by 2013).
3. Stakeholder and public support, as well as media attention, have driven the ONMS and the SACs for both GFNMS and MBNMS to consider the expansion of MBNMS to include the Exclusion Area.

Preliminary findings suggest that the reasons cited for omitting the Exclusion Area from sanctuary designation in 1992 have changed. The SFPUC has improved its treatment facilities, and the Oceanside Wastewater Treatment Plant has functioned for 17 years without a permit violation. Vessel traffic patterns in the Exclusion Area have been altered since 1992, and much of the traffic going toward the Main Shipping Channel into the Port of San Francisco and the Port of Oakland already passes through MBNMS. In addition, dredged material placed within the Exclusion Area is reported to be clean and is permitted by the Environmental Protection Agency [13]. This report addresses the accuracy of these preliminary findings.

The incorporation of the Exclusion Area is also under consideration because of the stipulation presented in the 2008 GFNMS Management Plan under Strategy XNRP-2, Activity 2.2, which reads as follows:

> "GFNMS staff will facilitate a public process in the next five years to consider whether the San Francisco Exemption Area (a.k.a. "the donut hole") should be incorporated into MBNMS. Such an action would require changing MBNMS regulations and designation document and require coordination with MBNMS staff, and approval from MBNMS Superintendent.
> **Products:** Assessment and recommendation on whether to include this area in MBNMS. This could result in a change to MBNMS regulations and designation document.
> **Partners:** GFNMS and MBNMS resource protection staff [21]."

This section of the 2008 GFNMS Final Management Plan requires that GFNMS facilitate a public process to consider the incorporation of the Exclusion Area (referred to in the Management Plan as the "Exemption Area") into MBNMS. As a result, NOAA published its intent to revise Sanctuary boundaries, prepare an Environmental Impact Statement (EIS), and hold public scoping meetings in the Federal Register on August 7, 2012.

In addition to the requirements in the 2008 GFNMS Final Management Plan, the support of stakeholders has been essential in driving the consideration of this issue. Support for incorporating the Exclusion Area into MBNMS has come from city and county governments including the San Mateo County Board of Supervisors and the City of Pacifica, and from non-profit organizations such as the Bluewater Network, San Pedro Creek Watershed Coalition, and Save Our Shores [19].

Stakeholders such as Aquarium of the Bay and Golden Gate Cetacean Research have also indicated support for incorporating the Exclusion Area. These organizations have identified (and collected data for) several species of marine mammals and seabirds that currently utilize the Exclusion Area, including harbor porpoise, bottlenose dolphin, Steller sea lion, minke and gray whales, common murre, and sevengill shark [22–24]. The presence of these species indicates that these waters might be of special ecological value.

In addition to support from local stakeholder organizations, there has been a groundswell of general public support for this project. Advisory councils from both sanctuaries have asked sanctuary staff to pursue incorporation of the Exclusion Area into MBNMS. Public support and awareness of this sanctuary expansion will likely increase during the 2013 America's Cup sailing race hosted by the City of San Francisco. As a part of this event, the Healthy Oceans Advisory Board has chosen to publicize Marine Protected Areas and use its international media platform to promote the conservation of special marine places. The ONMS hopes to take advantage of this international platform to highlight the importance of National Marine Sanctuaries and the expansion of MBNMS into the Exclusion Area.

Expansion Process Timeline and the Role of this Report

The process associated with the designation or expansion of a National Marine Sanctuary is typically highly political. Political and public support for sanctuary status are primary drivers of the designation process. Numerous city and county governments, as well as stakeholders groups, have expressed support for the expansion of MBNMS into the Exclusion Area, indicating that this is an ideal time for GFNMS staff to initiate the public process required by the JMPR.

In order for the Exclusion Area to be considered for incorporation into MBNMS, the proposed project must follow the requirements of the National Environmental Policy Act (NEPA). The intent to review MBNMS boundaries and prepare an EIS was published in the Federal Register on August 7, 2012. Next, a series of public scoping meetings were held in the San Francisco Bay Area to gather public comment on the proposed sanctuary expansion. The public comment period ended on October 10, 2012, at which point GFNMS began working on a Draft EIS for the proposed expansion. Our report will guide, inform, and supplement the Draft EIS by providing an impartial review of the Exclusion Area's suitability for sanctuary status. After the Draft EIS is completed, public comments will be solicited. These comments will be considered, and a Final EIS and Management Plan for the expansion will be completed.

In summary, this report provides an impartial, scientific review of the suitability of the Exclusion Area for sanctuary status. Portions of this report may be incorporated into the Draft EIS. We expect our report

will serve as a tool for the decision-makers responsible for continuing the NEPA process beyond the Draft EIS stage.

Sanctuary Management

If the Exclusion Area were to be incorporated into MBNMS, it would most likely fall under the purview of GFNMS, because GFNMS currently manages the "Northern Management Area" of MBNMS. It is unclear what specific regulations would be imposed on the Exclusion Area if it were incorporated.

If the Exclusion Area were incorporated into MBNMS, the regulations imposed on the Area would be included in the Area's Management Plan, which will be created by GFNMS along with the Final EIS associated with the sanctuary expansion. In general, sanctuary regulations are tailored to each specific sanctuary site.

In the case of Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries, staff work together on a Joint Management Plan Review (JMPR) since they operate within the same region and "share many of the same resources and issues [25]." The process of developing regulations and the JMPR includes public scoping meetings, prioritizing issues, developing action plans, and preparing draft and final management plans in accordance with the NMSA and NEPA [25]. This process is mandated to occur every five years; however, in practice these revisions are made only as needed to clarify regulations, redefine sanctuary boundaries, or make more substantial regulatory changes. If the Exclusion Area were incorporated into MBNMS, it would be subject to this process.

Methodology

The ultimate goal of this report is to help determine whether the San Francisco-Pacifica Exclusion Area should be incorporated into Monterey Bay National Marine Sanctuary (MBNMS). To accomplish this goal, we address two main research questions:

1. **Do the three factors that resulted in the San Francisco-Pacifica Exclusion Area's omission from Monterey Bay National Marine Sanctuary currently present barriers to the proposed Sanctuary expansion?**
2. **Does the San Francisco-Pacifica Exclusion Area fulfill the sanctuary designation criteria in the National Marine Sanctuaries Act?**

Research Question 1

Research question 1 asks whether the three barriers to Sanctuary expansion cited in 1992 are still relevant today:

1. **Combined sewer outflows into the Area from the City & County of San Francisco**
2. **Placement of dredged material in the Area**
3. **High vessel traffic through the Area along San Francisco Bay's Main Shipping Channel.**

Associated with these topics are two uncertainties. First, these cited reasons may not have been valid reasons to omit the Exclusion Area from MBNMS in 1992. Second, these activities may or may not *currently* be compatible with Sanctuary status. Our analysis seeks to clarify these issues. We review the nature and intensity of each activity from 1992 to present, focusing on specific topics that are typically of interest to sanctuary managers. The analysis of dredging characterizes current dredging activities (including dredging and the placement of dredged material) within the Exclusion Area and how sanctuary designation could impact the future of dredging activities. The analysis of wastewater outflows describes the number of combined sewer discharge events into the Exclusion Area over time, along with the water quality measurements at several beaches in the Area. The analysis of vessel traffic compares current levels of vessel traffic within the Exclusion Area to that in existing sanctuaries and discusses the interaction between sanctuary regulations and Federal regulations on vessel discharges.

Within these analyses, we explore whether each activity could reasonably be cited as justification for excluding an area from a National Marine Sanctuary. First, we inventory the text regarding dredging, wastewater, and vessel traffic in each of the thirteen existing Sanctuaries' designation Environmental Impact Statements (EIS) to determine the nature and intensity of each activity that has historically been considered compatible with National Marine Sanctuary status. Next, we compare these precedents with our analysis of the three activities in the Exclusion Area, thus revealing whether the three activities could legitimately take place within a sanctuary based on historical standards.

Research Question 2

Research Question 2 asks whether the Exclusion Area meets current sanctuary designation criteria. According to the National Marine Sanctuaries Act (NMSA), a candidate sanctuary site must have "*special national significance* due to its conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities; the communities of living marine resources it harbors; or its resource or human-use values" [1]. Additionally, candidate sites can only be designated as sanctuaries if "existing State and Federal authorities are inadequate or should be supplemented to ensure coordinated and comprehensive conservation and management of the area, including resource protection, scientific research, and public education; [and] the area is of a size and nature that will permit comprehensive and coordinated conservation and management" [1]. We analyze the Exclusion Area in the context of each of these criteria. To facilitate these analyses, we group these criteria into the following categories:

1. **Ecological Significance** – includes "conservation qualities," "ecological qualities," and "communities of living marine resources."
2. **Human Use Significance** – includes "resource or human-use values."
3. **Recreational Significance** – includes "recreational qualities" and "esthetic qualities."
4. **Historical, Cultural, and Archaeological Significance** – includes "historical qualities," "cultural qualities," and "archaeological qualities."
5. **Educational Significance** – includes "educational qualities."
6. **Scientific Significance** – includes "scientific qualities."
7. **Adequacy of Existing Management** – includes the requirement that "existing State and Federal authorities are inadequate or should be supplemented to ensure coordinated and comprehensive conservation and management of the area, including resource protection, scientific research, and public education."
8. **Ease of Management** – includes the requirement that "the area is of a size and nature that will permit comprehensive and coordinated conservation and management."

Categories 7 and 8 require fairly simple analyses. We map the jurisdictions of each managerial authority in the Area and discuss gaps that exist in their collective purview. Additionally, we analyze whether the Exclusion Area could be easily managed based on its size and location, along with the reported availability of Office of National Marine Sanctuaries (ONMS) resources.

Categories 1 through 6 require more detailed analyses. Because the criteria are listed as an "or" statement, sanctuary status can be justified if any one of these categories is considered to be of "special national significance." Therefore, we first assess the qualities of the Exclusion Area that fall into each category. Because each category represents a broad range of subjects, we focus on topics commonly included in sanctuary designation EISs, Sanctuary Condition Reports, and Sanctuary Management Plans. Next, we analyze whether those qualities should be considered of "special national significance."

Defining "Special National Significance"

The phrase "special national significance" is subjective and vague, and neither Congress nor the ONMS has ever clarified its definition [4], [8]. How would a decision-maker considering sanctuary expansion into the Exclusion Area know whether the region's qualities meet these standards? What qualities and uses of a marine environment qualify as having "special national significance?" We operationalize this phrase by analyzing the historical interpretation and implementation of the NMSA. We examine the existing National Marine Sanctuaries and determine specific qualitative and quantitative thresholds for sanctuary status that have emerged over time.

Over the 40-year history of the National Marine Sanctuary System, decision makers have designated sanctuaries based on the criteria in the NMSA. They were required to report the characteristics of each potential sanctuary site that gave it "special" value in an EIS [26]. Consequently, an inventory of the reasons cited for the designation of each of the thirteen existing National Marine Sanctuaries reveals specific qualitative and quantitative site characteristics that qualify as "nationally significant" and thus justify sanctuary designation. We name characteristics shared between all or most of the Sanctuaries "emergent sanctuary designation criteria." These criteria represent the standards for sanctuary status that have emerged over time as decision-makers interpreted and implemented the NMSA. While these criteria are not meant to replace legislative sanctuary designation standards, they can be used as a frame of reference or a starting point for decision-makers who must evaluate whether the characteristics of the Exclusion Area (or any other sites under consideration) qualify as "nationally significant" under the NMSA.

To identify emergent sanctuary designation criteria, we break down the text in each sanctuary's designation EIS by subject. Next, we compare the sanctuaries across each subject, and if any emergent criteria exist, they are noted. For example, we compare how many species of seabirds each EIS lists, and then deduce whether there is a common number shared among all National Marine Sanctuaries. These common traits and quantitative thresholds are considered emergent sanctuary designation criteria.

In the course of this analysis, it became clear that the thirteen sanctuaries could fall into three basic sanctuary types. Because one of the types is particularly similar to the Exclusion Area, we split the sanctuaries into three categories (Table 3) and deduce emergent sanctuary criteria for each one.

Table 3: National Marine Sanctuaries by Category.

West Coast Sanctuaries: 1. Monterey Bay 2. Gulf of the Farallones 3. Cordell Bank 4. Channel Islands 5. Olympic Coast	Sanctuaries on the west coast of the continental United States. Most were designated to protect biologically diverse and productive natural ecosystems along with valuable human uses.
East Coast, Tropical, and Subtropical Sanctuaries: 1. Gray's Reef 2. Florida Keys 3. American Samoa 4. Flower Garden Banks 5. Stellwagen Bank 6. Hawaiian Islands Humpback Whale	Sanctuaries on the east and south coasts of the continental United States, along with one sanctuary in Hawaii and one in American Samoa.
Historically focused Sanctuaries: 1. Monitor 2. Thunder Bay	Sanctuaries designated for the sole purpose of protecting historically and culturally significant shipwrecks.

We derive emergent sanctuary criteria for each of these three sanctuary types, along with a small number of emergent criteria shared across all thirteen existing National Marine Sanctuaries. The West Coast Sanctuaries are the most relevant to the Exclusion Area because they share similar habitats, oceanographic conditions, and human uses. However, emergent criteria from the two other sanctuary types are still of interest, because they also reflect the historical interpretation of the phrase "special national significance."

In the following chapter, we analyze the Exclusion Area's characteristics that fall into each designation criterion. We then compare those characteristics to the emergent sanctuary criteria. This comparison reveals how well the Exclusion Area meets the standards set by the past interpretation of the NMSA. If the Exclusion Area fulfills a compelling amount of emergent criteria in any one category, it can be considered "nationally significant" in that particular category.

The NMSA sanctuary designation criteria are written as an "and" statement with three main requirements. However, one of these requirements states that the area must be of "special national significance" in one of many categories, and these categories are listed as an "or" statement. Therefore, the Exclusion Area needs to fulfill emergent criteria in just one of the categories to be considered "nationally significant," *and* it needs to fulfill the remaining two requirements to fulfill NMSA sanctuary designation criteria.

Emergent Sanctuary Designation Criteria

The Environmental Impact Statements associated with the creation of each existing National Marine Sanctuary describe the qualities of each site that justified its designation as a sanctuary. Appendix B distills this information into matrix form. Appendix A lists emergent sanctuary designation criteria for 1) west coast sanctuaries, 2) east coast, tropical, and subtropical sanctuaries, 3) historically focused sanctuaries, and 4) all sanctuaries. The rest of this report refers to the results in these appendices.

Dredging And The Placement Of Dredged Material

Introduction

In 1992, the deposition of dredged material was listed as one of three reasons for omitting the Exclusion Area from Monterey Bay National Marine Sanctuary (MBNMS). This chapter analyzes whether the placement of dredged material in the Exclusion Area was a logical reason for the omission of the Area from MBNMS in 1992. We also analyze if the placement of dredged material currently presents a barrier to the proposed sanctuary expansion. Next we describe current dredging activities (which include dredging and the placement of dredged material) in the Exclusion Area and explain how sanctuary designation will impact sediment management in this region. Our results indicate that placement of dredged material was not a valid reason for the original exclusion as it occurs in other National Marine Sanctuaries. We also find that dredging activities do not currently present a barrier to sanctuary expansion as management of dredging activities has improved since the original designation of MBNMS and the material dredged from the Main Shipping Channel is considered "free" of toxins. However, the Sanctuary will need to work closely with the U.S. Army Corps of Engineers and Environmental Protection Agency to ensure that critical human uses of the area are maintained.

Methods

Information for this chapter was obtained through interviews, e-mail communications, and reviews of agency reports and published papers. The U.S. Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), and NOAA were all key contributors. Information from all sources was compiled to create a summary of current dredging activities (which includes dredging and the placement of dredged material) within the Exclusion Area.

We did not analyze the impacts of dredging itself. The Exclusion Area sits at the mouth of the San Francisco Bay, host to several regionally and nationally important ports. Dredging of San Francisco Bay's Marine Shipping Channel (MSC) is essential to provide access to these ports. Due to the economic significance of shipping activities in the region, dredging must continue regardless of sanctuary designation. Therefore, we determined that analyzing the impacts of dredging itself is beyond the scope of this analysis. We will instead focused on how sanctuary designation of the Exclusion Area would affect current operations; specifically the placement of dredged material.

Was Placement of Dredged Material a Valid Reason for Exclusion in 1992?

Our analysis of existing sanctuaries reveals that dredging and the placement of dredged material occurs in other sanctuaries. Therefore, the placement of dredged material in the Exclusion Area was not a valid reason for omitting the Exclusion Area from MBNMS in 1992.

Figure 3 depicts dredging placement sites within MBNMS. Each year, about 400,000 cubic yards of dredged sand and 100,000 cubic yards of fine dredged material (mud) are placed within MBNMS to

maintain access to Santa Cruz, Moss Landing, and Monterey Harbors [27], [28]. This quantity is similar to the amount of sand placed within the Exclusion Area. The MBNMS Management Plan includes language that gives the Sanctuary the right to review and permit all dredged material placements at these designated sites [28]. Since 1992, they have allowed 98% of all proposed sediment placements [28]. The current MBNMS process for reviewing and permitting dredged material placement would likely guide the management of operations within the Exclusion Area if it were incorporated into MBNMS.

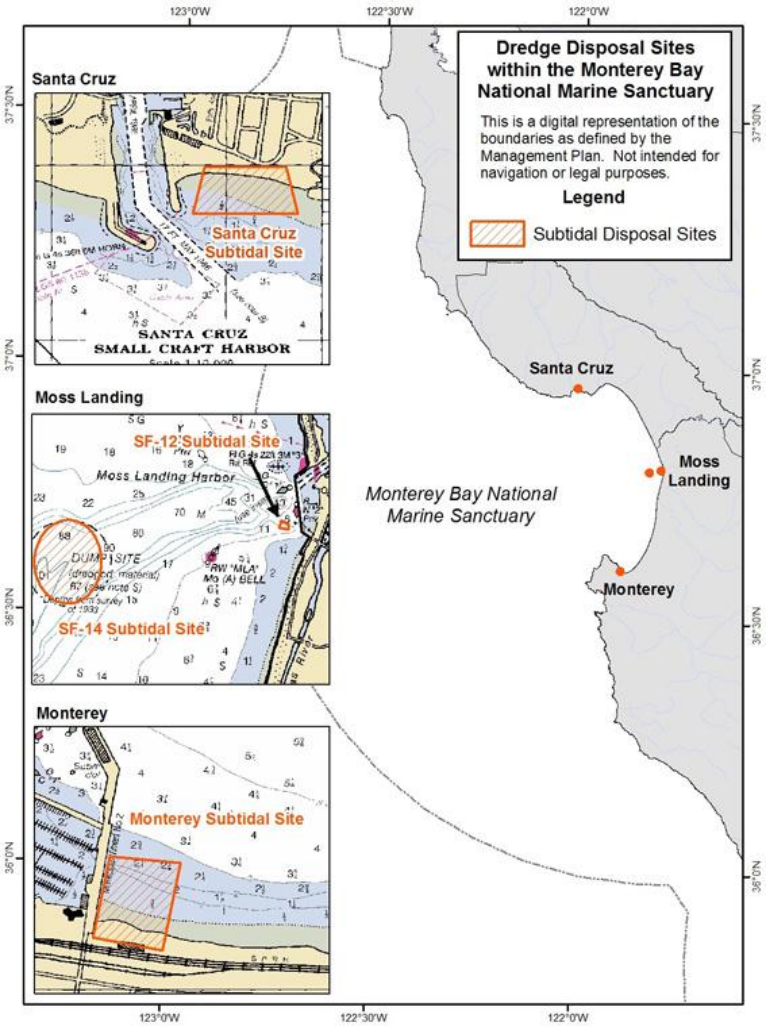

Figure 3: Dredged material placement sites within Monterey Bay National Marine Sanctuary [29].

Stellwagen Bank National Marine Sanctuary (SBNMS) is another sanctuary that has a relationship with dredging activities. The Massachusetts Bay Disposal Site (MBDS) is located adjacent to the western border of SBNMS (Figure 4). Material dredged from Boston, Hingham, Salem, and Gloucester Harbors has been deposited at or near this location since 1940. Since official designation of MBDS in 1993, an average of nearly 600,000 cubic yards of material is placed adjacent to Sanctuary borders each year [30]. However, unlike the material dredged from the MSC in the Exclusion Area which is considered “free” of toxins, historical, unregulated industrial dumping in Massachusetts Bay has significantly impacted the

sediment that is placed near SBNMS [31]. A 2004 analysis by NOAA concluded that "Stellwagen Basin (which includes the MBDS) shows clear evidence of significantly contaminated sediments (several samples have contaminant levels of tPCBs, tPAHs, chromium, nickel, lead, and zinc that exceed ER-M and/or AET criteria) which are probably having an adverse impact on benthic species" [32]. Due to this history, placement of dredged material near SBNMS has the potential to impact the benthic environment of the Sanctuary and requires coordinated management between SBNMS, EPA, and USACE. Dredging operations near SBNMS indicate that there is precedent for dredging activities, even ones that may impact the Sanctuary, to coexist with sanctuaries.

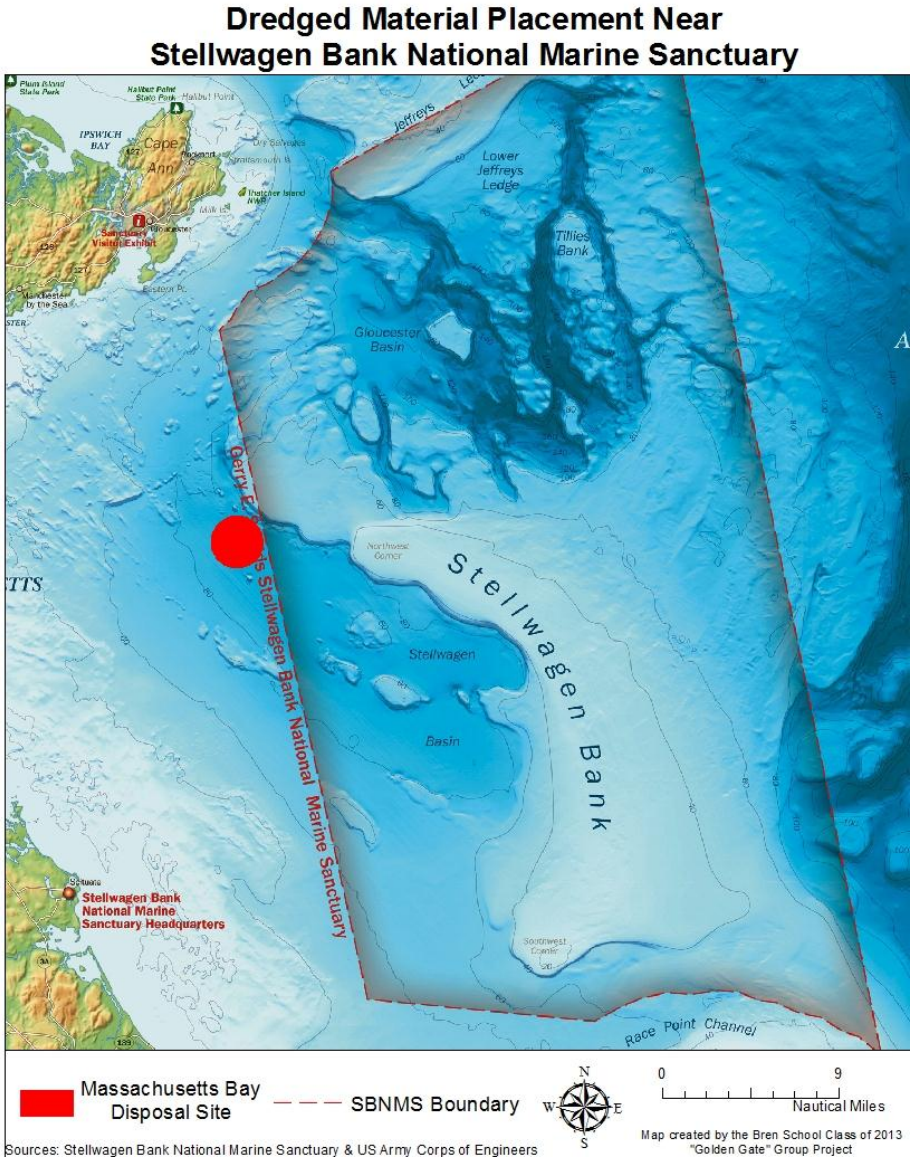

Figure 4: Dredged material placement site near Stellwagen Bank National Marine Sanctuary.

Our analysis of existing sanctuaries reveals that there is substantial precedent for dredging activities within sanctuary boundaries. Dredging occurs in some U.S West Coast Sanctuaries to maintain access to

important ports. Dredging activities are also present in about half of the U.S East Coast, Tropical, and Subtropical Sanctuaries and the Historically Focused Sanctuaries. EISs for the designation of National Marine Sanctuaries often acknowledge that the construction of new harbors and increased vessel traffic may increase the need for dredging operations in the future. It is clear that dredging activities, including the placement of dredged material, have been accepted in other Sanctuaries and is not a valid reason for outright exclusion.

Is Placement of Dredged Material a Current Barrier?

There are several reasons why the placement of dredged material does not currently present a barrier to sanctuary expansion.

- First, dredging is necessary to maintain safe conditions for vessel transits along the MSC and alternate placement sites for material from these operations may cause greater environmental impacts and are more costly.
- Second, significant changes in dredging management have increased oversight and reduced the impact of dredging activities in the San Francisco region.
- Third, the materials being deposited within the Exclusion Area are considered "free" of toxins because 98% of the material is not expected to hold pollutants due to its large grain size.
- Fourth, placement of dredged material in the Exclusion Area is classified as "like to like."[1]

For these reasons, the placement of dredged material is not currently a legitimate barrier to the proposed sanctuary expansion.

Current Dredging Activities are Necessary

The Port of San Francisco and the Port of Oakland are critical to commerce in Northern California. Both ports rely on maintenance of the MSC to create an adequate depth to allow large vessels to safely transit into and out of the Bay. In 2010 nearly 63 million tons of commodities, valued at $68 billion passed through the MSC [33]. The Port of San Francisco Port also supports 60-80 cruise ship calls annually [34]. Additionally, the Port of Oakland's cargo volume makes it the fourth busiest container port in the U.S. This port activity ranks San Francisco Bay among the top three principal Pacific Coast gateways for U.S. cargoes [35]. If the MSC were not dredged to maintain safe passage for large ships, a large portion of the economic activities generated by the ports would be essentially eliminated. It is clear that regardless of sanctuary designation, dredging of the MSC must continue.

Similarly, there are several reasons why placement of dredged material from the MSC must continue within the Exclusion Area rather than move to sites outside current Sanctuary boundaries. The MSC can only be dredged using a specialized vessel called a hopper dredge. This vessel is only available to the USACE for projects in the San Francisco area for less than 30 days each year [36]. If dredged material had

[1] "Like to like" is used to describe a sediment characteristic when sediment from one area is of the same grain size and chemical makeup as sediment in another area.

to be placed at sites outside of the Sanctuary, the hopper dredge would need to travel at least 50 miles further (one-way) to deposit material. These longer trips would be associated with an increased cost and other necessary dredging projects in the San Francisco area might not be completed due to time restraints. Additionally, placing sand from the MSC at deep-water sites outside of the Exclusion Area would remove about 500 thousand cubic yards of sand from the littoral cell each year, potentially exacerbating coastal erosion problems in the area [33]. Ultimately, current USACE operations within the Exclusion Area are the most efficient and least impactful options currently available for the placement of dredged material. Other alternatives outside the Exclusion Area would be less ideal.

Improved Management

The EPA and USACE have joint authority to regulate dredging and the placement of dredged material within the waters of the Exclusion Area under section 402 of the Clean Water Act (CWA) as well as section 103 of the Marine Protection, Research, and Sanctuaries Act [37]. In 1996, four years after the original omission of the Exclusion Area, the EPA and USACE made significant improvements to the San Francisco Bay Long Term Management Strategy for Dredging to improve disposal techniques and monitoring [38]. All dredging activities within the San Francisco Bay Area are now overseen by the Dredged Material Management Office (DMMO), an interagency collaboration between the San Francisco Bay Conservation and Development Committee, EPA, USACE, and state and regional Water Control Boards [39]. This improved oversight ensures that the quality of the material placed within the Exclusion Area is strictly regulated and that placement activities are executed with minimal environmental impact.

Material is Considered "Free" of Toxins

EPA testing indicates that MSC dredged material is 98% sand with less than 1% total organic carbon (TOC) [40], [unpublished data provided by USACE]. These characteristics qualify the MSC material to meet the exclusionary criteria for testing under 40 CFR 227.13(b) [41], [42]. The EPA makes these exemptions because the grain size (sand) and the low TOC indicate that there is "no expectation of pollutant loading" [41], [43]. The concept that sediments with large grain size and low TOC content have limited pollutant loading compared to finer-grained and higher TOC sediments is referenced extensively in sediment management literature [40], [44], [45], [46], [47]. Although the EPA exempts MSC material from testing, the USACE Master Sampling and Analysis Plan for MSC materials stipulates that testing will be conducted every six years to ensure that grain size, TOC, and total solids remain within exemption levels.

While the majority of the material from the MSC is not likely to hold pollutants, about 2% of the material is fine grain sediment that does have the potential to hold pollutants. The 1997-2008 San Francisco Public Utilities Commission (SFPUC) Summary Report gives the relative levels of pollutant loading for the small fraction of fine grain sediments along the MSC. Figure 5 below shows the concentrations of copper, mercury, and selenium in sediments within the MSC. This figure is significant because it demonstrates the influence of grain size and sediment type on pollutant loading. While heavy metal concentrations are high in the MSC when normalized to percent silt (the lighter green circles), the actual concentrations (dark blue circles) are low compared to other reference points because the material is

primarily sand. This characterization is why MSC material is classified as “free” of toxins despite small concentrations of pollutants. This finding is consistent with the EPA’s determination that dredged material from the MSC are unlikely to harbor significant levels of toxic contaminants.

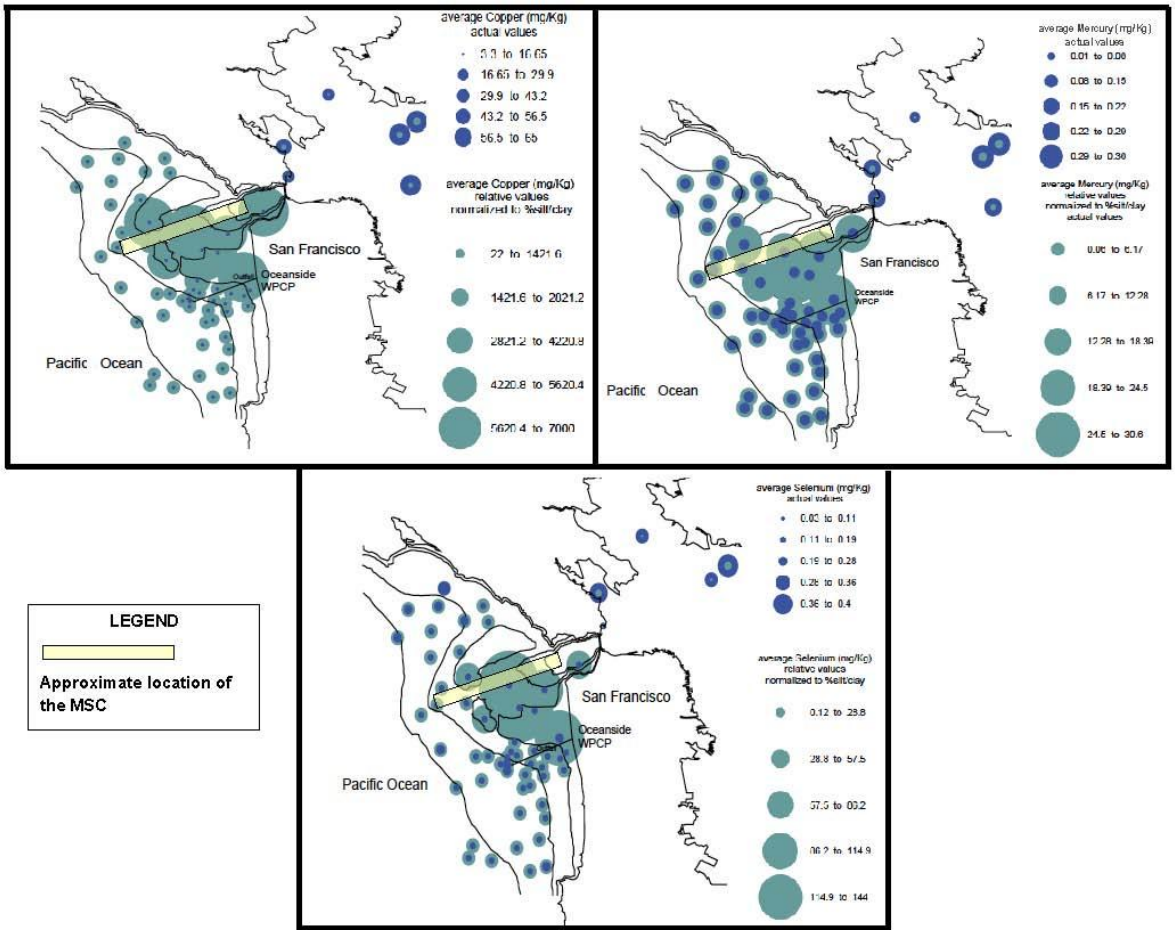

Figure 5: Effect of Grain size on pollutant loading of MSC material.
Actual concentration and concentration relative to percent silt for copper, mercury, and selenium within the Exclusion Area with approximate location of the MSC. Source: [40].

Placement is Considered “Like-to-Like”

The deposition of MSC material at the current placement sites in the Exclusion Area is considered “like-to-like”. The MSC dredged material is 98% sand, so placement is considered “like-to-like” when these materials are deposited in other sandy bottom environments. “Like-to-like” placement has limited impact on receiving environment because the added sediment is similar to the native sediment [48–51]. Current placement sites in the Exclusion Area have sandy bottom habitats, with a similar native grain size to sediments dredged from the MSC material [40]. The “like-to-like” classification of dredging activities and the lack of pollutants indicate that MSC material has a minimal impact on the Exclusion Area’s receiving marine environments.

Current Operations

The USACE and EPA are the primary agencies responsible for managing dredging activities within the Exclusion Area. Figure 6 shows all current projects in the Exclusion Area. Dredging of the MSC is the only operation that physically removes material from the seafloor of the Exclusion Area, and SF-8 is the only current site permitted for placement. However, SF-8 is not an ideal site for placement as sediment dispersion is not occurring and the accumulation of sediment is creating a safety concern for the hopper dredge [33]. SF-17 was selected as a superior placement site and is being permitted. It is currently being used as a test site and receives the majority of material dredged from the MSC. If designated, SF-17 would become the official primary placement site for the MSC's dredged material. An average of 400,000 cubic yards of material is dredged from the MSC annually and placed at SF-8 or SF-17 [52].

Dredging Activities in the San Francisco-Pacifica Exclusion Area

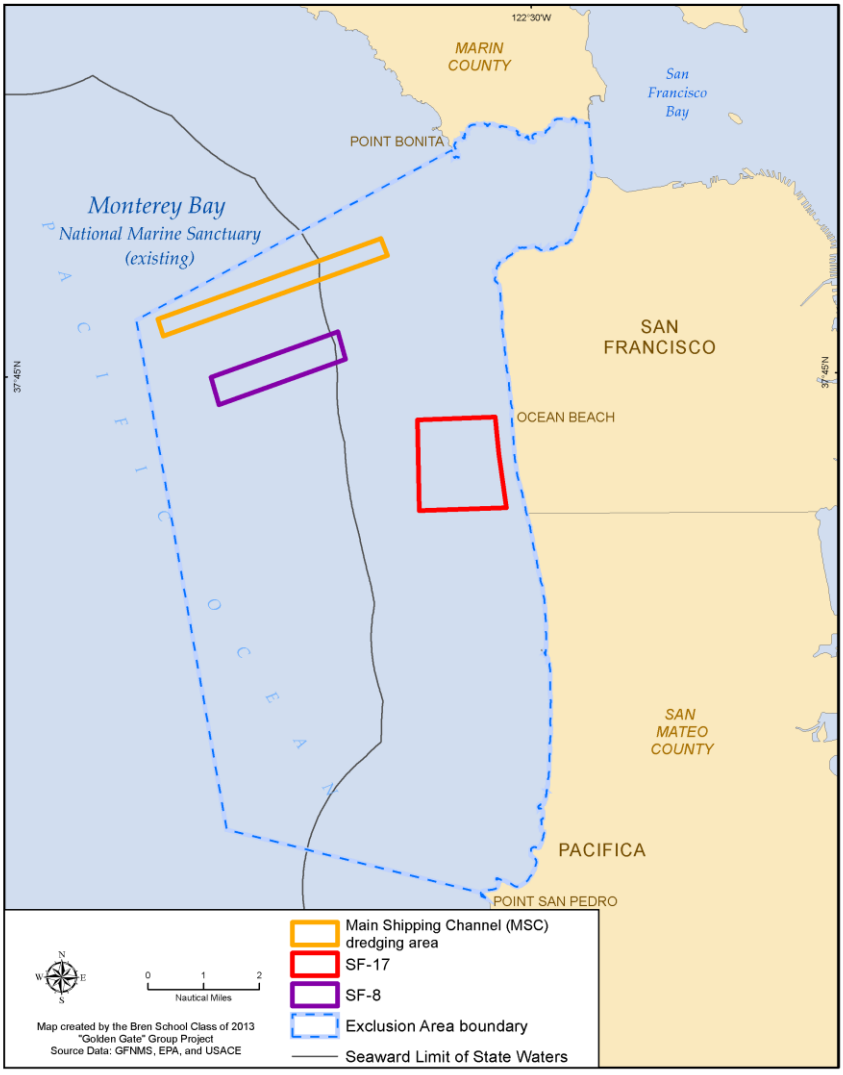

Figure 6: Dredging and dredging placement sites within the Exclusion Area.

EPA regulations [40 CFR 228.15(l)(4)] state that SF-8 can only be used as a placement site for material from the MSC. Also, the material must be at least 95% similar in grain size to the naturally occurring sediment at the site. An exception exists for the eastern portion of SF-8, which allows material from dredging projects other than the MSC to be deposited within this portion of the site (Figure 7). This exception is applicable because the eastern portion of SF-8 lies within three miles of the coast and is regulated under Section 404 of the CWA rather than the EPA regulations cited above. Dredged material from other sites that are placed in the eastern portion of SF-8 must have the same grain size and TOC as MSC material. Any material placed within this section from a project other than the MSC is permitted on a case-by-case basis by the EPA and the USACE [42]. If the Exclusion Area is incorporated into MBNMS, the Sanctuary would also need to have oversight of permitting dredged material placement.

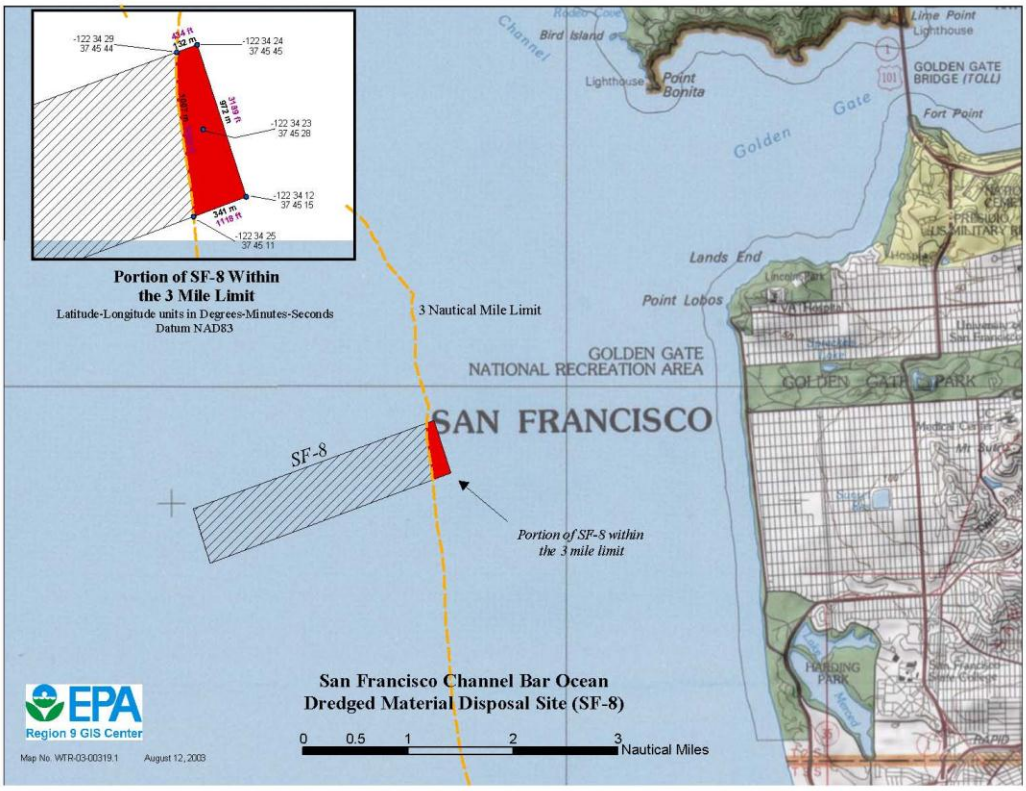

Figure 7: SF-8 and the three nautical mile limit of State waters.
Red shading indicates where material from projects other than the MSC can be placed.

SF-17 is a new site currently in the process of being permitted. Its designation as the primary site for MSC material would impact sanctuary management if the Exclusion Area were incorporated into the Sanctuary. Although it has not officially been permitted, as a test site, SF-17 currently receives the majority of the dredged material from the MSC. Specific SF-17 regulations have yet to be finalized, but as the site is located within three miles of the coast it would be regulated under the CWA. It is undecided if the site will be allowed to receive material from other projects (as does the eastern section of SF-8). Regardless, the site will only receive material that is composed primarily of sand [27].

SF-17 was selected as a potential new placement site because it may facilitate beneficial reuse of dredged material. Rather than dispose of material at an offshore location, beneficial reuse sites are utilized to reduce erosion and replenish beaches. Beneficial reuse has become a primary recommendation for sediment management, as it promotes strategic placement of materials to address erosion issues. The Ocean Beach Master Plan, the San Francisco Bay Long Term Management Strategy, and the Coastal Regional Sediment Management Plan, as well as polices of the California Coastal Commission, and the San Francisco Bay Conservation and Development Commission all recommend beneficial reuse of dredged material.

Beach nourishment is a specific type of beneficial reuse of dredged material. Beach nourishment is currently recognized as a better erosion management tool than breakwaters and groins because downdrift beaches are not negatively impacted [49]. SF-17 was originally designed to facilitate beach nourishment. However, results from the demonstration project at SF-17 suggest that the site may not be functioning as a beach nourishment site. Key findings of the 2005-2007 review by the USGS include: 1) more than half of the sand placed at the site during the study period remains at the placement site, and 2) for placement to produce a positive shoreline response, sand would need to be placed at depths no greater than 5 meters (most of SF-17 is 10 to15 meters deep) [53]. Additionally, the USGS study reports that the material placed at the site is medium-to-coarse grain sand, while Ocean Beach sand is fine-grained sand. This finding suggests that the placed sand is "not ideally compatible to stay on the beach."

Despite the lack of evidence that SF-17 functions as a beach nourishment site, it may help protect the beach against erosion by building up nearshore bars and dissipating wave energy and could therefore be a beneficial reuse site [53], [54]. It may also be a more ideal location than SF-8 because of these potential benefits.

Although placement of dredged material at SF-17 may provide benefits for Ocean Beach, there are potential impacts from this placement. Many studies point to several environmental impacts from placing dredged material nearshore [48], [49–51]. These include:

1. Altered sediment characteristics
2. Death to marine organisms from burial during placement and increased turbidity
3. Reduced foraging for bird species due to compaction and increased turbidity

The EIS for the official designation of the SF-17 site is still in progress. While operations at SF-17 are designed to minimize environmental impacts, the potential impacts to the marine environment from placement activities will not be clear until USACE completes the site EIS. The Sanctuary should work with the EPA and USACE to ensure that the EIS addresses potential impacts to marine resources. The forthcoming EIS will help the Sanctuary make decisions about the future of dredged material placement within its boundaries, should the proposed boundary expansion move forward.

Role of Sanctuary Language in the Future of Sediment Management

If the Exclusion Area were incorporated into the National Marine Sanctuary System, the Sanctuary would have the authority to determine whether dredging and the placement of dredged material would be allowed. This oversight has significant implications for the future of sediment management within the Exclusion Area. First, it is unclear if dredge deposition activities at the SF-17 site would be allowed to continue under current MBNMS regulations. Also, there are concerns that current sanctuary regulations would not allow the USACE to establish new projects for addressing erosion issues or responding to climate change impacts. However, precedent set by other sanctuaries provides some flexibility for altering existing regulations and making exemptions for projects that are necessary.

Historically, Sanctuaries have "grandfathered" existing dredging and placement sites but prohibited the designation of any new sites. Regardless of whether SF-17 is classified as a beneficial reuse site, it is unclear whether placement at SF-17 would be able to continue given current sanctuary regulations. If the proposed expansion moves forward, the EPA permitting process for SF-17 may not be complete before the Exclusion Area is incorporated into sanctuary boundaries. The regulations that exempt dredging activities from sanctuary regulations state that sites must have been permitted by the EPA prior to designation. The current MBNMS regulations explicitly state that a site must have been designated before January 1, 1993. Therefore, SF-17 would not qualify for exemption. SF-8 would qualify, but it is a less ideal site for placement. However, Section 922.133(b) of MBNMS regulations allows the Director of the Sanctuary to issue permits as he or she deems fit. The Sanctuary also has the authority to change their regulations and would be able to change the date associated with the grandfathering clause for dredged material. USACE and EPA are concerned that SF-17 might not be permitted under current MBNMS regulations. They have expressed a desire to work with the Sanctuary to ensure that operations at SF-17 can continue as the placement of dredged material at this site results in minimal environmental impacts compared to other existing sites and may provide erosion protection at Ocean Beach.

The USACE and EPA both contend that SF-17 should be permitted under MBNMS regulations because it is not a dredge disposal site, but rather a beneficial reuse site. These agencies argue that NOAA, as an agency, has supported beneficial reuse of dredged material and that the Office of National Marine Sanctuaries (ONMS) should reflect the values of their parent agency. In 2003, the National Dredging Team (NDT) released its Action Agenda that addressed national recommendations for dredging projects [55]. The National Ocean Service (a branch of NOAA) is a member of the NDT and NOAA's Director of the Ocean and Coastal Resource Management Office sits on the steering committee. A primary recommendation from the 2003 Action Agenda was to utilize dredged material for beneficial reuse projects to "the greatest extent possible." As an agency, NOAA has identified beneficial reuse of dredged material as an ideal practice when conducted appropriately. However, ONMS has not yet adopted this view and their general regulations still prohibit dredged material placement of any kind without an exception permit. This discrepancy should be rectified within NOAA and a decision made as to whether beneficial reuse of dredged material should receive agency-wide support. If this decision were made, ONMS would still have authority to review permits for placement projects within sanctuary boundaries

to ensure they are carried out in an environmentally friendly manner. Sanctuaries would also be able to adjust regulations to allow these types of projects, including operations at SF-17, if they are deemed appropriate.

The second issue concerning the future of sediment management in the Area is that it is unclear whether existing MBNMS regulations would allow the USACE to pursue necessary projects in the future to address erosion, adapt to sea level rise, and mitigate storm surge impacts. Current MBNMS regulations prohibit any new projects that "discharge or deposit any material or matter within or into the Sanctuary." The USACE and EPA have both expressed concerns that they would not be able to properly respond to climate change under these regulations. Additionally, the forthcoming Coastal Regional Sediment Management Plan (CRSMP) for the San Francisco region is considering many potential responses to coastal erosion, including revetments, sea walls, and artificial reefs that would result in significant alterations to the shoreline and coastal environments of the Exclusion Area. Sanctuary management of the Exclusion Area's coastal regions could be complicated by future coastal erosion responses needed in the area. The types of approaches recommended in the final CRSMP and ultimately adopted by local counties and municipalities will dictate the extent to which sanctuary resources will need to shift to deal with resulting regulatory conflicts. Therefore, Sanctuary staff should continue to communicate with the Coastal Sediment Working Group (CSWG) of San Francisco that is developing the CRSMP. By communicating with stakeholders in the CSWG and coastal regions, sanctuary managers will be better able to anticipate the erosion management needs of different coastal communities. This will facilitate developing coastal erosion responses along the Exclusion Area's coastline that balance infrastructure protection with marine resource conservation.

Dredging activities in the Exclusion Area will intersect with the CRSMP, since beach nourishment at the SF-17 placement site is expected to be a core component of erosion mitigation for Ocean Beach. The placement of sand directly on beaches or near shore would be prohibited under current MBNMS regulations. If the Exclusion Area were incorporated into the National Marine Sanctuary System, the Sanctuary would need to work with USACE to permit these activities through case-by-case exemptions. Interagency collaboration between GFNMS, USACE, EPA, and the Bay Area CSWG would ensure that projects attempt to minimize their environmental impacts, while meeting the needs of coastal communities along the Exclusion Area.

Wastewater Discharge

Introduction

During the designation process of Monterey Bay National Marine Sanctuary (MBNMS), concerns surfaced about the possibility of discharges from sewer overflows from the City & County of San Francisco into the Exclusion Area. These “anticipated” sewer overflows became one of three reasons cited for the Exclusion Area’s omission from MBNMS [2].

San Francisco is one of only two cities in California with a combined sewer system (CSS), which joins storm water runoff, domestic sanitary flow, and industrial wastewater together into a single system for treatment [56]. Normally, this combined wastewater flow is treated and then discharged into the Exclusion Area from the Southwest Ocean Outfall (SWOO), a steel-reinforced concrete pipe originating at the local Wastewater Pollution Control Plant (WPCP) and extending roughly 7 km offshore [40]. However, when wet weather events cause the storm water component of wastewater to increase, the system’s capacity can be exceeded. In these instances, wastewater with varying levels of treatment is discharged into the Exclusion Area from the SWOO and up to seven coastal outfall structures (Figure 8). These wet weather outflows are referred to as Combined Sewer Discharges (CSD) [40].

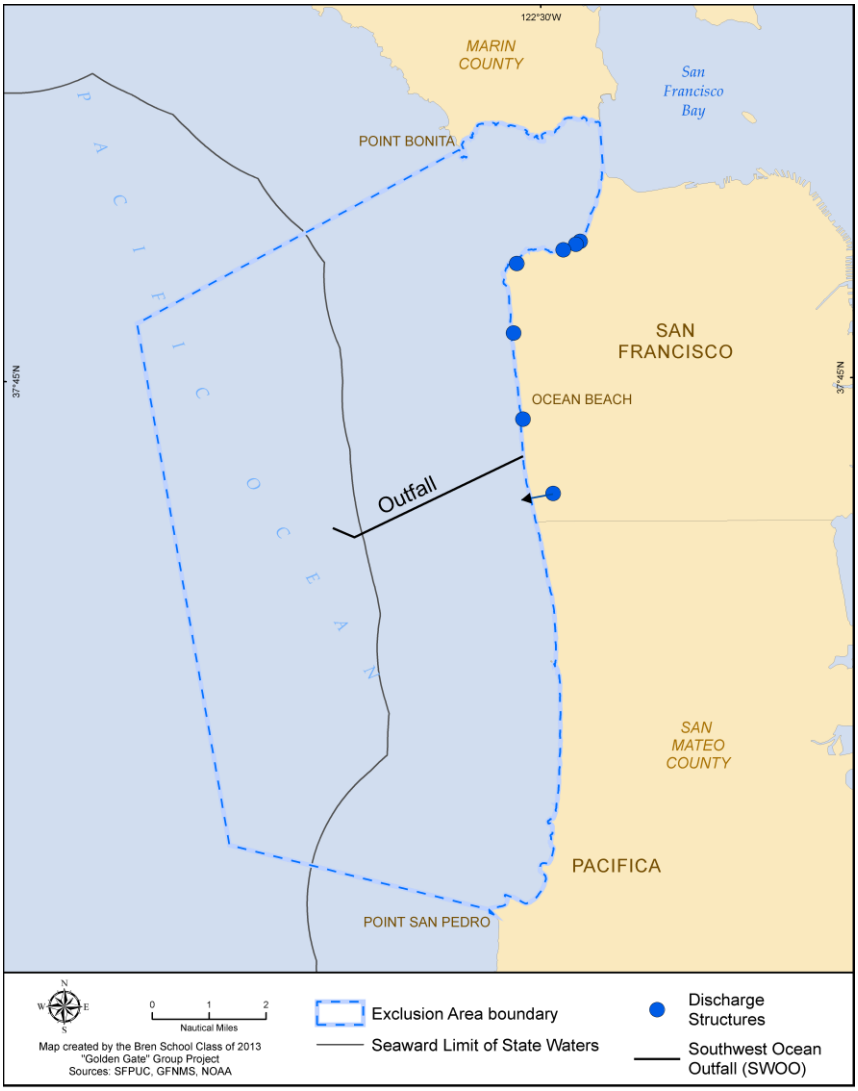

Figure 8: Wastewater infrastructure for San Francisco's west side.
Coastal discharge points are represented as blue dots, while the black-hooked line represents the Southwest Ocean Outfall. All discharge infrastructure is connected by storage and transport infrastructure (not visualized in this map).

When MBNMS was designated in 1992, the Richmond-Sunset WCPC was in use. Its limited wastewater treatment capabilities meant that the SWOO discharged wastewater that was only treated to the *primary level.*[2] Additionally, five of the seven coastal outfalls were not yet equipped with baffle technology that provides the equivalent of primary treatment to CSDs, meaning that many wet weather outflows consisted of *untreated* wastewater as of 1992. These discharge activities were deemed incompatible with National Marine Sanctuary status and resulted in the listing of anticipated sewer overflows as one of the three cited reasons for the Exclusion Area's omission from MBNMS [2].

[2] Primary treatment is limited to physical settling of suspended solids in wastewater. While primary treatment is effective for removing large particulate matter, it does not remove dissolved substrates or fine suspended solids in wastewater [63].

However, several updates to the region's wastewater treatment system were completed after MBNMS was designated:

- In 1993, the Oceanside WPCP replaced the Richmond-Sunset WPCP, providing a higher level of treatment to the wastewater discharged from the SWOO. The Oceanside WCPC provides *secondary* treatment for up to 43 million gallons of wastewater per day and *primary* treatment for up to 65 million gallons per day (MGD) [40].[3] Flows in excess of 65 MGD are directed to the Westside Wet Weather Facilities (WWFs) where they receive the equivalent of primary treatment before being discharged from the SWOO. In summary, the increased capacity of the Oceanside WPCP meant that after 1993, wastewater discharged from the SWOO during both dry and wet weather events was treated to a higher level than the wastewater discharged prior to the designation of MBNMS.
- Starting in 1993, additional wastewater storage and transport structures called the Westside Wet Weather Facilities (WWFs) were installed along San Francisco's western shoreline [56]. These WWFs provided two benefits. They accommodated larger volumes of wastewater than previous infrastructure, thus decreasing the number of CSDs from the coastal outfalls structures. They also provided the equivalent of primary treatment to all CSDs. Construction of these transport structures took place over many years, with some subsections coming online earlier than others. As a result, the storage capacity for the Oceanside WPCP grew incrementally over a decade (Table 4). The Westside transport structure runs along Ocean Beach and went online in 1987 (prior to MBNMS designation). The transport structure consists of baffle boxes installed beneath the Great Highway, and provides an extra 49 million gallons of storage capacity. The Lincoln and Vicente outfall structures are connected to the Westside transport (Figure 9). The Merced transport near Fort Funston is connected to the Lake Merced outfall structure. It was completed in 1993 and provides an additional 11 million gallons of storage capacity. The Richmond transport structure provides an additional 12 million gallons of storage along Baker and China Beach. It came online in 1997 and is connected with the Sea Cliff outfall structures [40].

Table 4: Wastewater Infrastructure Updates [40].

Transport Structure	Coastal Area	Connected Outfall Structures	Year Completed	Storage Capacity [in millions of gallons]
Westside Transport	Ocean Beach	Lincoln & Vicente	1987	49
Lake Merced Transport	Fort Funston	Lake Merced	1993	11
Richmond Transport	Baker & China Beach	Sea Cliff I & II, Mile Rock	1997	12

[3] Secondary treatment uses biological processes to remove dissolved substrates and fine particulate matter in wastewater, further reducing the total suspended solids in effluent after primary treatment [63].

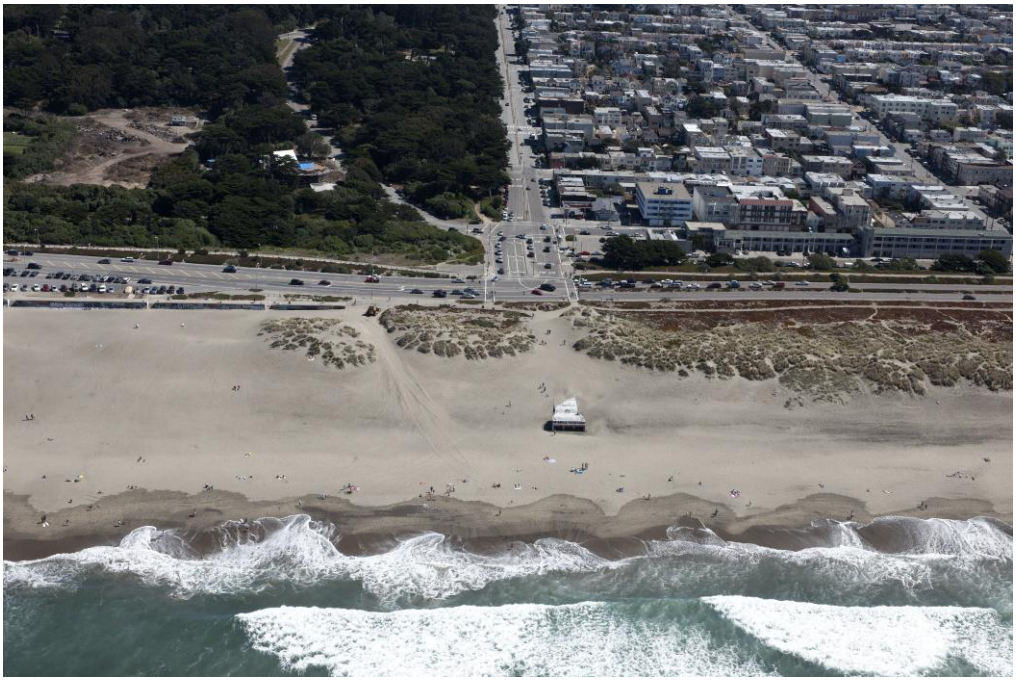

Figure 9: Outfall structure located along Ocean Beach.
This photo shows the Lincoln outfall structure - one of seven coastal outfalls structures that can release primary treated wastewater during wet weather events. (Photo Credit: Copyright © 2002-2010 Kenneth & Gabrielle Adelman, California Coastal Records Project, www.californiacoastline.org).

In summary, after 1993 (one year after the designation of MBNMS), infrastructure updates expanded the treatment and storage capacity of San Francisco's CSS. Together, the Oceanside WCPC and Westside WWFs brought the total capacity of San Francisco's CSS to 175 MGD. These updates increased the treatment quality of wastewater discharged into the Exclusion Area and reduced the number of CSD events per year.

To determine the significance of these changes, we evaluate trends in water quality indicators over the last twenty years. The results of our analysis suggest that the discharge of San Francisco's treated wastewater is not a barrier to the proposed incorporation of the Exclusion Area into MBNMS.

An important component of our analysis was data provided by the SFPUC. Wastewater discharges from the SWOO and CSD events are closely monitored by the SFPUC and regulatory agencies. Discharges from the Oceanside WPCP (including CSD events) are regulated under the Clean Water Act's (CWA) National Pollution Discharge Elimination System (NPDES) [57]. The NPDES permit, which is jointly administered by the EPA and the San Francisco Bay region's State Water Resource Control Board, requires the SFPUC to conduct regular testing of treated wastewater. More than 125 pollutants are monitored, with the regularity of testing varying across different pollutants and parameter being considered (Table 5).

Table 5: Effluent Monitoring Parameters for the Oceanside WPCP [40].

Parameters	Units	Sampling Frequency
Flow Rate	MGD	Daily
Biological Oxygen Demand	mg/L	1 per week
Total Suspended Solids	mg/L	5 per week
Grease & Oil	mg/L	1 per quarter
Turbidity	nephelometric turbidity units (NTU)	1 per quarter
pH	standard units	5 per week
Ammonia	mg/L of Nitrogen	1 per quarter
Chronic Toxicity	TUc	1 per quarter
Mercury	µg/L	1 per month
2,3,7,8-Tetrachlorodibenzodioxin (Dioxin) Equivalents	µg/L	1 per year
Other Inorganic & Organic Pollutants	µg/L	1 per quarter or year

The SFPUC's monitoring program for the Oceanside WPCP has onshore and offshore components [40]. The onshore component is a Beach Monitoring Program that tracks the number of CSD events and regularly tests water samples from beaches. The Beach Monitoring Program also measures and reports bacteria concentrations at recreational beaches. If a CSD occurs or if test results indicate bacteria concentrations are above State regulatory standards for water contact recreation, public notice is initiated through the Beach Monitoring Program as stipulated by the NPDES permit issued to the SFPUC [58].

The offshore component of the SFPUC's monitoring program evaluates physical, chemical, and biological characteristics around the SWOO for comparison with selected reference sites. The parameters that are monitored include sediment quality, benthic infauna community structure, demersal fish and epibenthic community structure, and physical anomalies and bioaccumulation of contaminants in organism tissues.

Methods

To determine whether wastewater outflows pose a barrier to the proposed expansion of MBNMS into the Exclusion Area, we assess how impacts to the Exclusion Area's receiving waters have changed from 1992 to present. This chapter has two sections: coastal analysis and offshore analysis. The first section evaluates impacts from CSD events on the Exclusion Area's coastal waters, and determines how these impacts have changed in the twenty years since MBNMS designation. The second section evaluates offshore environmental impacts from the SWOO's discharge of treated wastewater, as reported in the SFPUC meta-analysis for twelve years of monitoring program results.

The SFPUC provided data on the annual number of CSD events and test results for indicator bacteria concentrations that have been obtained through beach monitoring for our coastal analysis. Summary findings from the SFPUC's *Southwest Ocean Outfall Regional Monitoring Program: Twelve Year Summary*

Report were reviewed for our analysis of the SWOO's effect on receiving environments in the Exclusion Area.

Coastal Analysis

Two factors were considered in our coastal water quality analysis over the 20-year period since MBNMS designation:

1. The average number of CSD events for the periods before and after wastewater infrastructure updates were completed for the west side component of San Francisco's CSS.
2. The number of times indicator bacteria test results exceeded state water contact recreation standards along San Francisco's west side, which adjoins the Exclusion Area's coastal waters.

Trends in the annual number of CSD events was assessed to determine if the level of discharges into the Exclusion Area's waters has changed since MBNMS designation (Figures 10 and 11). Results are presented with annual rainfall data for San Francisco, since precipitation levels have a direct influence on the number of CSD events. In particular, intense or extended wet weather events are the most likely to cause CSD events. Our analysis was conducted for discrete CSD events across the entire west side CSS, and for non-discrete CSD events from individual outfall structures (a CSD event is considered discrete when it is separated by at least 6 hours in time from any other CSD event).

A Student's t-test was used to assess whether the average number of annual discrete CSD events in the period before infrastructure updates were completed (the "pre-update" period: 1992 to 1997) was statistically different from the average number of annual discrete CSD events in the period following infrastructure updates (the "post-update" period: 1998 to 2011). We found a decrease in the average annual number of CSD events for the post-update period (7 discrete events per year) when compared to the average annual number of CSD events in the pre-update period (50 discrete events per year). The difference between the two averages is statistically significant (alpha = 0.05, df = 4.08, two-tailed). These results agree with the average number of CSD events per year that is currently reported by the SFPUC and the number of CSDs for which the updated CSS system was designed (an annual average of 8).

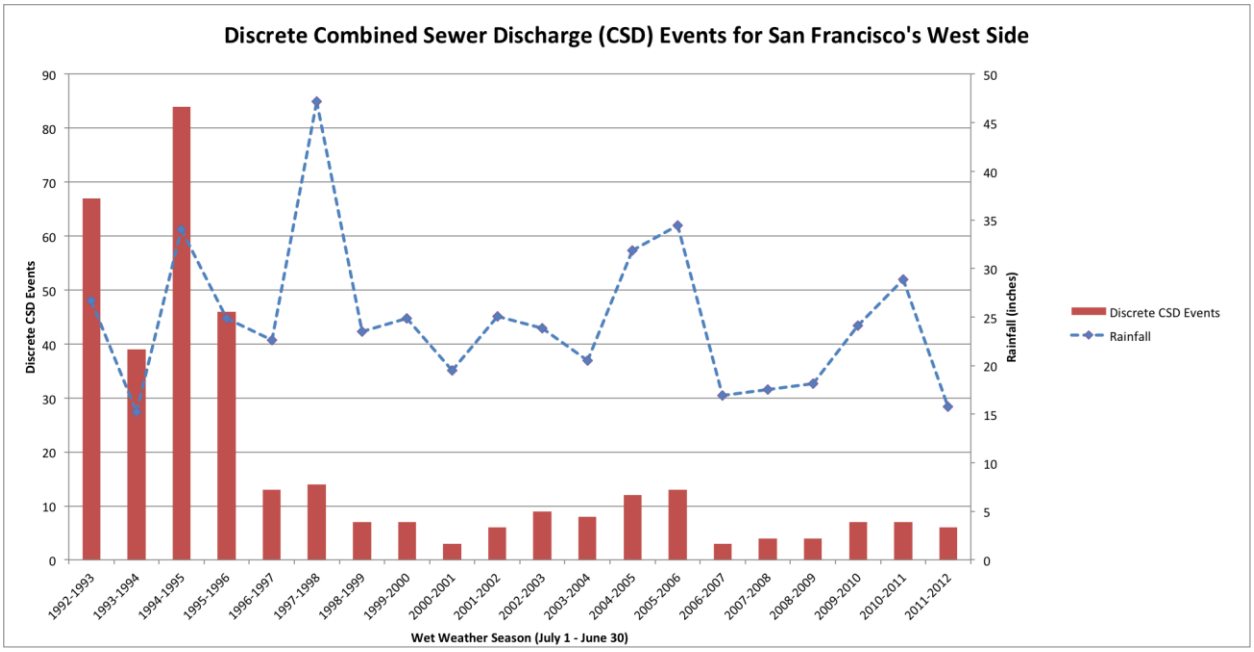

Figure 10: Discrete CSD events, San Francisco's west side combined sewer system.
A CSD event is classified as discrete when it is separated by all other CSD events across the entire combined sewer system by at least 6 hours. (Data: SFPUC).

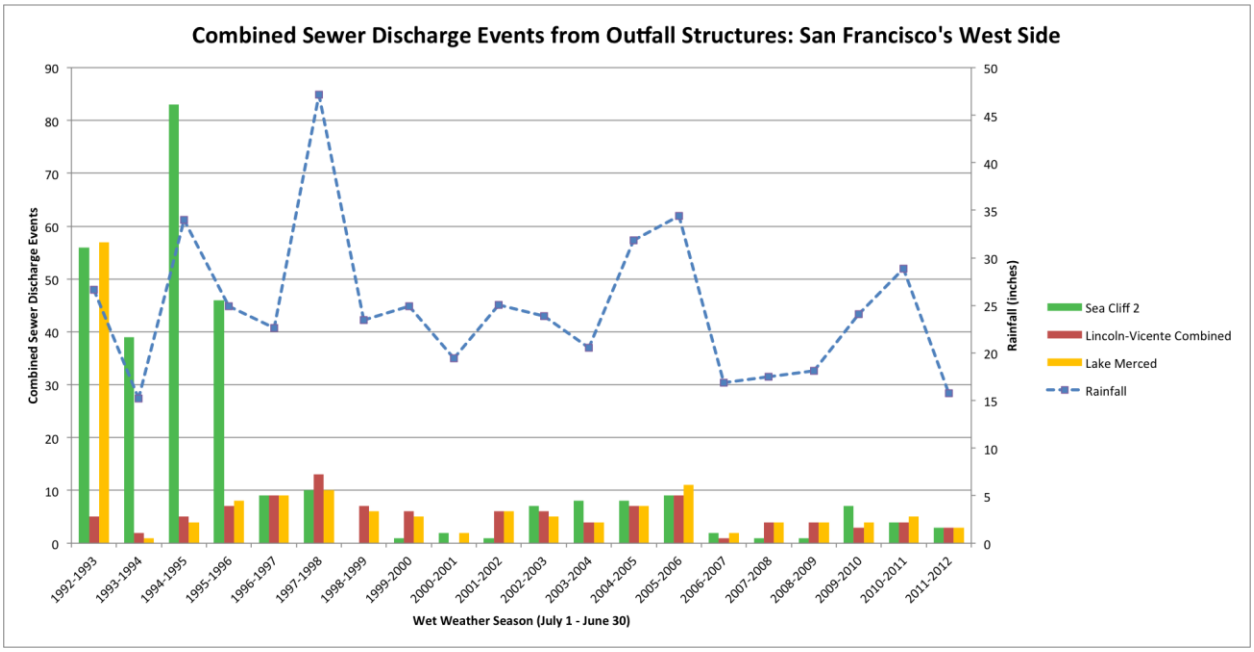

Figure 11: Non-discrete CSD events, San Francisco's west side combined sewer system.
Decreases for specific outfall sites coincide with the completion of infrastructure updates that increased storage capacity for the portion of the combined sewer system that outfall sites are connected to. (Data: SFPUC).

The second part of our coastal analysis evaluated trends in concentrations of fecal indicator bacteria (FIB) at beach monitoring sites along San Francisco's west side. CSD events increase concentrations of FIB in receiving coastal waters, and often result in FIB concentrations that exceed state standards for

water contact recreation. The current NPDES permit for the Oceanside WPCP requires the SFPUC to test FIB concentrations following CSD events, in addition to regular FIB testing. We assumed that coastal impacts to the Exclusion Area from CSD events would be reflected in the number of times California's water contact recreation standards were exceed per year (Figures 12-14). Data from 1992 to 2011 was considered for three different FIB standards set by California Assembly Bill No. 411 and the California Ocean Plan [58], [59]. Under these regulations, any samples that return test results for FIB concentrations above the following most probable number (MPN) of sampled water are defined as exceedances in our analysis:

- Total Coliform > 10,000 MPN/100 mL
- *Escherichia coli* (a subset of fecal coliform) > 400 MPN/100 mL
- *Enterococcus* > 104 MPN/100 mL

The proportion of samples with FIB concentrations above the state standards were also compared across pre-update and post-update periods for the Total Coliform, *Escherichia coli*, and *Enterococcus* indicators (Figure 15). The comparison was intended to determine if the proportion of samples that exceeded state standards had changed since infrastructure updates were completed in the years following MBNMS designation. The pre-update and post-update periods were the same as those used in our CSD analysis (1992-1997 and 1998-2011, respectively). Observed differences in the proportions for the two periods were tested for statistical significance. The temporal extent of the three-indicator analysis varied with data availability (data for *E.coli* and *Enterococcus* indicators was not collected from 1998 to 2003). Appendix C provides additional details on data processing and statistical methods for our analysis of water contact recreation exceedances.

Our analysis of Total Coliform showed a downward trend in the number of times per year that standards were exceeded from 1992 to 2011. The proportion of samples returning results above state water contact recreation standards also decreased for Total Coliform in the post-update period. The difference in proportions across pre- and post-update periods for Total Coliform was statistically significant ($z = 3.94$; $z_{crit} = \pm 1.96$; p-value < 0.0001, two-tailed).

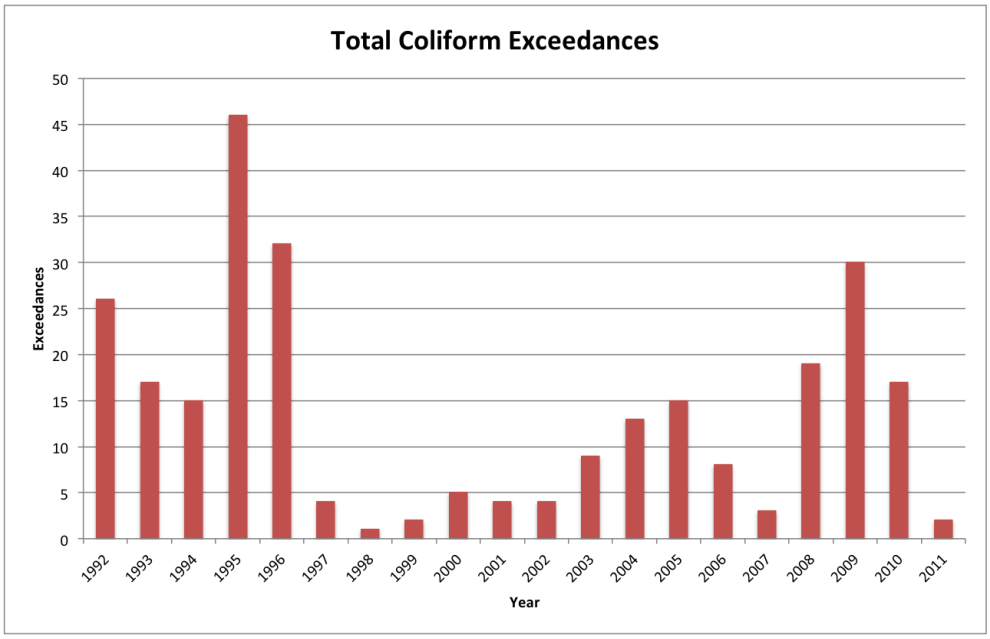

Figure 12: Total Coliform Exceedances.
Annual number of times that California water contact recreation standards for Total Coliform were exceeded within each year. (Data: SFPUC).

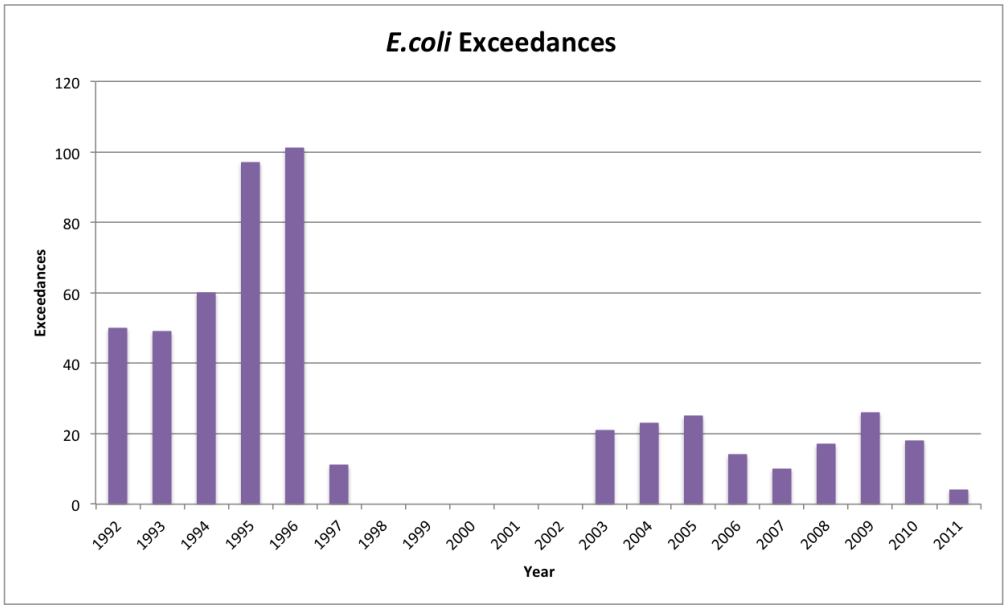

Figure 13: *E. coli* Exceedances.
Annual number of times that California water contact recreation standards for *E.coli* were exceed within each year. (Data: SFPUC).

The proportion of samples that returned estimated *E.coli* concentrations above state water contact recreation standards decreased for the post-update period. This decrease was statistically significant ($z = 2.38$; $z_{crit} = \pm 1.96$; p-value < 0.025, two-tailed). Data for *E.coli* were not available for the pre-update

period, so *E.coli* concentrations for this period were estimated from Fecal Coliform concentrations. *E.coli* is a subset of fecal coliform, and the adjusted fecal coliform concentrations assumed that *E.coli* constituted 80% of all samples. This assumption was based on the recommendation for comparing Fecal Coliform to *E.coli* standards that was issued by the California Department of Health Services. The fractions recommended for estimating *E.coli* concentrations from Fecal Coliform test results by agencies and experts range from 63% to 88% [60]. A sensitivity analysis conducted across this range indicates that our result for *E.coli* is robust to changes in the assumed fractions of *E.coli* that are present in water sampled for Fecal Coliform testing.

Like Total Coliform and *E.coli* indicators, *Enterococcus* indicators showed a downward trend in the annual number of exceedances over the last twenty years. However, unlike the Total Coliform and *E.coli* indicators, the proportion of *Enterococcus* samples returning results above state water contact recreation standards increased in the post-update period. This increase was statistically significant ($z = -2.94$; $z_{crit} = \pm 1.96$; p-value < 0.01, two-tailed).

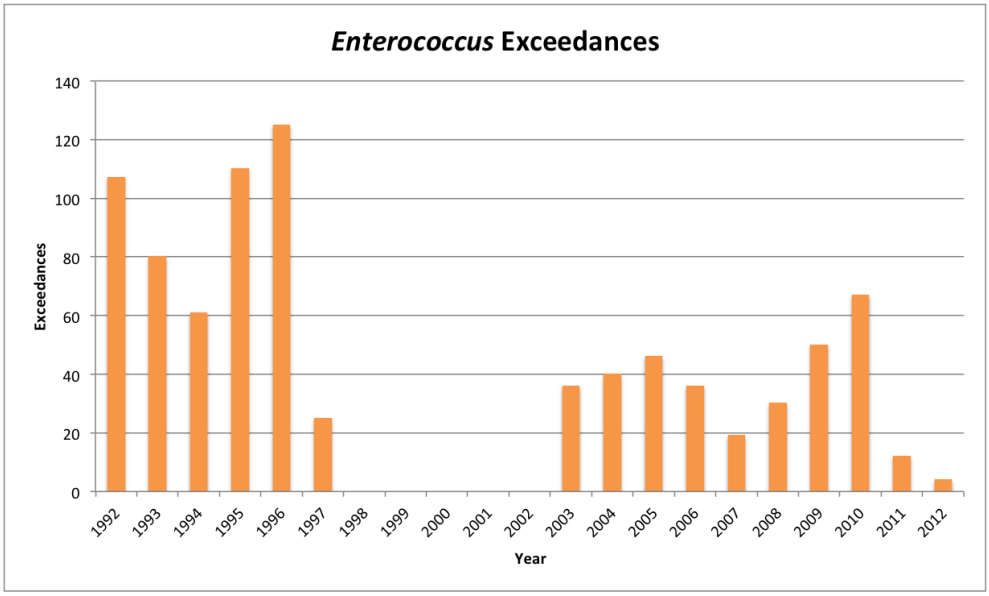

Figure 14: *Enterococcus* Exceedances.
Annual number of times that California water contact recreation standards for *Enterococcus* were exceed within each year. (Data: SFPUC).

We conclude that the coastal component of San Francisco's combined sewer discharge does not constitute a barrier to the proposed sanctuary expansion. Our analysis strongly suggests that the west side CSS's impacts on Exclusion Area water quality decreased following wastewater infrastructure updates completed in 1997. The statistically significant decrease in discrete CSD events supports this conclusion, as does the decrease in the proportion of samples that exceeded state water contact recreation standards for two of the three indicators.

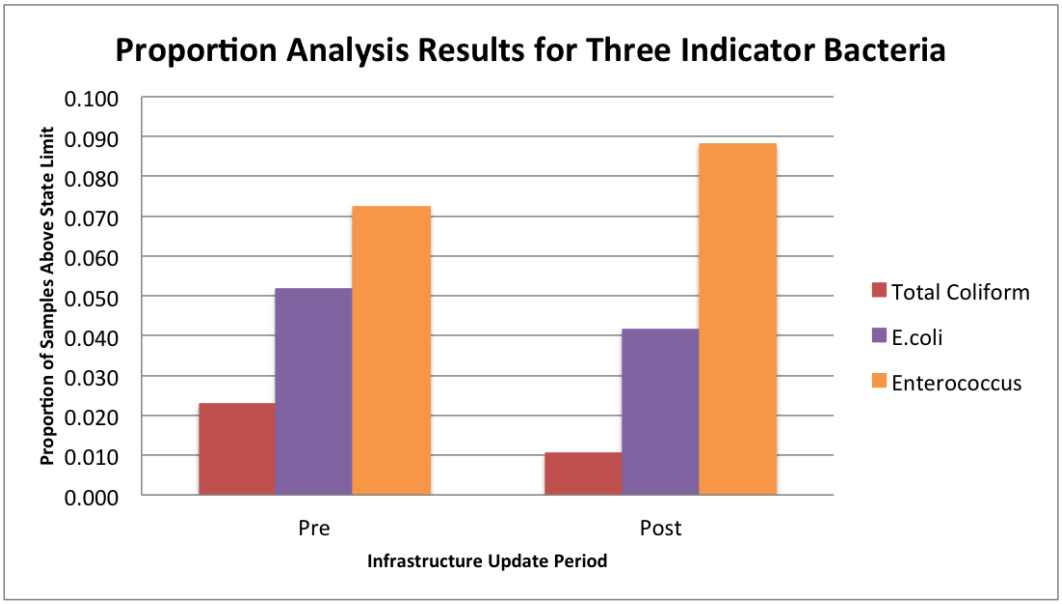

Figure 15: Proportion Analysis Results for Total Coliform, E.coli, & Enterococcus Indicators. Results showing the proportion of samples testing above state water contact recreation limits for pre- and post-infrastructure update periods. (Data: SFPUC).

Offshore Analysis

To determine the effects of SWOO discharge on the Exclusion Area's receiving environments, we reviewed findings from a meta-analysis of results from the SFPUC's offshore monitoring program. The agency's meta-analysis considered data from 1997 to 2008. Before 1997, the offshore monitoring program compared impacted outfall sites with only a single reference site, which was not sufficient to determine if observed differences between monitoring stations were caused by natural variability or SWOO impacts. Consequently, our analysis does not consider results from the offshore monitoring program that were collected before 1997.

The SFPUC's current (post-1997) study area corresponds closely to the Exclusion Area. The EPA's Environmental Monitoring and Assessment Program method (a random site selection process) was used to select 40 additional reference sites with similar hydrological and sedimentary environments to the SWOO outfall sites [61].

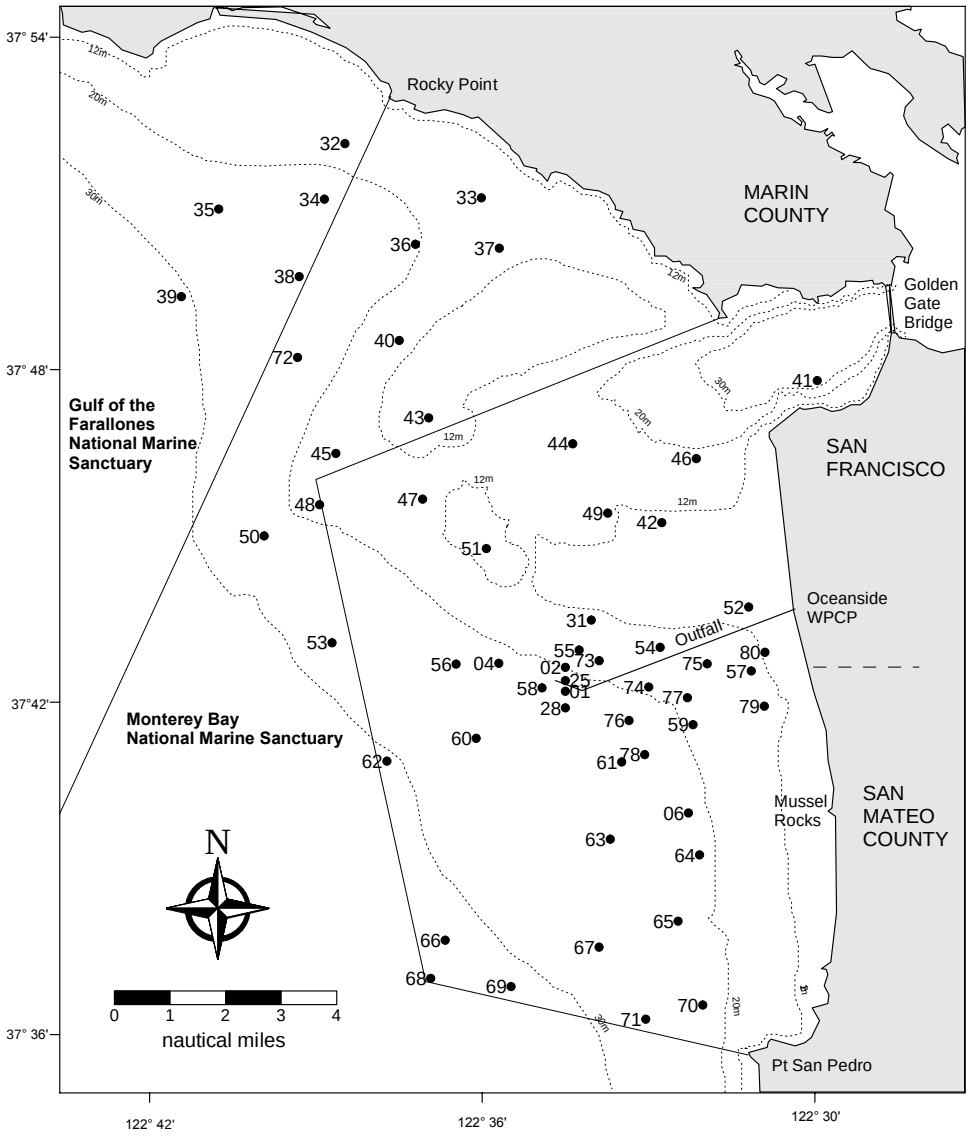

Figure 16: Offshore monitoring program sampling stations [40].

Sampling for the SFPUC offshore monitoring program was conducted during September or October to coincide with the Oceanic period of the California current season [40]. Four parameters were monitored by the SFPUC's offshore program: sediment quality, benthic infauna community structure, demersal fish and epibenthic community structure, and physical anomalies and bioaccumulation of contaminants in organism tissues. Observed differences between monitored parameters at outfall and references sites over the twelve-year study period were tested for statistical significance with multiple methods,

including Reference Envelop Analysis (REA) and a paired before-after-with-controls impact analysis (BACIP).[4]

The SFPUC's offshore monitoring program has found no significant negative impact on receiving waters for the Oceanside WPCP's treated wastewater effluent relative to reference sites in the Exclusion Area and adjacent National Marine Sanctuaries. These results extend across all four biological and ecological parameters evaluated by the SFPUC. The findings summarized below were generated as part of the SFPUC's analysis of data obtained through the offshore monitoring between 1997 to 2008, as reported to the EPA in 2010 [40]. A detailed discussion of the offshore monitoring program's methods can be found in Appendix C.

Sediment Grain Size and Quality

The SWOO has not had a significant impact on sediment characteristics and quality in the receiving environment. A comparison of sediment grain size across reference and outfall sites indicated a statistically significant difference. However, the difference was in the opposite direction of the expected impacts. Sediment grain size tends to decrease at offshore discharge points due to the fine particulates in wastewater, but the receiving environment of the SWOO has seen an increase in grain size over the study period. The SFPUC determined that the SWOO has not had a significant impact on sediment grain size based on these observations, since the increase in grain size cannot be explained by the discharge of fine particulates in wastewater from the SWOO. It is likely that the increase in sediment grain size is the result of oceanographic phenomenon and human-use activities (i.e. littoral cell transport and near-by dredge material deposition, respectively). Monitoring of sediments also revealed no significant changes in pollutant loading or contaminant concentrations at outfall sites relative to reference sites [40]. Tolerance bounds calculated in the SFPUC's Reference-Envelope Analysis were exceeded at outfall stations with the same or lower frequency as reference sites in the study region [40]. Weekly testing of the Oceanside WPCP's treated wastewater effluent that is discharged into the Exclusion Area has also yielded no results above NPDES standards for priority pollutants over the twelve-year study period.

Benthic Infauna Community Structure

Data collected following the introduction of secondary treatment is more similar across outfall and reference stations for benthic infauna measures than the data collected when discharge was only treated to the primary level. This suggests that the change to higher standards of treatment reduced impacts to receiving environments around the SWOO. An examination of long-term benthic infauna community data by Kellogg et al. (1998) found that seasonal and oceanographic factors significantly influenced infaunal community structure in the study area [62]. Trends observed in SFPUC monitoring data reflect these region-wide effects of climatic and oceanographic phenomenon such as the El Niño-Southern Oscillation [40]. Although higher levels of benthic infauna abundance at outfall stations was observed in some years, a persistent trend of elevated abundance was not observed. Statistical analysis

[4] Readers seeking detailed methods and complete findings from the SFPUC's current offshore monitoring program should review the *Southwest Ocean Outfall Regional Monitoring Program: Twelve Year Summary Report*.

of benthic infauna community structure revealed insignificant differences across outfall and reference sites for pre- and post-discharge periods [40]. Benthic infauna community characteristics around the SWOO did not fit the Pearson/Rosenberg model in “a classical sense” according to the SFPUC [40]. The SFPUC concluded that the observed community characteristics at the outfall stations were not different from those at the reference stations and that the effects were smaller than has typically been observed for offshore outfalls. The agency concludes that the diminished magnitude was a product of high energy tidal regime in the SWOO’s receiving waters, relatively low volumes of discharge, and the higher level of treatment at Oceanside WPCP [40].

Epibenthic and Demersal Fish Community Structure

Epibenthic and demersal fish community structure fluctuated at monitored stations over the study period. No discernable pattern was found that would indicate an effect from wastewater discharge along the SWOO. The analysis measured community parameters including number of species, log of abundance, Shannon-Weiner Diversity, and Pielou's Evenness [40]. Reference Envelope Analysis was used to determine patterns in differences of community parameters between outfall and reference sample stations. Some community metrics results for both demersal fish and epibenthic invertebrates at the outfall stations occasionally fell above or below the reference envelope and, more rarely, metrics at reference stations exceeded the reference envelope [40]. There are no apparent long-term trends in the differences between reference and outfall stations. These data are justifiably interpreted by the SPFUC monitoring program to indicate that there is no consistent difference between communities at outfall and reference stations. As with analysis of benthic infauna, results of the SFPUC's BACIP analysis indicates there is no statistical difference in community parameters between the two time periods, implying that the SWOO discharge does not have an effect on these species assemblages [40].

Physical Anomalies and Bioaccumulation of Contaminants

Discharge from the SWOO did not affect environmentally significant bioaccumulation of contaminants or the prevalence of physical anomalies. Physical anomalies observed in English sole and Dungeness crabs were not significantly different across reference and outfall sites. Adult Dungeness crab were examined for black necrotic disease, or shell disease syndrome, while English sole were examined for abnormal growths such as tumors [40]. Significant bioaccumulation for some contaminants was observed in the tissue of tested specimens over the study period, but the high bioaccumulation of contaminants was observed at both reference and outfalls sites. English sole (*Pleuronectes vetulus*) and Dungeness crab (*Metacarcinus magister*) were the primary species collected for sampling. Organic and inorganic contaminants were considered. SFPUC bioaccumulation testing screened for three DDTs, 18 PAHs, and 53 PCBs. The SFPUC made clear that bioaccumulation data from their offshore monitoring program likely reflected broader contaminant exposure for the entire study area, rather than site-specific exposure in outfall or reference areas. Both English sole and Dungeness crab are mobile, and gain substantial biomass in estuarine habitats (which are common within San Francisco Bay) during their larval stages of development. As a result, it is possible that the contaminants detected through testing were accumulated in areas outside of the study region.

Implications of Offshore Findings

While it is not clear if offshore environmental impacts from the SWOO have decreased over the last decade, the SFPUC's offshore monitoring program clearly indicates that the effects of wastewater discharge from the SWOO have not significantly impacted the Exclusion Area. This conclusion is based on twelve years of findings from the SFPUC's extensive offshore monitoring program, which have been reviewed by the U.S. EPA and the State Water Resources Control Board of California.

The introduction of secondary treatment one year after the designation of MBNMS is significant, given the large difference in quality between primary and secondary treated wastewater effluent. Primary treatment is limited to separation of solids and floatables from wastewater, and is not effective at removing finer particulate or dissolved matter [63]. Secondary treatment uses biological processes to remove the fine suspended solids that primary treatment processes do not capture. This second treatment step is responsible for reducing biologically available carbon substrates, pathogens, and excess nutrients in wastewater [63]. The release of wastewater with higher concentrations of excess nutrients into marine environments is a major cause of eutrophication, which can create anoxic dead zones in marine environments through a cascade of physical and biological events that cause a spike in biological oxygen demand [63]. By implementing secondary treatment at the Oceanside WPCP in 1993, the SFPUC effectively reduced the likelihood of eutrophication and other adverse impacts in the Exclusion Area.

Table 6: Summary of Results for Coastal Analysis and Offshore Monitoring Program Review.

Parameter	Measurement	Change from 1992-present
Discrete CSD events	Number per year	Decrease
Total Coliform State Standard Exceedances	Number per year	Decrease
	Proportion across pre- and post-periods	Decrease (Statistically significant)
E.coli State Standard Exceedances	Number per year	Decrease
	Proportion across pre- and post-period	Decrease (Statistically significant)
Enterococcus State Standard Exceedances	Number per year	Decrease
	Proportion across pre- and post-period	Increase (Statistically significant)
Sediment Grain Size and Quality	Multiple analyses	No significant impact
Benthic Infauna Community Structure	Multiple analyses	No significant impact
Epibenthic and Demersal Fish Community Structure	Multiple analyses	No significant impact
Physical Anomalies and Bioaccumulation of Contaminants	Multiple analyses	No significant impact

Discussion

The findings from our coastal analysis and the SFPUC's offshore monitoring program indicate that the combined sewer discharge for the City & County of San Francisco is not currently a significant source of ecological or environmental impacts to the Exclusion Area, and does not constitute a barrier to the proposed sanctuary expansion. The results from our coastal and offshore water quality analyses support this conclusion.

Including WPCP ocean outfalls in National Marine Sanctuaries is not without precedent. A number of treatment plants currently exist within MBNMS, some of which were present at the time of the sanctuary's original designation. Table 7 provides a summary of wastewater treatment plants in the Exclusion Area and MBNMS to illustrate this point.

Table 7: WPCPs with Point Source Discharges into the Exclusion Area or MBNMS (2005) [64]**.**

Location	WPCP	Average Total Suspended Solids *(lbs/day)*	Average discharge *(MGD)*	Treatment level	Distance from shore *(miles)*	Depth *(feet)*
Exclusion Area	San Francisco (west side)	1,6470.78 (Data from 2002)	16.97	Secondary (flows < 43 MGD) & primary (flows > 43 MGD)	3.5	78
Exclusion Area	North San Mateo County Sanitation District	414.38	3.12	Undisinfected secondary	0.47	32
MBNMS*	Half Moon Bay	201.67	2.19	Secondary with chlorination and dechlorination	0.36	37
MBNMS*	Santa Cruz	371.03	11.38	Secondary with UV disinfection	1	110
MBNMS*	Watsonville	529.36	7.63	Secondary with chlorination and dechlorination	1.39	64
MBNMS*	Monterey Regional	1,114.53	10.71	Undisinfected secondary	2.13	100
MBNMS*	Carmel Area	58.07	1.95	Secondary	0.11	35
MBNMS	Ragged Point Inn	0.61	0.01	Secondary with disinfection	0	0
MBNMS	San Simeon	6.11	0.07	Secondary with chlorination and dechlorination	0.17	20

* = existed during original 1992 designation of MBNMS

Recommendations

Due to the lack of identified impacts from their current discharges and the expense of reducing wet weather discharges of primary treated flows, we feel that GFNMS should exempt the west side's Water Pollution Control System from the primary discharge prohibitions of Section 922.132(f). An exemption under the provision of Section 922.132(f) is possible because the EPA permitted point source discharges from the Oceanside WPCP prior to January 1, 1993.

The SFPUC has indicated that further reducing the annual number of CSDs into marine waters is likely to be cost prohibitive for the City & County of San Francisco. SFPUC staff provided cost estimates for reducing the annual number of CSD events below the current average (7 discrete discharges per year). Table 8 provides a breakdown of the cost estimates and the required increase in treatment capacity for these reductions.

Table 8: Project Costs and Treatment Capacity Increases for Further CSD Reductions [65]**.**

Reduction in Discrete CSD Events	Discrete CSD Events per Year	Cost [millions of U.S. dollars]	Required Treatment Capacity Increase
3	4	$196	70 MGD
4	3	$277	100 MGD
7	0	$534	200 MGD

Decreasing the number of discrete CSD events would further reduce near-shore discharges of partially treated wet weather flows, while increasing the volume of treated wastewater discharged from the SWOO. Previous analyses of the costs and feasibility of increasing storage and/or secondary treatment capacity found these options extremely cost-prohibitive and technically challenging.

These projected costs cover only construction, and do not incorporate fixed costs related to necessary land acquisition, or increases in variable costs related to operation and maintenance [66]. These additional costs are unaccounted for in estimates provided by the SFPUC and could be significant. In the event that new infrastructure cannot be built on existing SFPUC land, additional financial outlays could be required to purchase or lease new property. Assuming that operating the new treatment infrastructure would only be necessary during wet weather events, the annual variable costs of operation could be small relative to the projected costs of construction and land acquisition. However, the energy inputs needed to pump an additional 70 to 200 MGD of wastewater for discharge along the SWOO during wet weather periods could be significantly larger than the energy inputs needed under the current system, and may significantly increase variable costs and air emissions for the agency in winter months [63].

Additional exemptions or exceptions with regard to seafloor regulations may be necessary to allow for maintenance of the SWOO. The Ocean Beach Master Plan clearly indicates that placing dredged material at the proposed SF-17 site has important implications for the maintenance and protection of coastal wastewater infrastructure along Ocean Beach [67]. Portions of this coastal stretch are undergoing extensive coastal erosion, which is a threat to the baffled box infrastructure underneath the Great Highway. These baffled boxes provide storage and transport for wastewater destined for treatment at the Oceanside WPCP. During wet weather events, wastewater flows can be pushed above the CSS's storage capacity. Outfall structures along Ocean Beach serve as discharge points for the excess wastewater when capacity is exceeded. The storage and transport infrastructure is important for

ensuring public health along the city's west side, given that discharging excess wastewater from outfall structures prevents system overflows into the streets and tenements of San Francisco.

Reusing dredged materials may be necessary but not sufficient to protect SFPUC infrastructure along Ocean Beach. Additional protections such as artificial reefs, revetments, and coastal armoring may be necessary to effectively protect SFPUC infrastructure along Ocean Beach [65], [67]. We recommend that the SFPUC and GFNMS engage in joint development of regulations and management approaches. Collaboration between the two agencies will promote a balance between the protection of valuable marine resources and the provision of water pollution control services in the region [67].

Vessel Traffic

Introduction

San Francisco Bay's Main Shipping Channel (MSC) is located in the northern region of the Exclusion Area and contains all vessel traffic that enters or exits San Francisco Bay. In 1992, the presence of the MSC was cited as one of three reasons for omitting the Exclusion Area from MBNMS. An analysis of vessel traffic in the Exclusion Area and existing National Marine Sanctuaries indicates that the current level of vessel traffic in the MSC is not a barrier to the proposed expansion. However, existing National Marine Sanctuary regulations on vessel discharges may impact the effectiveness of the 2012 California No Discharge Zone regulations. We therefore recommend that the Sanctuary work closely with the Environmental Protection Agency (EPA) to reconcile discharge regulations for the Area to allow for critical human uses of the Exclusion Area and supplement California water quality management.

Main Shipping Channel Characteristics

The MSC is part of San Francisco Bay's Traffic Separation Scheme (TSS), which is part of a larger network of vessel traffic lanes created by the International Maritime Organization (IMO) to mitigate the risk of vessel collisions and groundings. The IMO works jointly with the U.S. Coast Guard to implement TSS routes in the United States. Between 2008 and 2010, the MSC averaged 7,390 transits for commercial shipping vessels over 300 gross registered tons. This equates to an average of 3,695 arrivals to ports within the San Francisco Bay for this class of vessel [68]. Table 9 gives average vessel characteristics for arriving vessels.

Table 9: Average Vessel Traffic Characteristics for San Francisco Bay for 2008-2010 [68].

Vessel Type	Average Speed [knots]	Number of Arrivals to SF Bay	Pct. Of Total Vessel Traffic
Bulkers & Tankers	13-16	1,103	30
Container, Car Carrier, & Cruise Ships	18-26	2,115	57
Tug & Barge	8-12	477	13

Vessel Traffic Routes and National Marine Sanctuaries

The presence of vessel traffic lanes in numerous National Marine Sanctuaries demonstrates that the MSC alone is not sufficient for precluding the incorporation of the Exclusion Area into MBNMS [69–71]. Major marine traffic lanes traverse several existing National Marine Sanctuaries, including Stellwagen Bank National Marine Sanctuary (SBNMS), Channel Islands National Marine Sanctuary (CINMS), Cordell Bank National Marine Sanctuary (CBNMS), GFNMS, and MBNMS. Several of these sanctuaries had TSSs within their boundaries prior to being designated under the NMSA. Shipping lanes providing access to

and from the Boston Harbor run through SBNMS, and the MSC for San Francisco Bay has comparable levels of vessel traffic to CINMS [26]. An estimated 5,725 transits of CINMS were made by commercial vessels over a one-year period between July 1, 2008 and June 30, 2009 [72].

Vessel Traffic in MBNMS and Surrounding Sanctuaries

MBNMS contains the fan-out point for the MSC and therefore receives the same amount of vessel traffic as the Exclusion Area. The fan-out point in MBNMS is technically a part of the MSC, demonstrating that the MSC's presence in the Exclusion Area is not a valid barrier to National Marine Sanctuary designation. Additionally, there are three vessel traffic routes that emanate from the MSC's fan-out point - all of which run through existing sanctuaries along California's North Central Coast. The westward and northward routes stemming from the fan-out point traverse GFNMS and CBNMS respectively. The southward route traverses MBNMS. The current location of the fan-out point means every commercial shipping vessel passing through the Exclusion Area also passes through MBNMS, and may pass through other existing sanctuaries along California's North Central Coast (depending on the vessel traffic route used).

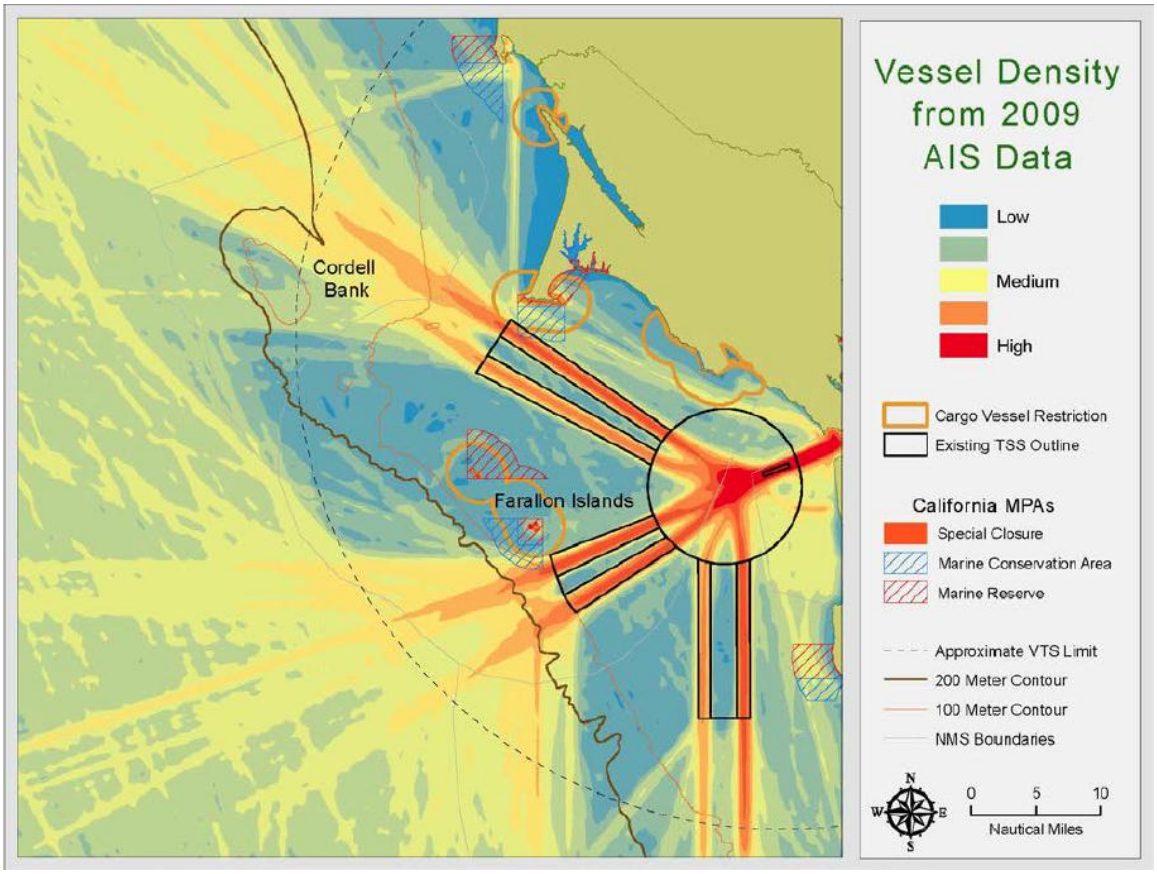

Figure 15: 2009 vessel density at the entrance to the San Francisco Bay [68]**.**

CARB Low-Sulfur Fuel Rule

Although vessel traffic along the MSC has not changed significantly since the 1992 designation of MBNMS, low-sulfur fuel rules for ocean-going vessels enacted by the California Air Resource Board (CARB) have decreased nearby vessel traffic along the southward shipping lane. This decrease in vessel traffic may have reduced acoustic impacts and criteria pollutant air emissions to the Exclusion Area.

CARB enacted its low-sulfur fuel rule for ocean-going vessels on June 28, 2009 [73]. These regulations required all ocean-going vessels transiting within 24 nautical miles (nm) of the California coast to burn fuels with a sulfur content of no more than 0.5% [74]. Vessel traffic densities in the three TSS lanes that emanate from the MSC have changed in response to CARB's low-sulfur regulations and the price differential fuels with low-sulfur content [68].[5] By using westward lanes, vessel operators can reduce costs by combusting conventional bunker fuels once they are outside of the 24 nm low-sulfur fuel zone. These cost-savings on fuel cannot be achieved in the northward and southward lanes, since they remain within the 24 nm limit. Consequently, vessel traffic has increased in the westward lane that takes ships further away from the California coast (Table 10). This has coincided with a decrease in vessel traffic traveling along the southbound lane that runs through MBNMS and is adjacent to the Exclusion Area.

Table 10: Vessel traffic patterns in lanes outside of the entrance to San Francisco Bay before and after implementation of CARB's low-sulfur fuel rules [68]**.**

	Pre-CARB Low Sulfur Fuel Rule			Post-CARB Low Sulfur Fuel Rule		
Lane	**Pct. Traffic in Lane**	**Vessels per Month**	**Vessels per Day**	**Pct. Traffic in Lane**	**Vessels per Month**	**Vessels per Day**
South	36%	220	7	26%	159	5
West	35%	214	7	50%	307	10
North	29%	178	6	24%	147	5

Whether this decrease in vessel traffic along the southward lane will persist is uncertain. This uncertainty is due to the dynamic cost structure of the shipping industry and CARB's recent changes to its low-sulfur fuel rule.

Interactions with the California No Discharge Zone

The California No Discharge Zone (NDZ) was established in 2012 under Section 312(f)(4)(A) of the Clean Water Act [75]. The NDZ regulation prohibits the discharge of treated or untreated sewage from vessels over 300 gross registered tons within three miles of the California coast [76]. However, vessels that enter the NDZ with an empty holding tank can discharge treated sewage if their holding tank becomes full while traveling through the NDZ. MBNNS regulation 922.132(a)(2)(b) is similar to California's NDZ, as

[5] The price per ton of low-sulfur marine oils is significantly higher than the conventional bunker oils burned by ocean-going vessels [72].

it prohibits the discharge of treated or untreated sewage from vessels over 300 gross registered tons within sanctuary boundaries but allows discharge of treated sewage if the vessel lacks sufficient holding tank capacity. The EPA has communicated concerns about the Exclusion Area's incorporation into MBNMS, stating that existing sanctuary regulations of vessel discharges could undermine the effectiveness of NDZ regulations.

The portion of the Exclusion Area outside state waters (3 miles from the coastline) is currently the only unregulated area where vessels can discharge their treated sewage after entering CBNMS from the north, MBNMS from the south, and GFNMS from the west, as they approach San Francisco Bay [76]. Therefore, if the Exclusion Area were incorporated into MBNMS, vessels could lose the last chance to discharge treated sewage between the outer boundary of the group of sanctuaries and the NDZ. Because the collective size of CBNMS, GFNMS, MBNMS, the Exclusion Area, and the San Francisco Bay is so large, vessels may accumulate so much sewage that they would exceed their capacities. Without any recourse, the vessels might be forced to violate regulations and discharge in either NDZ or sanctuary waters. This limitation would reduce the effectiveness of California's NDZ regulations.

We recommend the Sanctuary work with the EPA to evaluate if (and how) applying National Marine Sanctuary regulations of vessel discharge to the Exclusion Area may impact the effectiveness of the NDZ. Key questions to answer include:

1. How many vessels would be able to comply with both the National Marine Sanctuary regulations and the NDZ regulation if the Exclusion Area is incorporated in MBNMS?
2. Would vessels be more likely to discharge in the sanctuaries or within the NDZ if they do not have access to the Exclusion Area for permitted discharge?
3. Is the Exclusion Area the most appropriate location for vessel discharges or is there another area that may be more appropriate if exceptions to the prohibitions under existing regulations were made?

If it is determined that there would be significant impacts to the quality of California waters and the effectiveness of the NDZ, the Sanctuary could potentially alter regulations to exempt vessels from discharge prohibitions within the Sanctuary (wherever is deemed least impactful) that would promote the effectiveness of NDZ regulations. If there is a significant impact to the effectiveness of the NDZ, restructuring the regulations would facilitate comprehensive and coordinated management of vessel discharge off the California coast. Due to the Sanctuary's ability to alter regulations, we do not believe the interaction of National Marine Sanctuary regulations and the NDZ regulation presents a barrier to the proposed expansion. However, GFNMS needs to meet with the EPA to develop a coordinated interagency approach that will address the regulatory complexities if the proposed expansion moves forward.

Conclusions

The MSC's presence in the Exclusion Area does not present a barrier to the proposed sanctuary expansion. There are numerous examples of other sanctuaries that were designated with existing TSSs in their boundaries, and current levels of vessel traffic are similar in existing sanctuaries. While National

Marine Sanctuary prohibitions on vessel discharge have the potential to negatively impact the effectiveness of the California NDZ regulations, coordinated management between the Sanctuary and the EPA would limit the adverse effects of this regulatory interaction. Consequently, our analysis supports the conclusion that the presence of the MSC is not a valid reason for omitting the Exclusion Area from MBNMS, and that vessel traffic does not currently present a barrier to the proposed expansion.

Ecological Significance

Introduction

According to the National Marine Sanctuaries Act (NMSA), a candidate site can become a sanctuary if one of several characteristics is deemed "nationally significant." One of these characteristics is the ecological significance of the area. The purpose of this chapter is to identify the Exclusion Area's ecological qualities, and determine if those qualities should be considered "nationally significant" under the NMSA.

The San Francisco-Pacifica Exclusion Area's oceanographic qualities, connectivity with the San Francisco Bay and surrounding sanctuaries, proximity to major urban areas, and use by important species indicate that it has "special national significance." Our findings regarding these qualities meet many of the emergent sanctuary designation criteria we developed to describe "significance" as commonly applied to sanctuary designation and expansion. They also fit the NMSA's specific criteria for ecological significance. The Exclusion Area therefore has nationally significant ecological qualities and warrants Sanctuary designation.

Methods

No comprehensive list of species or habitats exists which focuses solely on the Exclusion Area. Therefore, an ecological and biological portrait of the Area was compiled by consulting various reports and sources on the nearshore marine environment of north central California and the surrounding sanctuaries, and extrapolating for the Exclusion Area. In some cases, it was difficult to determine whether the resources mentioned occur in the Exclusion Area specifically or in the surrounding waters generally, but attempts were made to clarify wherever possible.

Sources

The Regional Profile of the north central coast study region (from Alder Creek near Point Arena in Mendocino to Pigeon Point in San Mateo County) was created by the California Marine Life Protection Act (MLPA) Initiative in 2007. It provides background information on the biological, oceanographic, socioeconomic, and governance setting for the region. It was created to provide support to stakeholders and policy-makers during the Marine Protected Area planning process. The Exclusion Area covers about half of Subregion 4 of the North Central Coast Study Region, which extends from Double Point in Marin County to Point San Pedro in San Mateo County [77].

The Environmental Sensitivity Index (ESI) for Central California (from Point Reyes National Seashore to Point Conception in Santa Barbara County) was created by NOAA in 2006. The ESI identifies sensitive resources at risk during oil spills, and provides spatial information about shoreline types, sensitive biological resources, and human-use resources. Two of the maps from the ESI (maps 35 and 36) almost exactly overlay the Exclusion Area [78].

The report “A Biogeographic Assessment off North/Central California in Support of the Cordell Bank, Gulf of the Farallones and Monterey Bay National Marine Sanctuaries” (BGA) was conducted to support the management plans for these three sanctuaries. Phase I was conducted from 2001-2004 and Phase II was completed in 2008. The report identifies biological and environmental data and describes the ecological setting of the north central California coast. The Exclusion Area covers the entirety of one cell on the maps produced by the report, and is not specifically discussed in the report independently of the surrounding region [24].

Other sources of information include interviews with scientists in the area, published scientific articles, and various government documents and websites.

Oceanographic Characteristics

This section explores the oceanographic characteristics of the Exclusion Area that might contribute to its standing as “nationally significant.” The entire central California coastline, including the San Francisco-Pacifica Exclusion Area, shares certain key oceanographic characteristics, including three distinct oceanographic periods. Surface currents and the degree of upwelling or downwelling distinguish these periods [24]. The Exclusion Area lies within the zone of highest chlorophyll concentration along the California coast (Figure 17) [79].

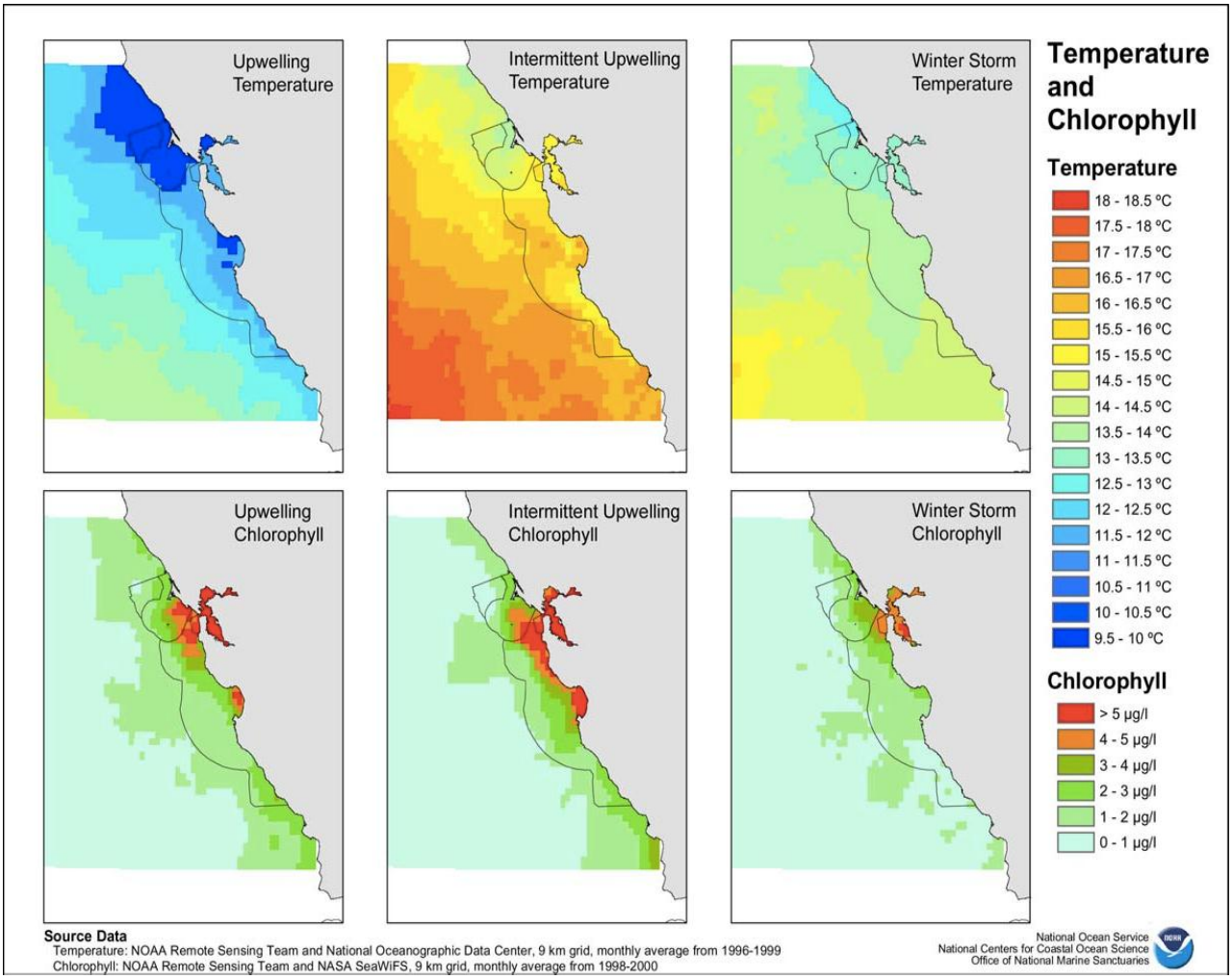

Figure 17: Seasonal sea surface temperature and chlorophyll.
These maps were developed summarizing monthly averages for temperature (1996 – 1999) and chlorophyll (1998 – 2000) in a 9 km grid. Maps are representative of upwelling, intermittent upwelling and winter storm periods [79].

The first oceanographic season occurs from early spring to summer. During this time, strong northwest winds occur along the California coast, driving the south-flowing California Current. The Coriolis force causes Ekman transport of warm surface waters offshore and south, pulling cold, nutrient-rich water toward the surface. The intensity of this upwelling varies throughout the season, but upwelling episodes usually occur in 7-10 day periods punctuated by brief periods of diminished upwelling, or relaxation [79]. Upwelling of nutrient-rich water supports particularly large concentrations of plankton because the water carries a high amount of suspended micronutrients, which are typically the limiting factors of primary production. Consequently, the area supports blooms of various types of phytoplankton, including the larvae of a variety of species. High phytoplankton productivity supports growth at all levels of the food web, thus fostering general biological abundance [79]. During upwelling, coastal plumes and jets can play an important role in connecting coastal waters such as the Exclusion Area to offshore environments by transporting water, phytoplankton, and nutrients offshore [24].

The second season usually occurs from late summer to early fall. It is defined as a period of wind relaxation, which causes upwelling to diminish [24]. At the start of this season, wind relaxation may occur in 2-6 day periods, alternating with periods of upwelling. Typically, periods of relaxation increase in frequency as the summer months progress, eventually becoming dominant by fall. As a result of diminished upwelling, a barotropic pressure gradient causes offshore waters to move inshore, and surface waters warm as they are heated by sunlight [79]. This movement causes some larvae, which were previously transported offshore, to return to inshore waters and settle in coastal habitats. This movement of larvae is one of the ways the Exclusion Area is connected to the waters further offshore in Gulf of the Farallones, Monterey Bay, and Cordell Bank National Marine Sanctuaries [79].

By late fall and early winter, the storm season (or Davidson current period) begins. This oceanographic season typically lasts until early spring. Low-pressure systems near the southern region of the Gulf of Alaska generate southerly winds and large waves along the central Californian coastline [79]. Southerly winds depress upwelling and allow the north-flowing Davidson Current, which flows deep beneath surface waters in the rest of the year, to rise to the surface.

The region's three oceanographic phases are some of the key drivers of local biological processes. California's upwelling zone is one of only four temperate upwelling systems in the world. Its high biological abundance has been a major factor in the designation of conservation areas such as the Farallon Island Reserve, GFNMS, and MBNMS [77]. The Exclusion Area covers an important region of the upwelling zone, which contributes to the density and diversity of marine life in the surrounding sanctuaries.

Another important oceanographic process that connects the Exclusion Area to the surrounding regions is nutrient outflow from the San Francisco Bay. All of northern California's large watersheds drain into the San Francisco Bay, creating a rich nutrient outflow at the mouth of the Bay called the San Francisco Bay plume. These nutrients play an important role in maintaining the productivity of the area when upwelling slows in the winter (Figure 18) [80]. The San Francisco Bay plume can extend miles offshore, traversing through the Exclusion Area and bending either northward or southward depending on the time of year. During the winter, the plume tends to flow north along the shoreline, and in the summer it tends to flow south and west, reaching further offshore. Like the nutrients and phytoplankton that result from upwelling, plume nutrients and phytoplankton blooms are advected offshore by eddies and jets in the ocean currents, nourishing the extensive offshore ecosystems in the region [24]. Connectivity between the mouth of the San Francisco Bay and other offshore areas means that conditions in the Exclusion Area have the potential to affect the surrounding areas, including GFNMS, CBNMS, and MBNMS.

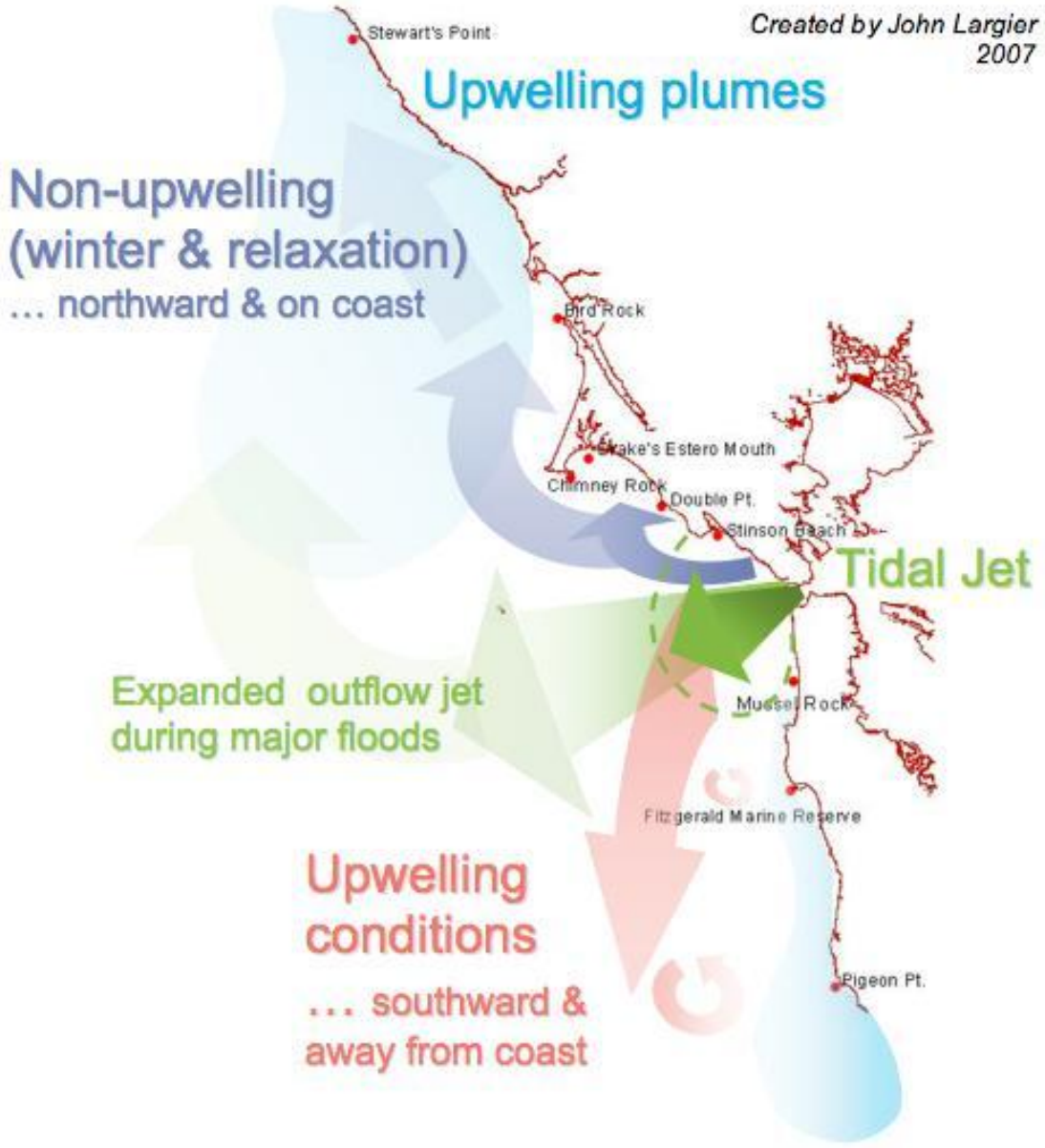

Figure 18: Upwelling patterns and the San Francisco Bay tidal plume.
During upwelling, the tidal plume extends southward and away from the coast. During relaxation, it travels northward along the coast [81].

The Exclusion Area is located on one of the broadest sections of continental shelf along the West Coast of the United States, and this bathymetry directly influences the biology of the area. The broad shelf is mostly sandy and relatively shallow (<120 meters) with interspersed rocky substrate habitats [77]. Nutrients from both coastal upwelling and the San Francisco Bay plume influence the local ecosystems. These processes contribute to important habitat and forage for seabirds, marine mammals, sea turtles, invertebrates, and fish. The highly productive waters around the nearby Farallon Islands support many

species of top predators, including one of the world's largest congregations of white sharks and California's largest concentration of harbor seals [77]. In addition, the mouth of San Francisco Bay is an important migratory corridor for many other species that use the Bay as a migration route or nursery ground [77].

Habitat Types

The shoreline of the Exclusion Area consists predominantly of fine-to-medium grained sand beaches. Other habitat types interspersed throughout include coarse-grained sand beaches, gravel beaches, mixed sand and gravel beaches, riprap, exposed rocky shores, exposed wave-cut platforms in bedrock, and exposed man-made structures [78]. The offshore region of the Exclusion Area lies entirely within the shallow continental shelf, with mostly sandy soft-bottoms and some hard-bottom rocky substrate, similar to much of the central California nearshore environments [77]. Such sandy bottom habitats lack structural complexity and have typical community assemblages of bottom-dwelling invertebrates and fish. (See Appendix D for a map of coastal habitat types in the Exclusion Area.)

Important Species in the Area

This section details the species known to occur in the Exclusion Area that might contribute to its standing as a "nationally significant" region.

Birds

The Exclusion Area has high bird density and diversity relative to the surrounding coastal areas. The Biogeographic Assessment (BGA) concluded that

> "based on the available data, the boundaries of the National Marine Sanctuaries off north/central California generally encompass the areas of high concentrations and diversity for marine birds in the study area, except for: 1) the western edge of the Gulf of Farallones area; 2) *the "sanctuary exclusion area", off San Francisco and 3) Pacifica, which is excluded from the Monterey Bay National Marine Sanctuary*" [24].

This information suggests that if the Exclusion Area were incorporated into MBNMS, the Sanctuary would encompass a more complete range of the bird populations that make the region significant.

The nearshore regions of the Exclusion Area are especially valuable to local marine birds. Many species of marine birds have short ranges and are highly dependent on nearshore food sources and habitat, especially while breeding [77]. The BGA revealed that the Exclusion Area is important habitat for several species of marine birds. The Area is especially crucial for those that breed within GFNMS and forage for food close to the coast. These species include western and Clark's grebes, the sooty and black-vented shearwater, white-winged and surf scoters, the brown pelican, two species of cormorants, six species of gulls, two species of terns, and the common murre [24]. The Exclusion Area is an important forage habitat for these birds, as it supports large populations of small forage fish.

There is an abundance of prey in the Exclusion Area due to the high productivity of the California current and numerous habitats suitable for nesting and roosting. The bathymetric and oceanographic features of the Area contribute to important foraging grounds for seabirds [77]. The Exclusion Area as a whole shows average-to-high marine bird density relative to the surrounding area encompassing GFNMS, CBNMS, and MBNMS, as well as high relative marine bird diversity (Figures 19-21) [77].

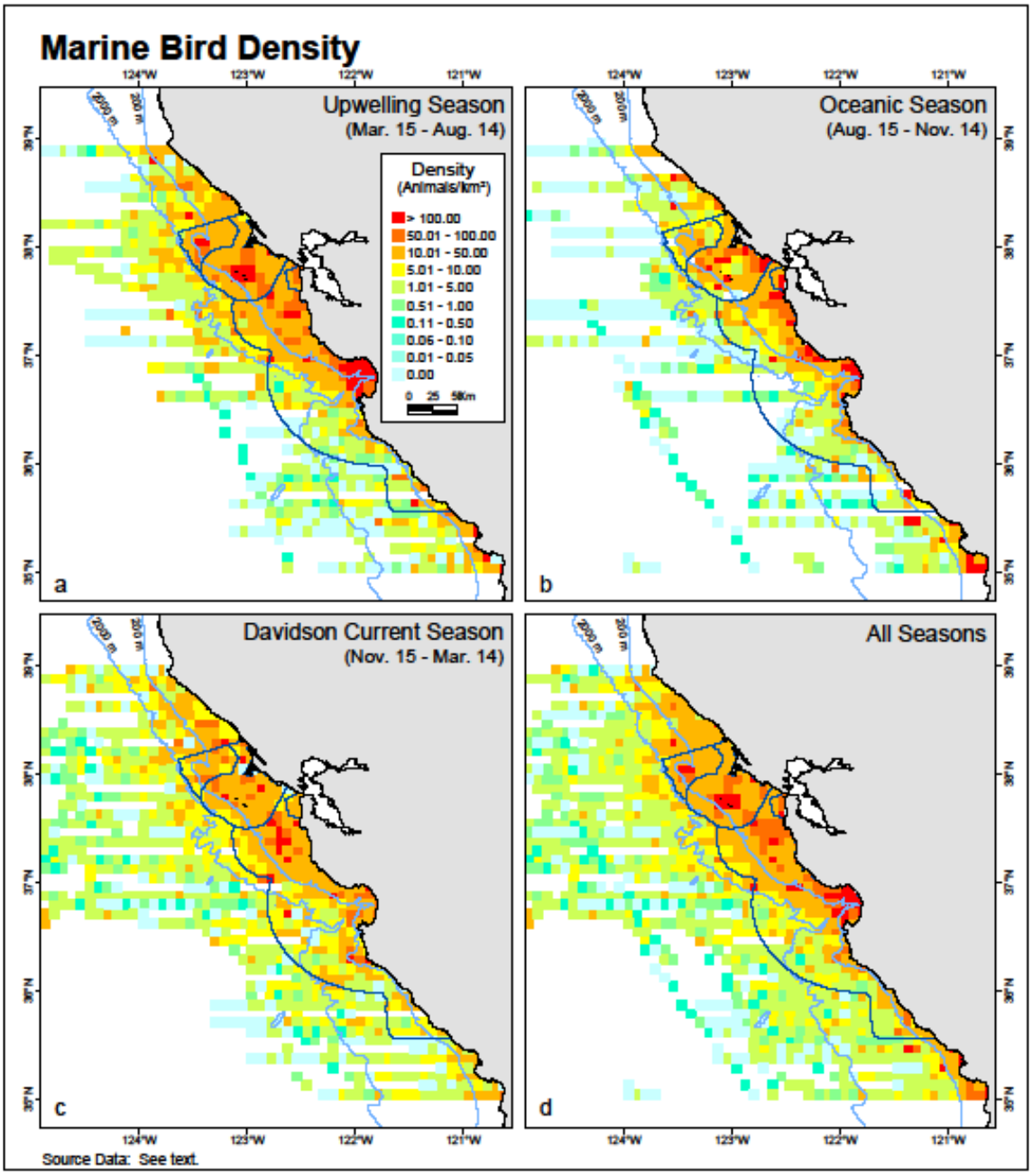

Figure 19: Marine Bird Density [24].

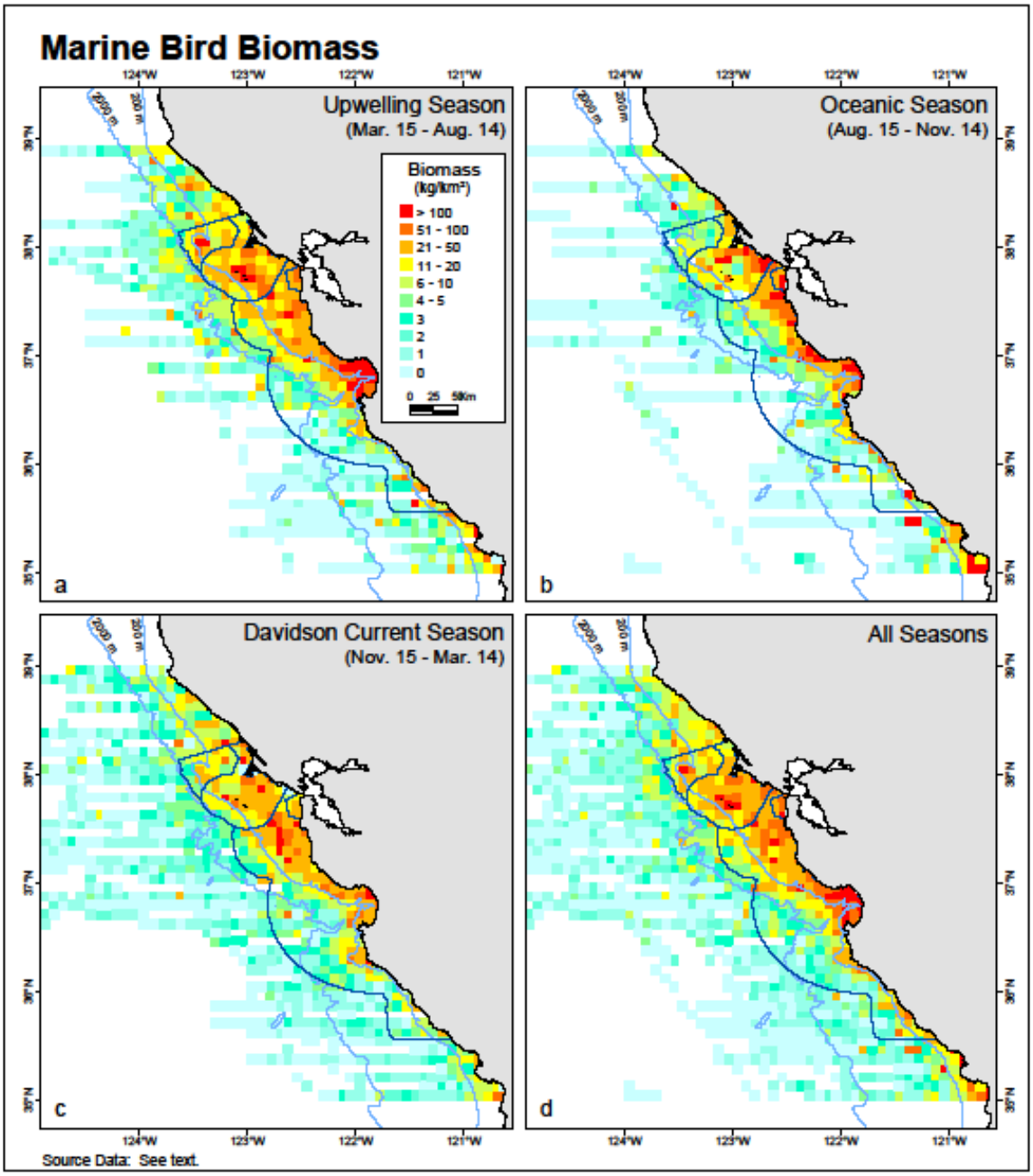

Figure 20: Marine Bird Biomass [24]**.**

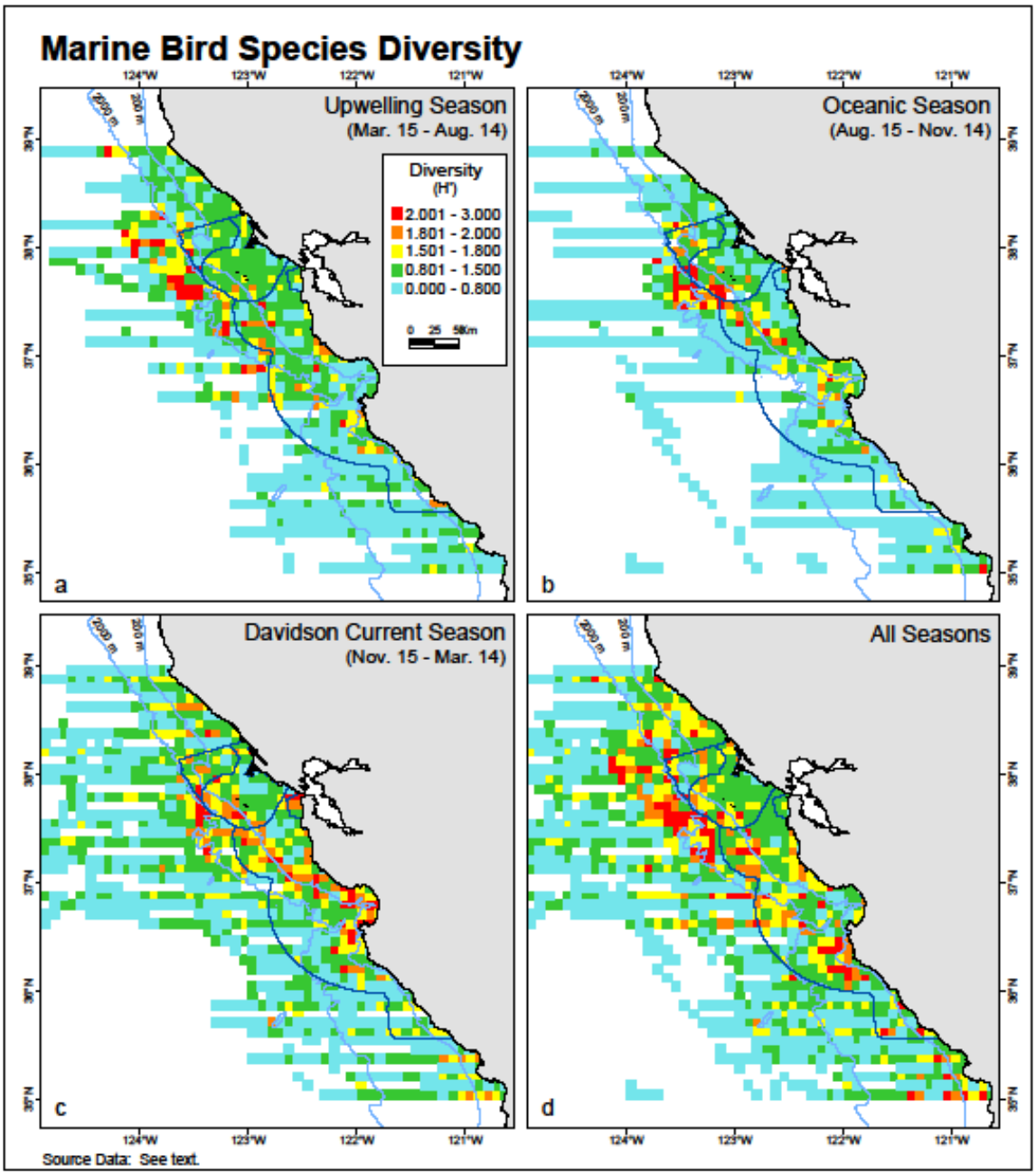

Figure 20: Marine Bird Species Diversity [24]**.**

The following birds are listed in the ESI as "common in coastal waters" *near or in* the Exclusion Area: Cassin's auklet; western, Clark's, eared, and horned grebes; common murre; cormorants; gulls; Pacific loon; phalaropes; pigeon guillemot; rhinoceros auklet; white-winged and surf scoters; marbled murrelet (federally threatened); and sooty shearwater [78]. Among these, species that are listed in other sources (BGA and/or Regional Profile) as occurring *in* the Exclusion Area are: western and Clark's grebes; sooty

and pink-footed shearwaters; white-winged and surf scoters; brown pelican; Brandt's, double-crested, and pelagic cormorants; Glaucous-winged, western, California, ring-billed, mew, and Heermann's gulls; Caspian/elegant and Forster's terns; common murre; and Pacific loon [24].

Birds occurring along the shoreline of the Exclusion Area include (but are not limited to): western snowy plover (federally threatened); brown pelican (endangered in California); black oystercatcher; Brandt's cormorant; pelagic cormorant; pigeon guillemot; western gull [78].

Many of the seabirds in the area aggregate into colonies, especially in breeding season. These colonies include: Brandt's cormorant at Lobos Rock and Land's End; pelagic cormorant and pigeon guillemot at Point Bonita; Brandt's cormorant and brown pelican roosting at Seal Rocks; nesting shorebirds and roosting pelicans at Point San Pedro; and seabirds that forage at the mouth of San Francisco Bay [77]. Other seabirds with colonies in the Exclusion Area include common murres, least tern, and black oystercatcher [77].

Grebes, loons, and scoters migrate through the area in high concentrations for most months of the year [78].

Marine mammals

Marine mammals are charismatic, readily identifiable, and easily seen from shore or from boats, thus garnering special significance with people. Many are endangered or threatened, giving them further status as important species. Their presence in the Exclusion Area lends higher value to the area in terms of significance.

The following marine mammals are listed in the ESI as "common in coastal waters" *near or in* the Exclusion Area: bottlenose dolphin, Dall's porpoise, fin whale (endangered), killer whale, long-beaked common dolphin, minke whale, northern right whale (endangered), Pacific white-sided dolphin, Risso's dolphin, sea lions, seals, Southern sea otter, short-beaked common dolphin, short-finned pilot whale, harbor porpoise, blue whale (endangered), humpback whale (endangered), and gray whale. Among these, species that are listed in other sources (BGA and/or Regional Profile) as occurring *in* the Exclusion Area include: bottlenose dolphin, Dall's porpoise, minke whale, harbor seal, southern sea otter, harbor porpoise, humpback whale, gray whale, and Steller sea lion [24], [77].

Nearshore, marine mammals present in the Area include California sea lion (concentrated at Mussel Rock) and harbor seal (concentrated at San Pedro Rock), with a high concentration of pinnipeds around Point Lobos [78]. There are no marine mammal rookeries in the Exclusion Area [80], but there are rookeries inside the San Francisco Bay. There have been numerous strandings of marine mammals on the beaches of the Area, including a dense-beaked whale, Hubbs' and Blainville's beaked whales, and a pilot whale, as well as many of the species already listed here [82], [83].

Southern sea otter (*Enhydra lutris nereis*)

Southern sea otters are listed as federally threatened under the Endangered Species Act (ESA). Hunting during the 18th and 19th centuries drastically reduced populations of sea otters. However, the species

has been recovering since the early 20th century. Their geographic range tends to fluctuate, and sightings in northern California have been increasing in recent years. The sea otter's officially recognized range is concentrated further south, but they do appear in the Exclusion Area occasionally, and have been sighted as far north as Point Reyes [77]. This occurrence outside of their normal range likely represents transient movements of individual animals, although their range has been increasing further north and south[24].

Cetaceans

Harbor porpoise (*Phocoena phocoena*), San Francisco-Russian River Stock

After being absent from San Francisco Bay for approximately 65 years, the harbor porpoise re-occupied habitat in San Francisco Bay and its adjacent entrance waters within the last several years. Historically, the harbor porpoise was common in the Bay, but disappeared after steel torpedo and submarine nets were placed across the entrance to the Bay during WWII and ship traffic increased. However, harbor porpoise sightings increased around 2007 and continue to occur in the Exclusion Area on a daily basis, year-round. Large numbers of sightings have been recorded from the Golden Gate Bridge. In 2012 Golden Gate Cetacean Research (GGCR) reported 100 or more individual porpoises on a number of their marine mammal surveys [84], [85]. The highest concentration of harbor porpoises in the MLPA Initiative's north central coast region occurs in the Exclusion Area [77].

The photo-identification catalog kept by GGCR contains 500 harbor porpoise individuals spotted in and near the entrance to the Bay, representing over 5% of the entire estimated stock of 9,186 individuals that are genetically distinct from other harbor porpoise stocks [84], [86]. The harbor porpoises in this area are regularly observed travelling in cow-calf pairs, mating, and foraging [84].

This sighting data indicates that the Exclusion Area is important for the movement of marine mammal populations, and represents a return to historical conditions for at least one species in the area. The return of the harbor porpoise may also indicate that the marine environment of the Exclusion Area is different than it was in 1992, when it was excluded from Sanctuary boundaries. This difference may be related to greater productivity, with greater food stocks supporting more top-level predators such as the harbor porpoise [84].

In addition, GGCR has indicated that the harbor porpoise regularly travels through MBNMS and GFNMS waters to the north and south of the entrance to the San Francisco Bay, moving into and out of the Bay. Such corridors form important parts of species' habitats. This highlights the connectivity between sanctuary and non-sanctuary waters, reinforcing the fact that jurisdictional boundaries do not correspond to the actual usage of the marine environment by important species. The existing sanctuary boundaries create an artificial, invisible delineation bisecting one contiguous habitat [84]. As the Guide to California's Marine Life Management Act states, "Marine wildlife pays no attention to these artificial boundaries. Some populations remain on the high seas or within state waters, but more frequently, populations of marine wildlife straddle or move across boundaries" [87].

Coastal bottlenose dolphin (*Tursiops truncatus)*, California Coastal Stock

The coastal bottlenose dolphin's historic range extended throughout Southern California and Baja California, Mexico, until the early 1980s when they began moving further north with an El Nino warm water incursion. When MBNMS was designated in 1992 they were very rarely observed in the Exclusion Area. However, the National Marine Fisheries Service (NMFS) 2008 Stock Assessment Report placed the northern edge of their range at the southern boundary of the Exclusion Area. Since 2006, coastal bottlenose dolphins have been regularly reported in the Exclusion Area, especially in summer and fall. They have been seen feeding in the Exclusion Area, and are known to pass through the Area on their way into and out of the Sanctuaries to the north and south. The dolphins now utilize the waters of the sanctuaries, the Exclusion Area, and the San Francisco Bay, and have been observed rapidly transiting from the sanctuaries to the Exclusion Area and back. Numerous individuals resident to Monterey Bay have been documented north of the Exclusion Area, in GFNMS waters, including cow-calf pairs. [84] They are also found at Bakers Beach and offshore of Pacifica [77].

Humpback whale (*Megaptera novaeangliae*), California/Oregon/Washington Stock

Humpback whales are occasionally sighted in the Exclusion Area, and regularly occur in GFNMS and MBNMS waters. The first observation of humpbacks in the Exclusion Area was in 2006, with one spotted off Pacifica. There were nine sightings in 2009 and five in 2012 off Pacifica. In 2012, several were spotted near the entrance to San Francisco Bay, reportedly foraging for food in the tidal rip currents [84], [83]. The presence of humpbacks in the Area peaks during the upwelling season (spring and early summer) [24].

This local stock of humpback whales is genetically distinct from other humpback populations. Humpbacks on the West coast remain within their region due to fidelity to feeding grounds. Humpback whales are federally listed as endangered under the Endangered Species Act (ESA) and as depleted and strategic under the Marine Mammal Protection Act (MMPA) [86].

Gray whale (*Eschrichtius robustus*), Eastern North Pacific Stock

Gray whales are also spotted in the Exclusion Area, especially during their migration. Active feeding occurs during the Upwelling Season off Pacifica as they migrate north along the California coast [84], [83]. Strandings along the coast have increased in recent years for unknown reasons [24].

Minke whale (*Balaenoptera acutorostrata scammoni*), California/Oregon/Washington Stock

Minke whales make rare appearances in the Exclusion Area, occasionally following shoaling fish from Sanctuary waters into the area near the entrance to San Francisco Bay. Recently, there have been several observations of minke whales entering San Francisco Bay to forage briefly before returning to the surrounding sanctuaries. The entire stock of minke whales in this area is less than 500 individuals [84].

Pinnipeds

California sea lion (*Zalophus californianus californianus*)

There is a sea lion haul-out site at Seal Rocks on the outer San Francisco coast in the Exclusion Area, and at various locations inside the Bay. Sea lions breed primarily in the southern part of their range (in the Gulf of California) and feed in upwelling waters of the continental shelf. Populations declined from hunting in the 18th and 19th centuries, but began growing substantially after passage of the MMPA in 1972 [77].

Harbor seal (*Phoca vitulina*)

The harbor seal is recovering after being hunted to very low levels in the 19th century, and its population grew after passage of the MMPA. Harbor seals in northern California constitute a separate California stock. The north central coast region has the highest concentration of harbor seals in California. There is a haul-out site at Point San Pedro, and rookery sites within the San Francisco Bay [77].

Steller sea lion (*Eumetopias jubatus*)

The Steller sea lion is federally listed as threatened under the ESA. The north central coast study region comprises the southern portion of the range of the distinct Eastern population. There is a Steller sea lion haul-out site at Seal Rocks [77].

Fish

California halibut and salmon are present in the offshore region of the Exclusion Area. Additionally, the following fish are present in the nearshore region: barred surfperch, calico surfperch, California grunion, jacksmelt, Pacific herring, redtail surfperch, striped bass, walleye surfperch, white seabass, and white seaperch [78].

The Exclusion Area also has high commercial fishing landings for halibut, herring, surfperch, salmon, shark, skate, ray, Dungeness crab, and rock crab relative to surrounding waters [77]. (See “Human Uses” section of this report for more on commercial and recreational fishing.)

Sharks

Broadnose sevengill shark (*Notorynchus cepidianus*)

The International Union for Conservation of Nature (IUCN) currently lists the sevengill shark as “Data Deficient,” meaning data about the shark’s abundance is lacking in most regions. This makes it difficult to assess the status of the species. The California population of sevengill sharks resides primarily in the Humboldt and San Francisco Bays, which serve as nurseries and safe havens. Due to its presence in these inshore waters, the sevengill shark faces intense fishing pressure, and is listed as “Near Threatened” in the Eastern Pacific [88].

Little is currently known about the San Francisco Bay population of sevengill sharks. For example, it is not known how many leave the Bay and migrate along the coast versus how many are resident in the

Bay year round. In addition, there is a possibility that the San Francisco Bay sharks constitute a distinct population from the Humboldt Bay sharks. However, research conducted by the Biotelemetry Laboratory at University of California, Davis and Aquarium of the Bay sheds light on the movements and level of residency of sevengill sharks in the San Francisco Bay. Twenty-six sharks were tagged and monitored, with preliminary data showing 70-90% site fidelity to the area around the Golden Gate Bridge. Furthermore, the San Francisco Bay may be the only shallow water bay in the American Pacific Coast that serves as a nursery for the species. Less is known about the movement of sevengill sharks outside of the Bay, as there were no monitoring stations located west of the Golden Gate Bridge for this study. The Exclusion Area likely serves as a gateway to important breeding grounds within the Bay. Sevengills show a seasonal pattern of movements into and out of San Francisco Bay, moving into the Bay during early spring and summer, and moving out of the Bay to Point Reyes in late spring and fall. These movements may be based on reproductive patterns, as the sharks prefer protected warm water during summer months. Tidal cycles also affect movements into and out of the Bay, with sharks moving through the Golden Gate Bridge during ebb and flood phases. They move out of the Bay with the ebb current during winter, and into the Bay with flood currents during spring, summer, and fall [89], [90].

White shark (*Carcharodon carcharias*)

The population of white sharks offshore of California is small, with an estimated “few hundred to few thousand adults” [77]. There is a genetically distinct population of eastern Pacific white sharks representing a “demographically independent management unit.” This population follows a highly predictable migratory cycle and shows strong fidelity to discrete and predictable coastal sites after returning from oceanic migrations. The sharks leave coastal central California foraging sites in winter, and return in late summer to their original locations after migrating 2,000-5,000 km offshore. This strong site fidelity makes the population well-suited to further assessment, monitoring, and management [91].

In an ongoing study, about 10% of tagged white sharks have been detected at the entrance to or inside the Bay (approximately 1.5 km inside the Golden Gate Bridge, and around Alcatraz Island) [91], [92]. This demonstrates that the distinct northeastern Pacific population of white shark regularly moves through the Exclusion Area. In addition, sightings of great white sharks have occurred in Pacifica [83].

Reptiles

Leatherback sea turtle (*Dermochelys coriacea*)

Leatherback turtles are listed as endangered throughout their range [93]. They occur in high concentrations in the Exclusion Area, and off the coast of Central California to Oregon, during migrations to critical feeding grounds [77], [78]. Turtles from nesting grounds in Indonesia travel approximately 10,000 kilometers across the ocean, arriving in California waters in the summer and fall to feed on jellyfish aggregations that form in the productive California Current upwelling system. The turtles specifically target dense aggregations of brown sea nettle (*Chrysaora fuscescens*) in the nearshore area. The coastal waters between Point Arena and Point Sur, which fully encompass the Exclusion Area, have been identified as the “principal foraging area offshore of California.” According to a 2012 NMFS report, “the occurrence of these prey species in sufficient “condition, distribution, diversity, abundance, and

density [is] essential for the conservation of leatherbacks in marine waters of the U.S. West Coast" [93].

Critical habitat designation for leatherback turtles was revised in 2012 to include large areas of marine habitat off the coast of central and northern California and Oregon [93]. In addition, in September 2012, California Assembly Bill 1776 designated the Pacific leatherback sea turtle as the official state marine reptile [58].

Invertebrates

The Pacific littleneck clam and Dungeness crab both occur in high concentrations along the shore of the Exclusion Area [78]. The assortment of benthic infauna and epibenthic invertebrates in the Exclusion Area is representative of species assemblages common in central California sandy soft-bottom offshore environments. Several distinct benthic infauna communities occur in the area, depending primarily on sediment grain size. These community compositions vary temporally with hydrologic conditions and sediment characteristic changes [40].

Over a twelve year monitoring period from 1997 to 2008, polychaetes (a type of annelid marine worm) were dominant in species richness and total abundance. The polychaete *Spiophanes norrisi* was the most abundant species overall [40]. The presence of this representative benthic species assemblage indicates that the Exclusion Area is part of a continuous marine environment along the continental shelf of California.

Conclusions and Emergent Criteria Evaluation

To determine if the Exclusion Area's ecological and biological qualities should be considered "nationally significant," we compare them with our emergent sanctuary designation criteria. The Exclusion Area's ecological qualities match several, but not all, of our emergent criteria. (See Table 11 for a complete list of emergent criteria met and not met by the Area). Most notably, there is:

- Seasonal upwelling and high productivity: exceptionally high relative to other temperate ocean regions around the world
- Marine mammal feeding habitat, with several endangered species
- Sites for key seabird life history events, including breeding and foraging, with several endangered or threatened species
- High abundance of commercially important fish species
- Presence of sea turtles

Table 11: Comparison of Ecological Qualities of the Exclusion Area with Emergent Criteria.

Emergent Criteria		Does the Exclusion Area fulfill this criterion?
West Coast Sanctuaries	Seasonal upwelling and high productivity	Yes
	Confluence of two major biogeographic regions, or a unique topographic feature	No
	Unusually high habitat diversity, defined either by varying substrates or by depth	No
	At least 14 species of marine mammals, as well as marine mammal breeding sites and feeding habitat. Typically, between 5 and 20 of these species are threatened or endangered.	Yes
	50 or more species of seabirds, along with sites for key seabird life history events, including breeding, rafting, and foraging. At least five of these species are endangered or threatened. The sanctuary is of paramount importance for at least one species, because, for example, it hosts the largest breeding population of the species or it contains the entire population of the species. The site contains significant general or species-specific seabird abundance, often representing the highest numbers within a particular region (the region sets a record on a particular metric).	Partially
	High diversity and abundance of fish, including commercially important species such as rockfish or salmon	Yes
	Exceptionally high diversity of benthic organisms, with assemblages of algae and invertebrates that provide vital links in the area's food chains	No
East Coast, tropical, and subtropical sanctuaries	Sanctuaries usually harbor either communities living at or beyond their normal geographical limits, or a rare ecosystem or species life history event.	Yes
	The sanctuary can often be split into at least two distinct habitat types either by substrate type, depth, or by distinctive topographical features.	No
	All sanctuaries contain at least two marine mammal species, but some individual sanctuaries harbor up to 24 species. In about half the sanctuaries, marine mammals use the site for important life history events, including birthing, mating, and foraging. Marine mammals are often found in low abundances in these sanctuaries. Two to fourteen endangered marine mammals are reported in the sanctuaries.	Yes
	When reported, most sanctuaries contain between 20 and 40 seabird species.	Yes
	Sea turtles are commonly reported in sanctuary waters, often including two to five species.	Yes (one species)
	High abundance and diversity of fish is often reported, either because the ecosystem has high biodiversity by nature, or because the area is a transition zone between two marine regions. Usually	Yes

	fish species number in the hundreds	
	Benthic fauna is usually highly diverse, often including a high number of algae and macro invertebrate species, along with many coral species if the sanctuary includes coral habitat.	No

We find that the Exclusion Area meets the standards of “significance” described in the NMSA. While the NMSA does not list specific parameters with which to define “significance” for most other qualities, it does for ecological qualities. These include an area’s “contribution to biological productivity, maintenance of ecosystem structure, maintenance of ecologically or commercially important or threatened species or species assemblages, maintenance of critical habitat of endangered species, and the biogeographic representation of the site.” While these are somewhat subjective criteria that require interpretation, it can be argued that the Exclusion Area meets all of these, and therefore meets the sanctuary designation criteria in the NMSA [5].

Scientific Significance

Introduction

According to the National Marine Sanctuaries Act (NMSA), a candidate site can become a sanctuary if one of several characteristics is deemed nationally significant. One of these characteristics is scientific significance of the area. Scientific significance might be demonstrated by the presence of research facilities nearby, historical use of the area for research, and the potential of the area to serve as a site for future research.

The Exclusion Area, lying between the San Francisco Bay, GFNMS, MBNMS, and CBNMS, presents unique and varied opportunities for scientific research and has high value to the scientific community. Research themes include wildlife, oceanographic processes, climate change impacts, and the urban-marine environment interface. The ecological and oceanographic qualities of the Area lend it to various types of scientific studies. Based on research activities currently conducted in the Exclusion Area and the potential for future research opportunities, it can be considered "significant" under our emergent criteria.

Research Institutions near the Exclusion Area

While there are no major research institutions located within the Exclusion Area, there are a number located in the surrounding area that conduct research in coastal and marine ecosystems. Academic institutions in the San Francisco Bay Area include University of California, Berkeley, San Francisco State University, University of California, Davis (through the Bodega Marine Lab), and Stanford University. Marine laboratories in the area include Bodega Marine Lab, Romberg Tiburon Center, Point Reyes Bird Observatory Conservation Science, the Marine Mammal Center, Tomales Bay Marine Station, Point Reyes National Seashore, and Southwest Fisheries Science Center. Government agencies involved in research in the area include California Department of Fish and Wildlife, California Sea Grant, Cordell Bank, Gulf of the Farallones and Monterey Bay National Marine Sanctuaries, San Francisco Bay National Estuarine Research Reserve, National Park Service, and U.S. Geological Survey. In addition, non-governmental organizations also conduct research in the surrounding areas [77].

Featured Research in the Exclusion Area

In order to begin defining the scientific value of the Exclusion Area, we can look to the number of scientific collecting permits for the Area. The California Code of Regulations authorizes the take or possession of marine plants or animals for scientific, educational, or propagation purposes with a permit issued by California Department of Fish and Wildlife. Holders of scientific collecting permits are required to submit a Report of Specimens Collected or Salvaged within 30 days of the permit expiring.

Region 4 of the Marine Life Protection Act (MLPA) North Central Coast Study Region extends from Double Point in Marin to Point San Pedro in Pacifica. It fully encompasses the Exclusion Area and is about twice the size of the Exclusion Area. Within a recent 1 ½ year period, 12% of scientific collecting permit reports filed for the North Central Coast Study Region were within Region 4 [77]. While this is not

very high compared with areas like the Farallon Islands or the Monterey Bay, it does indicate that the Area is important for scientific research.

Also, scientific collecting permits are regularly requested from the National Park Service for research activities in Golden Gate National Recreation Area, which includes the shoreline areas lying within the Exclusion Area [94].

One study that takes place in the Exclusion Area, conducted by the Cohen Lab at the Romburg Tiburon Center for Environmental Studies at San Francisco State University, conducts genetic sampling and population monitoring of the six-rayed seastar *Leptasterias aequalis*. This study has found that populations of the seastar closest to the Golden Gate Bridge show a distinct genotype. This finding may correlate with oceanic factors including the offshore current patterns from SF Bay [95].

The Applied California Current Ecosystem Studies (ACCESS) is a partnership between Point Reyes Bird Observatory Conservation Science, CBNMS, and GFNMS that has been conducting research offshore of northern California since 2004. ACCESS surveys oceanic habitats in northern and central California and includes two transect lines through the Exclusion Area. Researchers monitor oceanographic processes, zooplankton, marine birds, and marine mammals. According to the ACCESS group, this integrative, collaborative, and multi-disciplinary research program aims to "inform managers, policy-makers and conservation partners about wildlife responses to changes in ocean conditions and human threats to mobilize public support for marine conservation" [96].

Conclusions and Emergent Criteria Evaluation

The Exclusion Area meets several of the emergent sanctuary designation criteria for scientific value, meaning it can be considered "significant" according to the NMSA. The Area has high research potential due to pre-existing research projects and the interesting nature of its natural resources. There are no established research facilities or major research projects based in the Exclusion Area, but numerous smaller scale projects or studies conducted by various organizations and institutions take place at least in part in the Exclusion Area. There are also numerous facilities near the Exclusion Area that conduct coastal marine research, and unique habitats and several species of interest for scientific research.

Table 12: Comparison of Scientific Qualities of the Exclusion Area with Emergent Criteria.

Emergent Criteria		Does the Exclusion Area fulfill this criterion?
West Coast sanctuaries	High research potential due to pre-existing research projects and the interesting nature of the sanctuary's natural resources	Yes
	Five to 21 research facilities or major research endeavors are being conducted or have been conducted in the area.	No
East Coast, tropical, and subtropical sanctuaries	Most sanctuaries have high research potential due to the presence of a unique habitat or a species of interest.	Yes
	While most sanctuaries do not cite the number of institutions that conduct research in their waters, it is clear that most sanctuaries are commonly used in field research.	Yes

Recreational Significance

Introduction

According to the National Marine Sanctuaries Act (NMSA), a sanctuary can be designated due to "the present and potential uses of the area that depend on maintenance of the area's resources, including commercial and recreational fishing" and "other commercial and recreational activities" [5]. The San Francisco-Pacific Exclusion Area contains many recreational and commercial resources. In this chapter, we analyze tourism and recreation in the Exclusion Area. By analyzing the Exclusion Area's contribution to California's tourism and recreation sectors, our analysis provides an evaluation of the Exclusion Area's recreational value relative to other coastal destinations. Next, we use a variety of sources to determine the types of recreational and commercial activities that take place within the Exclusion Area. Finally, we compare the findings of this evaluation with the emergent criteria to determine whether the current recreational and commercial uses of the Exclusion Area should be considered "nationally significant" under the NMSA.

Tourism and Recreational Value

Tourism and recreation within with the Exclusion Area's coastal region is of significant value to California's economy, as well as the nation's ocean economy. California has the single largest economy of any state, and its share of the national ocean economy is larger than its share of the total U.S. economy [97],[98]. Furthermore, "tourism and recreation" is the largest sector of the state's ocean economy. The value of tourism and recreation is indicative of the overall recreational significance of the Exclusion Area to the state and to the nation. According to economic data generated by NOAA's Coastal Service Center, San Francisco County alone was the single largest contributor (approximately 21%) to state-wide ocean-dependent tourism and recreation from 2005 to 2010 [99]. Marin and San Mateo Counties also contribute significantly to this sector of the economy. However, the connection between San Francisco County's tourism and recreation and the value of these activities to the Exclusion Area is more direct because San Francisco's entire coastline is within the Exclusion Area.

For Marin, San Francisco, and San Mateo Counties, tourism and recreation consistently contributed over 85% of the ocean-economy's gross domestic product (GDP) from 2005 to 2010. Figure 22 shows the magnitude of the "Tourism & Recreation" sector in the overall "ocean-economy." The National Ocean Economics Program defines the ocean economy as the portion of a region's total economy consisting of "all economic activity that derives all or part of its inputs from the ocean or Great Lakes." The industries contributing to the value of the tourism and recreation sector are boat dealers, eating & drinking places, hotels and lodging, marinas, recreational vehicle parks and campsites, scenic water tours, sporting goods, amusement and recreation services, and zoos and aquaria [100]. Total GDP for each of these counties has shown overall growth between 1997 and 2011 (Figure 23).

The recreational value of the Exclusion Area is derived from the number of people that visit the Area, the available recreational resources, and the types of activities that occur there. For the purpose of this analysis, we consider recreational resources to be the access to the Exclusion Area along with the areas within and adjacent to the Area. The activities that contribute to the recreational value of the Area are those that depend on the Exclusion Area's resources to shape the character of the recreational experience. For example, individuals may visit a beach and never make contact with the water; however, much of the experience of "going to the beach" is undoubtedly tied to viewing the ocean.

The following sections describe the recreational resources and activities that occur in the Exclusion Area. Where possible, we quantify the number of people that engage in these activities. The aggregate of these resources and activities constitutes the recreational "value" of the area. We do not attempt to quantify the proportional contribution of individual resources or activities to the economy, as the data available is inconsistent in temporal scope.

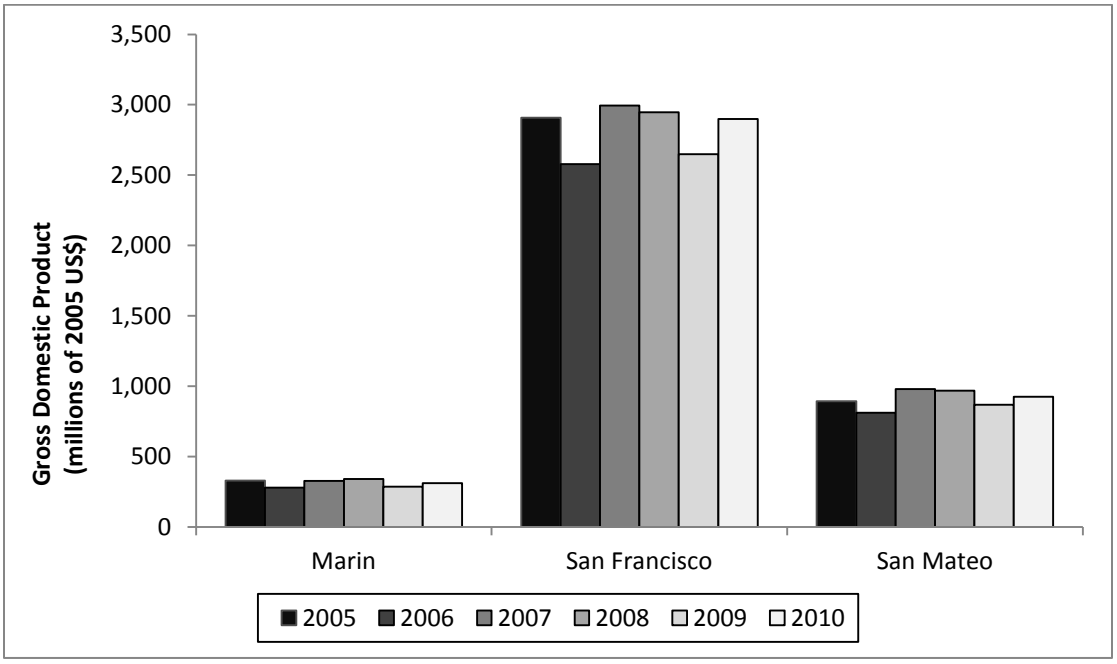

Figure 22: Ocean Dependent Tourism & Recreation sector of California's GDP.
(Data: [101])

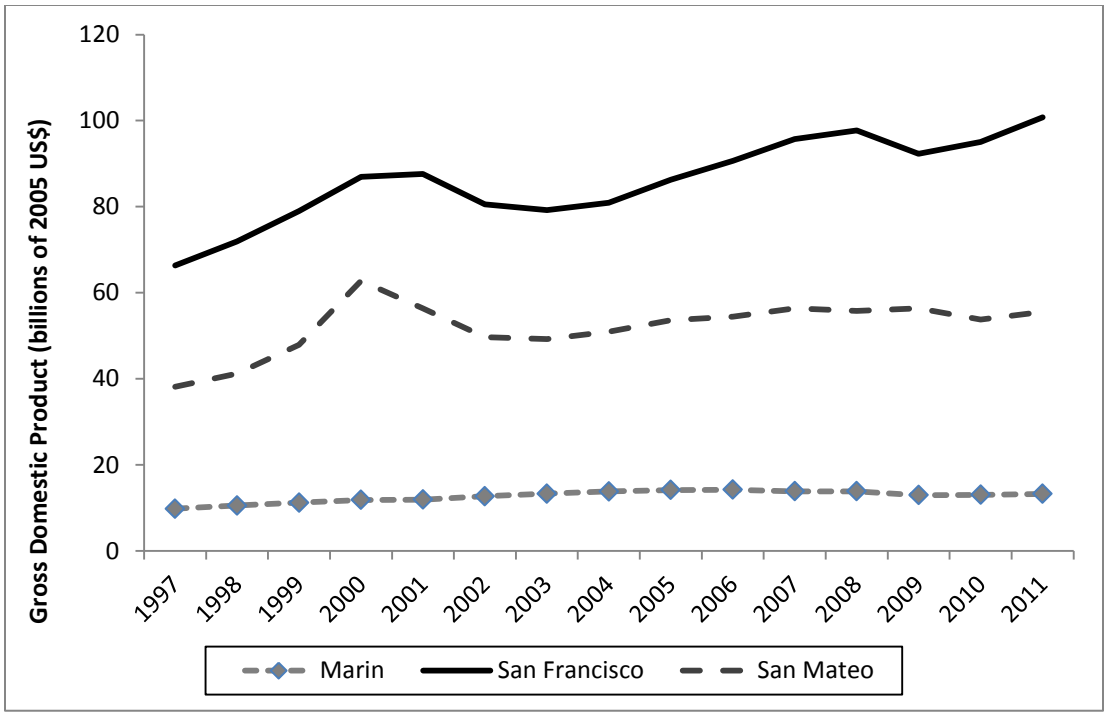

Figure 23: GDP by County (Data: [102]).

Recreation Resource Areas and Activities

The greater San Francisco Bay Area, and San Francisco in particular, is an important destination for domestic and international tourists. From 2000 to 2010, San Francisco was consistently in the top five U.S. cities for international tourists, hosting between 1.9 and 2.9 million visitors every year. These tourists accounted for approximately 10% of all international visitors to the U.S. in 2000, 2001, and from 2005 to 2010 [103]. A 2010 survey indicated that 75.4% of these visitors cited leisure or vacation as their primary reason for traveling to San Francisco [104]. In 2011, the San Francisco metropolitan area had the third largest number of domestic visitors to California [105].

In addition to international and out-of-state U.S. visitors, populations in San Francisco Bay Area counties are also recreational users of the Exclusion Area. The populations in San Francisco, Marin, Napa, Sonoma, Solano, Contra Costa, Alameda, Santa Clara, and San Mateo Counties have all seen modest growth between 2000 and 2010 and this growth is projected to continue [106]. Together with the increasing GDP of the immediately adjacent counties, these suggest an increasing potential for pressure on the Exclusion Area's resources.

The Golden Gate Bridge is an important tourist destination and is regarded as one of the top reasons to visit San Francisco [104]. Use of the west side of the Bridge, with views of the Exclusion Area, is more restricted than use of the east side. The west side is open on weekends and holidays only and is designated for cyclists; however, a small number of pedestrians use it as well. In a 2011 study of Bridge bicycle use, it was found that over 10,000 cyclists and a small number of pedestrians used the Bridge on

Saturday and Sunday. On a weekday, the west side had 603 cyclist visits [107]. Given that August is high-season for tourists; these statistics may not be representative of average numbers throughout the year. However, visitation statistics indicate that there are as many as 683,800 visitors to the Bridge annually.

The National Park Service's Golden Gate National Recreation Area (GGNRA) is the single most important recreational area along the Exclusion Area's coast. It has the highest visitation of any National Park in California, with over 14 million visitors every year since 2006 [108]. The GGNRA is also internationally recognized as part of UNESCO's Golden Gate Biosphere Reserve. The GGNRA is made up of a number of distributed sites, including the Marin Headlands and Fort Baker/Battery Spencer in Marin County; the Presidio, Fort Funston, and Ocean Beach in San Francisco; as well as Mori Point in San Mateo County. The GGNRA's Ocean Beach is the most visited beach along the north central Californian coast and is entirely within the Exclusion Area. It is estimated that Ocean Beach receives 300,000 visitors annually [67].

A comprehensive recreational use study along San Francisco's Ocean Beach was conducted by the San Francisco Public Utilities Commission (SFPUC), from October 1998 through September 2000. The study found that the majority of users were involved in non-water contact recreation. The results estimated that only 17% of the recreational users at Ocean Beach engaged in water contact recreation during the two-year study period [40]. This statistic is representative of the fact that most of the recreational uses of the Exclusion Area do not involve water contact.

In addition to Ocean Beach, there are 22 other discrete coastal access points distributed along the Exclusion Area's coastline [77]. The following table highlights individual sites along the Exclusion Area's shoreline and their notable activities:

Table 13: Recreational Resources Sites and Activities [77], [109], [110], [111], [112], [113].

Area	Recreational Resource Site	Activities
GGNRA	Marin Headlands	camping, hiking, fishing
	Ocean Beach	beach going, dog walking, picnicking, swimming, surfing, kite-surfing, wind-surfing
	Fort Funston	hang-gliding, dog walking, hiking
	China Beach	beach going, swimming, picnicking, tide-pooling
	Baker Beach	beach going, swimming, picnicking, tide-pooling, hiking, sunbathing
	Presidio of San Francisco	hiking, beach going, cultural history education
State Parks and Beaches	Thornton State Beach	hiking (no beach access)
	Pacifica State Beach (operated by the City of Pacifica)	surfing, beach going, dog walking, swimming
Local Parks	Mussel Rock Park	hiking
	Pedro Point Headlands	hiking, scenic viewing, surfing
	Sharp Park	pier fishing at Pacifica Pier, surfing
Other	Golden Gate Bridge	scenic vista viewing

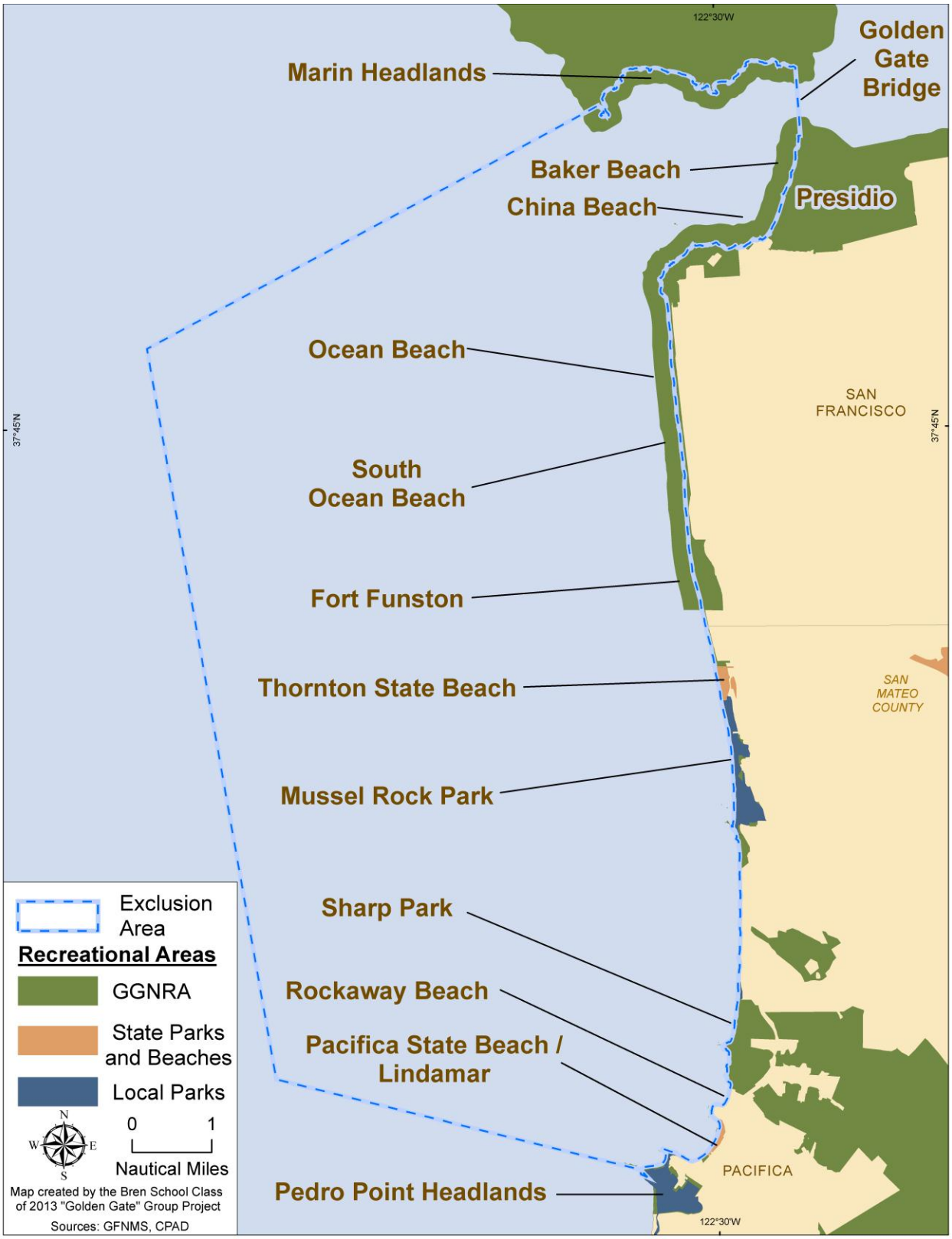

Figure 24: Recreational Areas in and around the Exclusion Area (Data: [114]).

Important Recreational Activities in the Exclusion Area

Surfing

Of the estimated 300,000 annual visitors to Ocean Beach, as many as 12,000 of them are surfers. The SFPUC recreational use study found that while the majority of recreational users were involved in non-water contact recreation, of those engaged in water contact recreation, up to 25% were surfers [40]. Considering that 17% of beach goers participate in water-contact recreation, this means that surfers accounted for just over 4% of the total recreational users at Ocean Beach.

Lindamar/Pacifica State Beach is another heavily used surf spot in the Exclusion Area [115]. However, the number of annual beach visitors is unknown.

Surf Spots Along the Exclusion Area's Coast [111]:

- Ocean Beach
- South Ocean Beach
- Sharp Park
- Rockaway
- Pacifica/Lindamar
- Pedro Point

Whale Watching, Bird Watching, and Other Wildlife Viewing

While marine wildlife in areas around the Golden Gate Bridge is world famous, most tours target the Farallon Islands outside of the Exclusion Area as a wildlife-viewing destination. However, given the connectivity of habitats in the region, viewers are likely to see many species within the Exclusion Area while traveling to the Islands. A 2009 report by the International Fund for Animal Welfare (IFAW) noted that humpback and blue whales, pelagic birds, seals, sea lions, dolphins, and porpoises are among the species viewed in the area [116]. (A detailed list of marine life within the Exclusion Area is presented in the “Ecological” chapter of this report.) The IFAW study estimated that between 4,500 and 5,000 passengers go on trips to the Farallon Islands every year, with most trips departing from San Francisco, Sausalito, or Half Moon Bay [116]. Trips based out of San Francisco and Sausalito will pass through the Exclusion Area.

Boating

Although the Exclusion Area is not known for recreational boating due to cold, rough waters, the region has a relatively high number of registered boats per person. However, there are no marinas in the Exclusion Area and therefore kayaking and kayak fishing are likely the most important types of boating activities in the coastal waters of the Exclusion Area. The Marine Life Protection Act (MLPA) Initiative’s Regional Profile for the North Central Coast Study Region highlights 13 discrete kayak fishing launch sites along the Area's shoreline [80].

Recreational Fishing

Recreational fishing activities in the Exclusion Area include beach fishing, pier fishing, and boat fishing from private and rental craft (including kayaks) [117]. The Recreational Fisheries Information Network samples recreational fishing sites throughout California, Oregon, and Washington. The organization samples two sites in San Francisco at Baker and Ocean beaches, and two locations in San Mateo County at Pacific Manor and Sharp Park, all of which are along the Exclusion Area's shoreline. Dungeness crab, perches and surfperches, striped bass, and white croaker are among the species most commonly caught [118]. The Pacifica Pier is an important location in the area for recreational fishing. Salmon, striped bass, and Dungeness crab are among the species commonly caught there [112]. Additionally, an annual California Department of Fish and Wildlife (CDFW) spearfishing competition is held near Sharp Park in San Mateo County [80].

Recreational CPFV fishing is another important commercialized fishing activity that takes place in the Area. A detailed discussion of these activities can be found in this report's assessment of Human Uses.

Aviation

General Aviation airports often support recreational flights and flight tours that enter the airspace above the Exclusion Area. A 2003 report for the Regional Airport Planning Committee included the number and types of aircraft based at nearby airports in Alameda, Contra Costa, Marin, Napa, San Mateo, Santa Clara, Solano, and Sonoma Counties. The report documented 5,011 single engine aircraft, 802 multi-engine aircraft, 90 jets, 63 helicopters, 28 gliders, and 26 ultra-lights. Local general aviation aircraft operations, exclusive of itinerant operations, numbered over one million per year [119].

Numerous local companies offer over-flight tours that pass above the Exclusion Area, often targeting views of the Golden Gate Bridge. Federal Air Regulations do not require a minimum altitude over open water except that "aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure" and "helicopters may be operated at less than the minimums ... if the operation is conducted without hazard to persons or property on the surface" [120].

Current MBNMS regulations require that aircraft maintain a minimum altitude of 1,000 feet over the Sanctuary. The character of flight tours and private recreational flights may therefore be affected by the additional restrictions that could be imposed if the Exclusion Area is incorporated into MBNMS. Though there is precedent for the creation of designated overflight zones that allow for lower minimum altitudes within certain areas of MBNMS, such special overflight zones would be designated in the Exclusion Area at the Sanctuary's discretion.

Assessment using the California Ocean Uses Atlas

We performed an overlay analysis with the geographic information system (GIS) layers of the California Ocean Uses Atlas to determine the types and locations of recreational activities occurring within the Exclusion Area's coastal waters. The Atlas is the result of a cooperative project between NOAA's Marine Protected Areas Center and the Marine Conservation Biology Institute to map the "full range of

significant human uses of the ocean in state and federal waters of the coast of California." Regional experts participated in workshops to collaboratively map the spatial extent of a variety of human uses along the entire California coast, from the shoreline to the limits of the Exclusive Economic Zone [117].

The overlay of the Atlas layers was performed in ESRI's ArcGIS using the "Union" tool. This created polygons that represent areas with unique combinations of recreational use. Layers depicting the dominant areas for 14 non-consumptive recreational and consumptive recreational fishing uses along the coast of California were symbolized by quartiles. Within the Exclusion Area, one area near Pacifica fell into the top 25% of distinct polygons (with nine of 14 uses occurring routinely), indicating that this portion of the Exclusion Area is an area with relatively high recreational use intensity for California (Figure 25). The high concentration of recreational uses in this portion of the Exclusion Area is evidence of nationally significant recreational value.

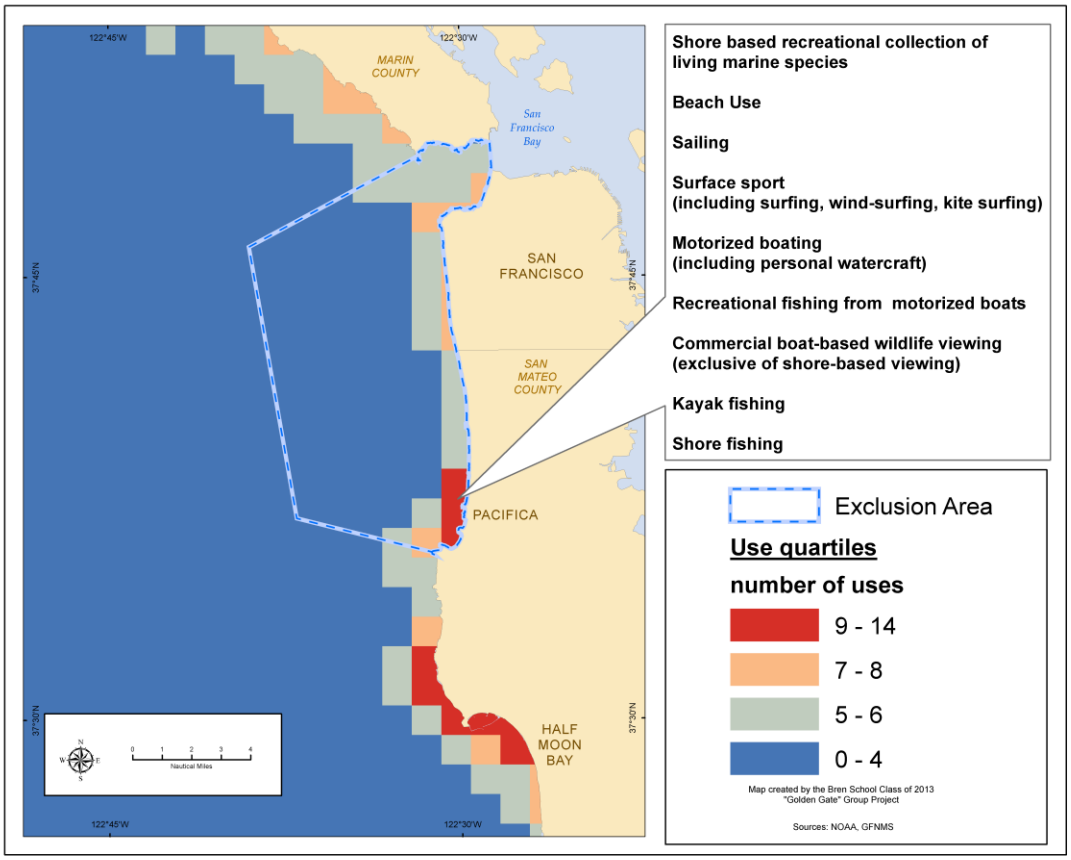

Figure 25: Non-consumptive recreation and recreational fishing hotspots (Data: [117]).

Conclusions and Emergent Criteria Evaluation

This characterization of the activities and ocean-related economy provides an evaluation of the Exclusion Area's overall recreational resource value. According to the emergent criteria, West Coast Sanctuaries shared a number of minimum characteristics; namely that the proposed areas showed 1) growing human activity intensity, 2) increasing accessibility to an urban population, 3) between five and ten recreational uses, and 4) a minimum of two recreation areas. The increasing intensity of human activity is evidenced by the increase in GDP, of which the "Tourism & Recreation" sector is the largest fraction. The intensity of human activity is likely to grow with the local metropolitan population.

There are numerous recreational activities that occur in the Exclusion Area or depend on views of it. Our analysis of the California Ocean Uses Atlas shows that at least nine recreational activities occur together in an area near to the City of Pacifica. There are many other distinct recreational activities that occur in other regions of the Exclusion Area, including: camping, dog walking, hang-gliding, hiking, picnicking, scenic viewing, sunbathing, and tide pool viewing. Based on these characteristics, the Exclusion Area meets all thresholds set by the emergent criteria and, therefore can be considered eligible for sanctuary designation on the basis of its recreational value.

Table 14: Summary of Emergent Criteria Evaluation for Recreational Value.

Emergent Criteria		Does the Exclusion Area fulfill this criterion?
West Coast sanctuaries	Trend of human activity intensity is growing	Yes
	Growing accessibility to an urban population, with accessibility getting easier	Yes
	Commercial Passenger Fishing Vessels are common.	Yes
	Five to ten cited recreational uses of the area.	Yes
	At least two pre-existing recreation areas in most cases	Yes
	It is common for visitors to sanctuaries to number in the millions.	Yes
East Coast, tropical, and subtropical sanctuaries	Human use of the area is increasing, causing increases in anchoring, illegal taking of species, and other recreational uses.	Partially
	Accessibility of sanctuaries varies from low to high, but usually at least some degree of human use occurs in the area.	Yes
	Recreational fishing in these sanctuaries is typically quite high, and both party and charter boat fishing is common.	Partially
	Water-based recreational activities are common in the area, and most sanctuary designation documents cite 3 to 10 major recreational activities that take place within the region.	Yes
	Tourism is often a key element of the economies near sanctuaries.	Yes

Human Use Significance[6]

Introduction

According to the National Marine Sanctuaries Act (NMSA), a candidate site can become a sanctuary if one of several characteristics is deemed nationally significant. One of these characteristics is the “human use significance” of the area. Both commercial and recreational fishing are human uses specifically mentioned throughout the National Marine Sanctuaries Act (NMSA) and are important activities within the scope of various NOAA programs. In this chapter, we analyze the fishing activities and important target species occurring within the Exclusion Area in order to determine whether fish caught in the Area make a significant contribution to fisheries at the national level. While fishing activities are not restricted under MBNMS regulations, sanctuary status for the Exclusion Area could provide for increased protection for fish, fish stocks, and habitat since protection of sanctuary waters and submerged lands are important aspects of the NMSA.

The San Francisco-Pacifica Exclusion Area is made up of both state and federal waters. State waters constitute more than half of the Area. Fisheries operations within state waters in the Area fall under the purview of the California Department of Fish and Wildlife's (CDFW) "San Francisco Management Area," formerly the "Northern-Central Management Area" [121]. The Management Area is further subdivided into District 10, which encompasses the ocean water and tidelands from Mendocino County to San Mateo, and District 11, which includes the area to the west of the Golden Gate [122]. The Exclusion Area is entirely within District 10 and partially overlaps District 11. Federal fisheries in the Area are managed by the National Marine Fisheries Service's (NMFS) Southwest Region and the Pacific Fisheries Management Council. These three agencies coordinate some management efforts and some regulations to be consistent across state and federal waters within the CDFW’s Management Areas. For instance, the CDFW requires that fish caught in areas beyond the 3 nautical mile limit of state waters are reported when they are landed in California.

Federal regulations and management have specified Essential Fish Habitat (EFH) for threatened groundfish and salmon species in the Exclusion Area. Groundfish EFH is designated throughout the Exclusion Area and EFH for Chinook and Coho salmon are located in the portion of the Exclusion Area at the mouth of the Golden Gate [123]. As mentioned in this report’s chapter, “Previous Boundary Expansions” (below), we have determined that the presence of EFH in areas adjacent to existing sanctuaries may be precedent for expansion, regardless of an area’s suitability for designation in and of itself.

[6] Data used in this publication were supported in part by the Ocean Protection Council, California Department of Fish and Wildlife, Ocean Science Trust, MPA Monitoring Enterprise, and the State of California under Grant Agreement #09-015, project #R/MPA-16 09-015, through the California Sea Grant College Program. The views expressed herein do not necessarily reflect the views of any of those organizations.

In our analysis of fishing activities we quantify the contribution of fish caught in the Exclusion Area to total U.S. commercial landings and to commercial-level recreational fishing in the region. Throughout this analysis we highlight species that are caught in relatively large quantities in the Exclusion Area, though they may not be significant at the national or regional level, in order to provide information about species that may be of interest to management of the Area in particular.

Commercial Fisheries

Fish caught in the Exclusion Area are likely landed in the regional port complexes of San Francisco, Bodega Bay, and Monterey Bay, with most landings at San Francisco ports. Port complexes are made up of numerous ports in each region. From 2006 to 2011, San Francisco, Princeton-Half Moon Bay, and Sausalito were the top three ports in the San Francisco complex with the largest landings. (Landings refer to the weight, dollar value, or number of fish recorded in port. The numerical values of landings exclude any fish, or parts of fish, discarded at sea.) The five species with the largest landings by weight in the San Francisco complex were Dungeness crab, Pacific herring roe, Market squid, Pacific sardine, and Dover sole. The top five most valuable fish landed in San Francisco were Dungeness crab, California halibut, swordfish, sablefish, and Chinook salmon [124]. (Appendix G contains a list of the ports making up each of these three complexes).

Between 2006 and 2011, Dungeness crab and California halibut have often been among the top ten most valuable marine-species in the United States. Most Dungeness crab is caught along the Washington, Oregon, and California coasts. The proportion of Dungeness crab landed in California, and at San Francisco ports in particular, has grown significantly between 2008 and 2011. Commercial landings data indicate that San Francisco ports have seen the largest proportion (by weight) of all California halibut.

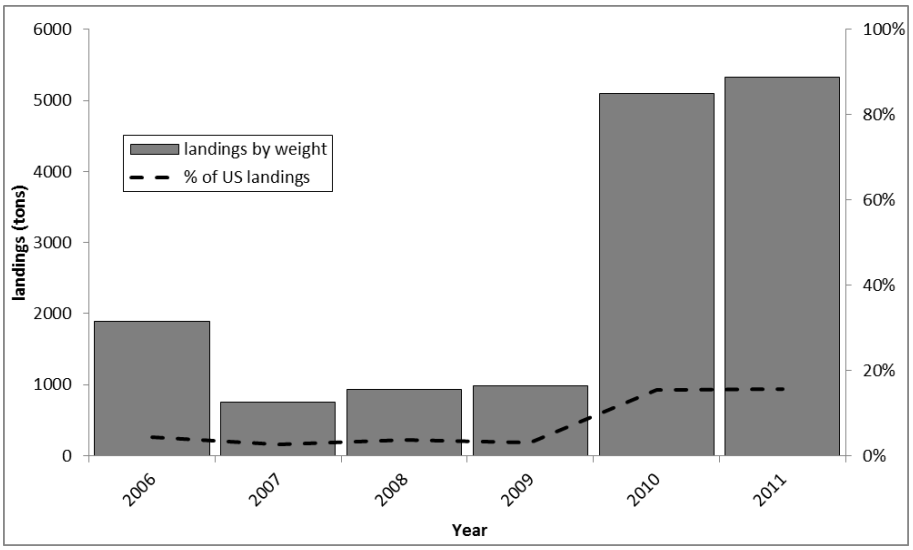

Figure 26: Dungeness crab landings.
Chart shows landings at San Francisco ports and percent of total U.S. landings. (Data: [124], [125]).

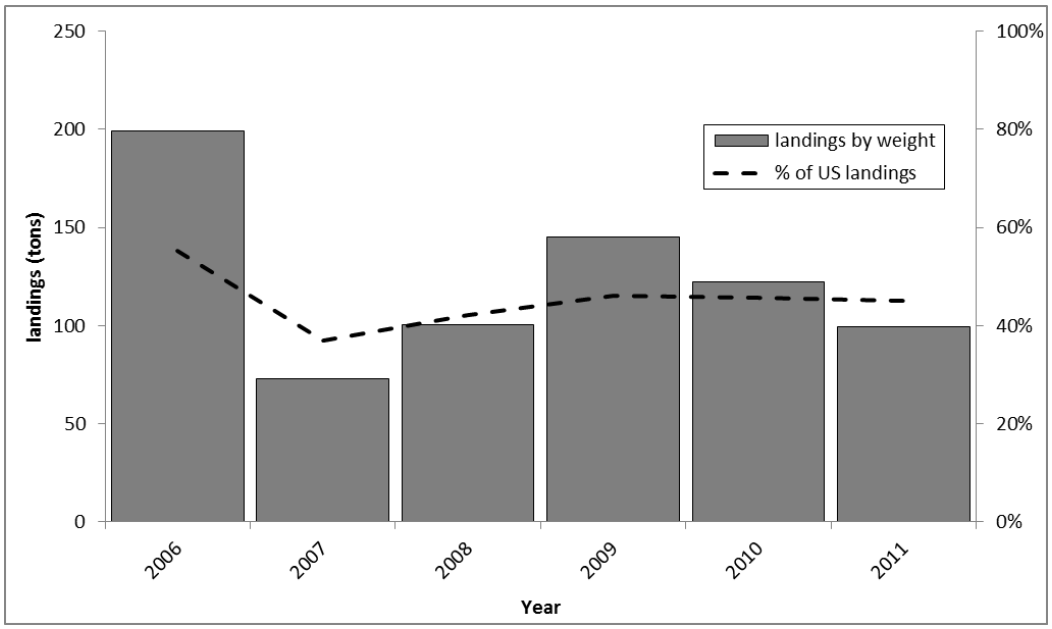

Figure 27: California halibut landings.
Chart shows landings at San Francisco ports and percent of total U.S. landings. (Data: [124], [125]).

The CDFW requires fishermen to report the location and numbers of their catch. The location is recorded according to a "block" grid. The Exclusion Area makes up most of block 455 in the Northern-Central Management Area (Figure 28).

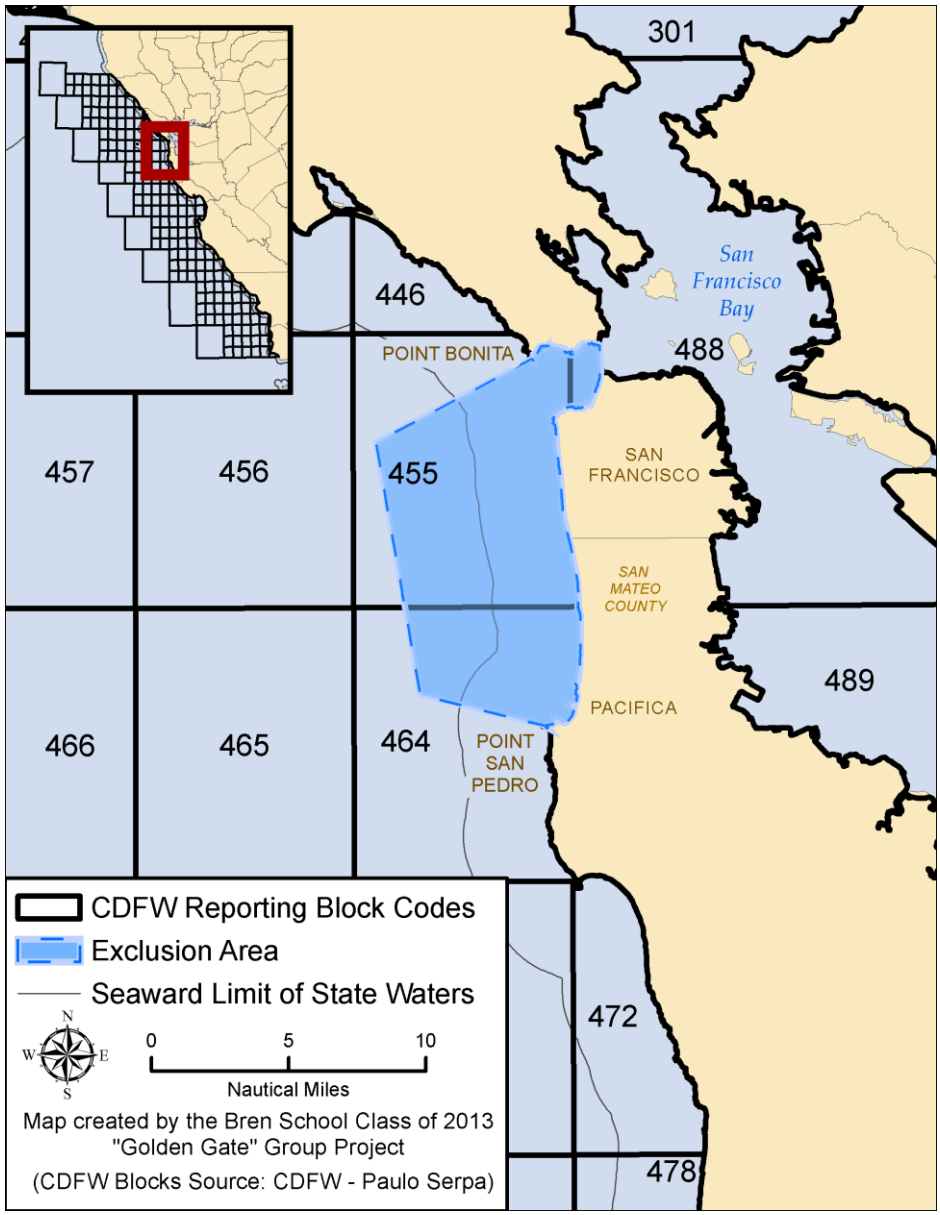

Figure 28: Reporting Blocks and the Exclusion Area.

From 2006 – 2011 no catch for Pacific sardine, Market squid, Dover sole, swordfish, sablefish, or Pacific herring roe was reported in block 455. However, California halibut and Dungeness crab are consistently in the top five species by weight and value. Unspecified surfperch are another group of species commonly caught in block 455 over this period, though they are not of particular value to the region. For catch reported in this block, correlated with catch in the Exclusion Area, Dungeness crab has seen a dramatic increase between 2008 and 2011. Catch of California halibut has seen inconsistent but modest growth, and surfperch landings have been decreasing. A summary of these most commonly caught and valuable species in block 455 is shown in Tables 15 and 16.

Table 15: Weight of species commonly caught in block 455 or valuable to regional ports and landed in regional ports (Data: [126]).

Year	Crab, Dungeness	Halibut, California	Surfperch, unspecified
2005	22,828	74,549	4,890
2006	6,969	41,317	3,342
2007	911	24,108	1,588
2008	7,988	55,801	1,302
2009	20,074	61,310	1,348
2010	230,975	68,297	1,167
2011	196,087	52,547	459
Total	485,831	377,929	14,095

Table 16: Nominal value of species commonly caught in block 455 or valuable to regional ports and landed in regional ports (Data: [126]).

Year	Crab, Dungeness	Halibut, California	Surfperch, unspecified
2005	$46,495	$234,023	$15,659
2006	$14,616	$156,575	$9,592
2007	$2,741	$110,651	$5,316
2008	$29,073	$269,144	$4,566
2009	$47,045	$257,910	$5,927
2010	$425,445	$309,808	$5,252
2011	$556,774	$284,763	$2,066
Total	$1,122,188	$1,622,874	$48,377

Based on CDFW commercial block reports and total U.S. landings data from NMFS, from 2006 to 2011 the only species with catch reported from block 455 that exceeded 3% of total U.S. landings in more than one year was California halibut. Some species names are reported differently between CDFW and NMFS data. Our valuation of the percent contribution of catch in block 455 to national landing is based on species classifications that were consistent between datasets. For instance, NMFS data for all species of surfperch are reported by the family name, “surfperches.” CDFW data available for surfperch report landings by the particular species (e.g. “surfperch, black”), or as “surfperch, unspecified” where the precise species identification is unknown. However, the majority of species caught in block 455 were represented by the same classification in NMFS data.

These data show that the Exclusion Area does not make a significant contribution to total U.S. landings. However, the catch of California halibut in the Exclusion Area may be of growing significance: the value of California halibut has peaked in from 2008 to 2011 (Table 17).

Table 17: Percent contribution of California halibut landed from block 455 to total U.S. landings (Data: [126] [125]).

Year	Percent of total U.S. landings	
	by weight	by nominal value
2005	8.0%	8.2%
2006	5.7%	5.8%
2007	6.1%	6.0%
2008	11.7%	11.7%
2009	9.7%	10.0%
2010	12.8%	13.2%
2011	11.9%	13.0%

Value of commercial fishing grounds within the Exclusion Area

The non-profit Ecotrust has published research on the value of commercial fishing grounds in other parts of California that indicates the location of fishing grounds within CDFW reporting blocks. The organization has been able to share information on commercial fishing grounds within the Exclusion Area with our group. This information can help to prioritize management within the Area. Preliminary data from a forthcoming report by Ecotrust indicates that the Exclusion Area contains valuable fishing grounds for California halibut and Dungeness crab. These data bring greater geographic context to the aspects of commercial fishing mentioned above. However, it is important to recognize the limitation of these data for the purposes of assessing the significance of the Exclusion Area's commercial fishing value.

The methodology used by Ecotrust in their valuation of these fishing grounds is explained in detail in their 2008 report, "Commercial and recreational fishing grounds and their relative importance off the North Central Coast of California" [127]. The valuation is accomplished by interviewing local fishermen, using a custom mapping tool ("Open OceanMap") built to assist the interviewees in sketching the extent of fishing grounds important to them, and then distributing the value of their catch across the area. Interviewees are grouped by the port to which they make their landings. By overlaying and adding the value of fishing grounds for a number of fishermen and for individual species, Ecotrust is able to create geographic information system (GIS) layers depicting the value of fishing grounds for various commercial fisheries at various ports. While these data do not, and are not intended to, capture the entire value of a fishery, they are a novel and important step in providing regional context to the value of fisheries to local economies. Ecotrust was able to share preliminary GIS layers for California halibut, Dungeness crab, nearshore finfish, and urchin landed at San Francisco, Bodega Bay, Bolinas, Half Moon Bay, and Point Arena. Ecotrust also provided a data layer showing total values for each fishery for all sampled ports. These data are from Ecotrust survey efforts undertaken in 2012 for the 2011 season and are therefore not representative of the value of fisheries over time. Nevertheless, with the caveats mentioned above, the data provide greater spatial resolution data for the source of landings.

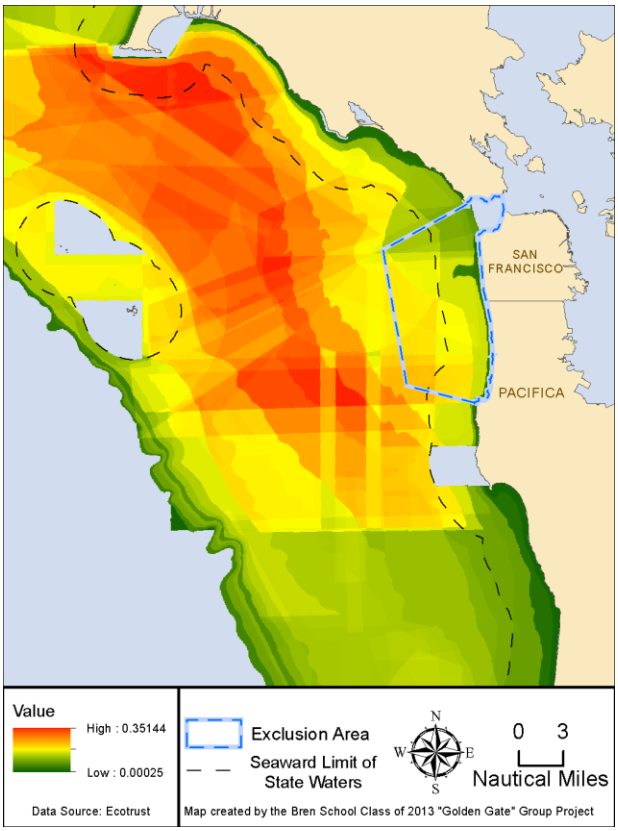

Figure 29: Relative value of Dungeness crab commercial fishing grounds to regional ports. (Source: Ecotrust, unpublished)

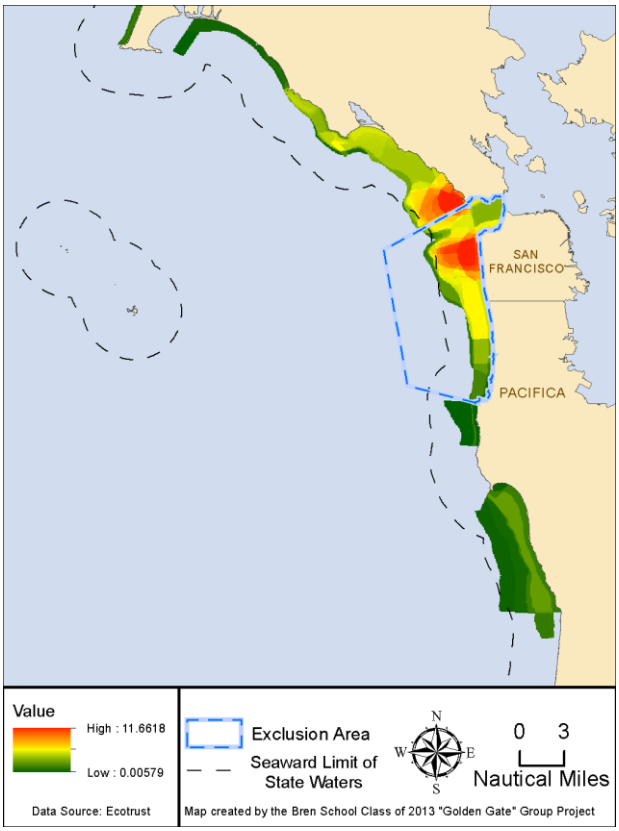

Figure 30: Relative value of California halibut commercial fishing grounds to regional ports. (Source: Ecotrust, unpublished)

The maps above indicate the locations of relatively valuable Dungeness crab and California halibut fishing grounds for the Exclusion Area in 2011. More valuable Dungeness crab grounds within the Exclusion Area are found outside of state waters. California fishing grounds important to the Exclusion Area are concentrated in state waters near the Golden Gate Bridge.

Commercial Passenger Fishing Vessel (CPFV) Fishing

Besides commercial fishing, Commercial Passenger Fishing Vessel (CPFV) trips make up a large fishing industry. CPFVs, also known as “party boats,” are operations in which privately captained boats take a number of anglers (up to 120) on fishing trips that are generally one-half to one day in length [128]. Considering the scale of this industry, we have included our analysis of its significance in this chapter on “Human Uses.” An analysis of recreational activities, including private recreational fishing, can be found in the “Recreational Significance” chapter.

Due to the length of most CPFV trips, most fish caught by party boats in the Exclusion Area are landed at San Francisco ports. The aggregate of many species of rockfish consistently make up the vast majority of CPFV landings in the San Francisco area. Dungeness crab, California halibut, and Striped bass are also important target species. Each of these species was among the top five important species landed by

CPFV's at San Francisco ports between 2006 and 2011. In Figures 31-32 "unspecified invertebrates" refers to "jumbo squid, CA spiny lobster, Dungeness crab, rock scallop, red sea urchin, sea cucumber, etc." "Rockfish" include blue, copper, gopher, yelloweye, and canary rockfishes, as well as "unspecified" rockfish" [124].

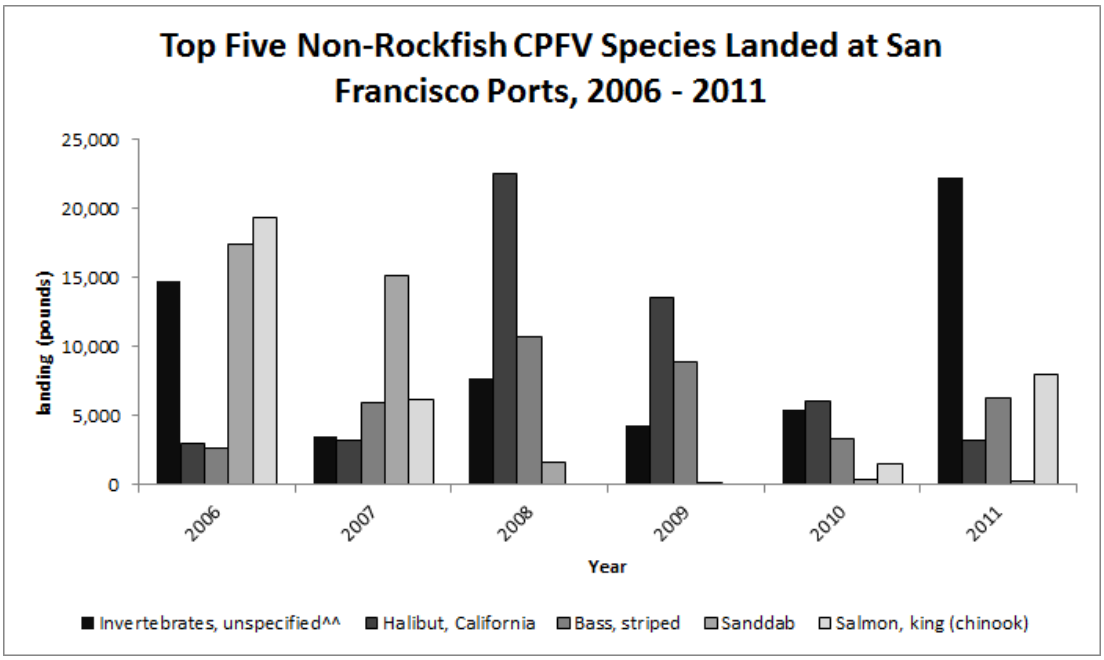

Figure 31: Non-Rockfish CPFV Landings (Data: [124]).

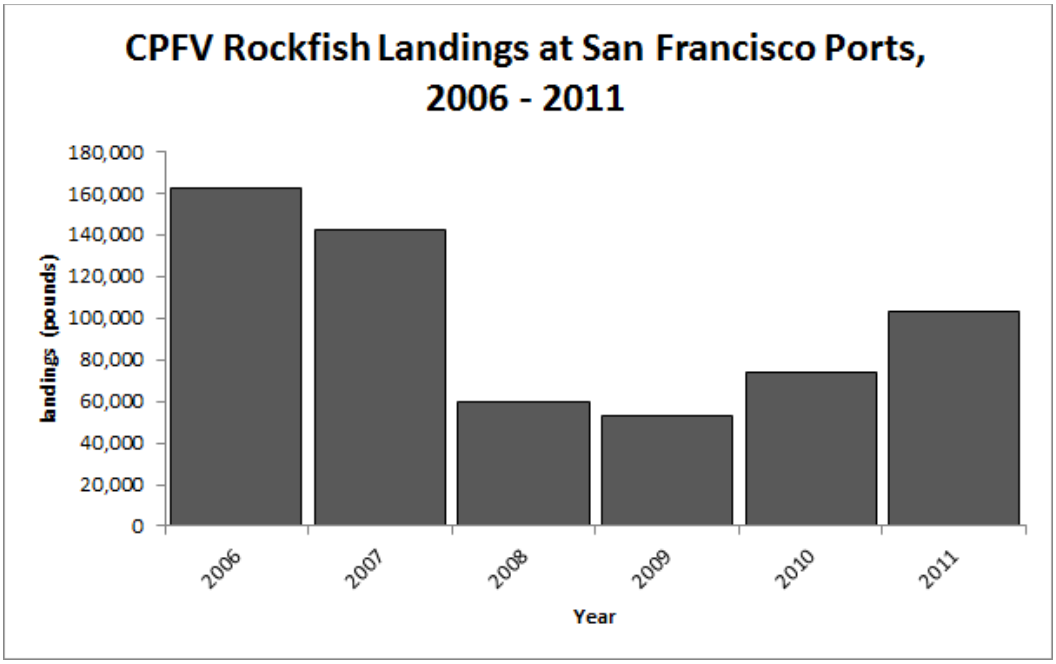

Figure 32: CPFV Rockfish Landings (Data: [124]).

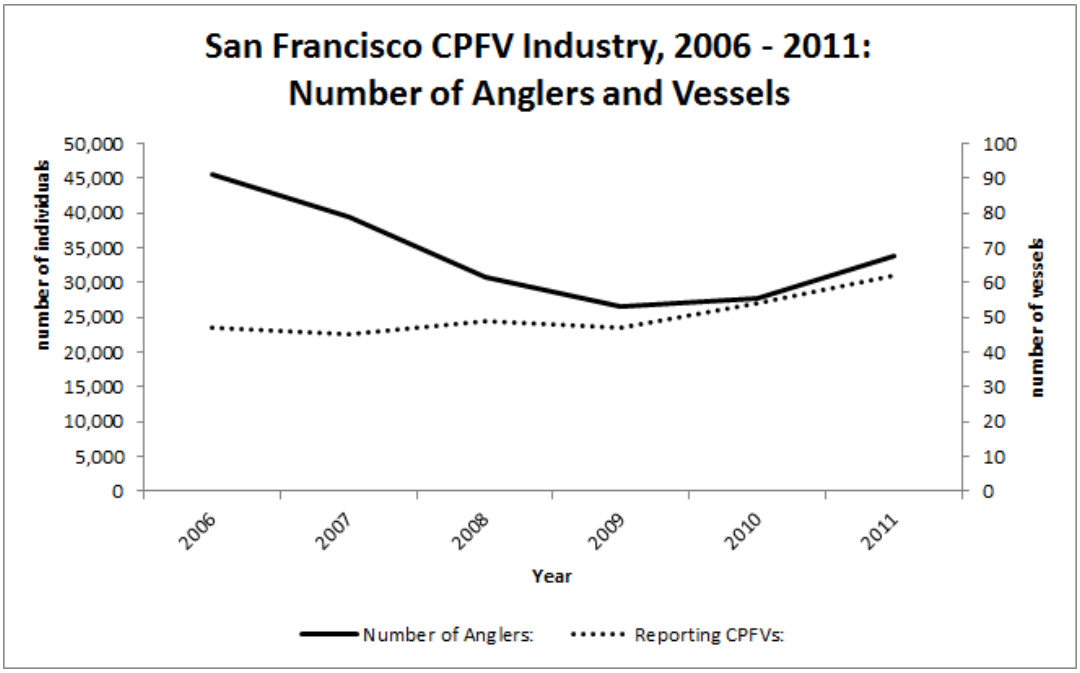

Figure 33: Number of Anglers and Vessels, San Francisco CPFV Industry, 2006-2011.
Since 2008 the CPFV fleet has seen an increase in fishing effort, both in terms of number of vessels and number of anglers. (Data: [124]).

CDFW catch data reported by CPFVs making landings at regional ports indicate that for the species caught in large numbers within block 455, the most important species from 2006 – 2011 are Chinook salmon, Dungeness crab, California halibut, and various rockfish; however, only California halibut made an appreciable contribution to CPFV catch landed in regional ports. In addition to California halibut, the two other species caught in block 455 that exceeded a 5% contribution to regional CPFV catch in more than one year were soupfin shark and thresher shark. Sanddab and Striped bass were not among the top species caught in the area; however, their importance for the regional CPFV industry makes them an important target species.

Table 18: Numbers of individuals kept for the top species caught in the Exclusion Area (Data: [126]).

Year	Salmon, Chinook	Crab, Dungeness	Halibut, California	Rockfish, unspecified
2005	1,995	264	48	196
2006	265	132	1	270
2007	85	-	18	54
2008	-	-	101	70
2009	-	-	740	23
2010	65	216	327	312
2011	862	1,753	178	80
Total	3,272	2,365	1,413	1,005

These data indicate that CPFV catch in the area does not make a significant contribution to the regional CPFV industry because the catch in block 455 is negligible for most species.

Value of CPFV fishing grounds within the Exclusion Area

Ecotrust was able to provide GIS data layers of CPFV fishing grounds for rockfish, salmon, Striped bass, Dungeness crab, and California halibut in 2011. Layers for the time period did not indicate importance of the area for rockfish, salmon, or Dungeness crab. However, the data highlight the portions of the Exclusion Area that are important for Striped bass and California halibut.

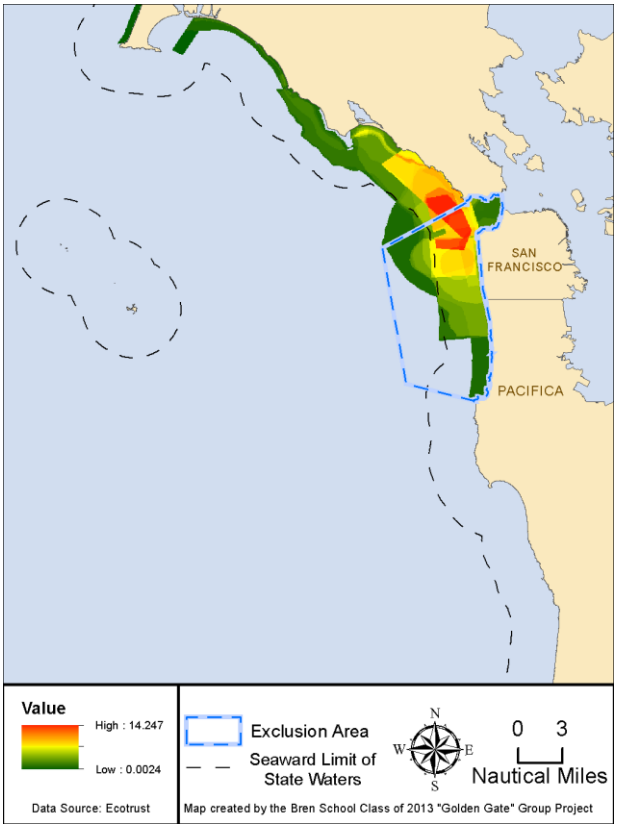

Figure 34: Relative value of California halibut CPFV fishing grounds to regional ports.
(Source: Ecotrust, unpublished)

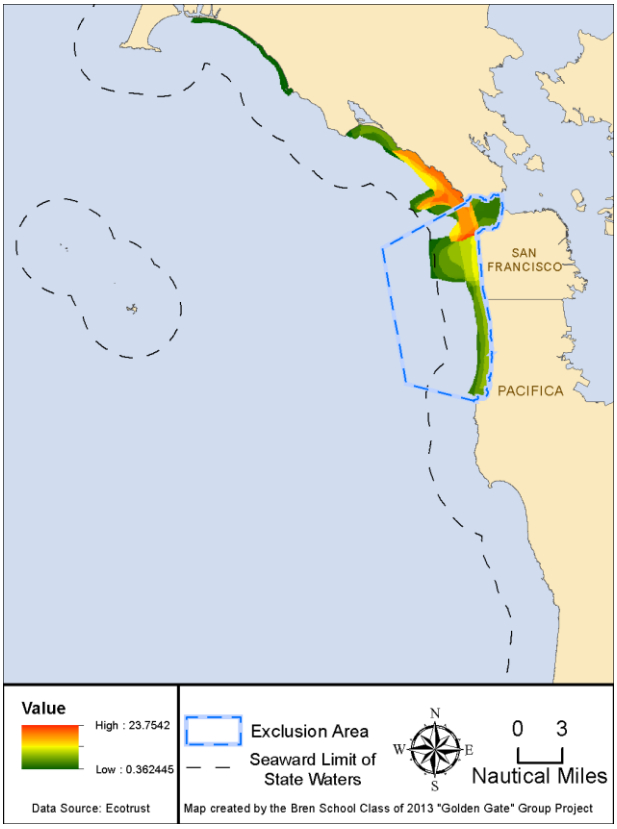

Figure 35: Relative value of Striped bass CPFV fishing grounds to regional ports.
(Source: Ecotrust, unpublished)

Potential Uses

The NMSA explicitly states that candidate sanctuary sites be evaluated on the basis of "potential uses of the area that depend on maintenance of the area's resources" [5]. The California Ocean Uses Atlas project (discussed in detail above) also studied potential uses of California coastal waters. Data from the Atlas suggests that portions of the Exclusion Area's coast have the potential for commercial dive fishing, commercial kelp harvesting, and alternative energy development [117]. Considering the difficulty involved in predicting the future uses of any area, and the density of current uses, these predictions should be considered with skepticism. For instance, most types of present alternative energy technologies are likely incompatible with the use of the area for commercial shipping. Also, most alternative energy requires anchoring into the benthic substrate. This type of activity would therefore violate sanctuary regulations for protection of the seafloor. In any case, if the Exclusion Area is

incorporated into a sanctuary, the managing sanctuary should be aware that regional experts consider these other uses possible.

Conclusions and Emergent Criteria Evaluation

These analyses of commercial and CPFV fishing show that a number of species that have national or regional significance are caught in the Exclusion Area; however, only one species, California halibut, makes an appreciable contribution to these landings. Although the NMSA explicitly mentions the value of fishing activities within an area as criteria for sanctuary designation, the Act does not describe levels of significance by which to judge these criteria.

We found that previous designations of West Coast Sanctuaries shared a number of minimum characteristics; namely that the proposed areas showed 1) growing human activity intensity, 2) increasing accessibility to an urban population, 3) between five and ten recreational uses, and 4) a minimum of two recreation areas. The increasing intensity of human activity is evidenced by the increase in the ocean-dependent GDP, of which the tourism and recreation sector is the largest fraction. It is also reasonable to expect that the intensity of human activity will continue to grow as the local metropolitan population grows. There are numerous recreational activities that occur in the Exclusion Area or depend on views of it. Our analysis of the California Ocean Uses Atlas shows that at least nine recreational activities occur together in an area near to the City of Pacifica. Elsewhere throughout the coastal recreation areas, including the Golden Gate Bridge, are many other distinct recreational activities: camping, dog walking, hang-gliding, hiking, picnicking, scenic viewing, sunbathing, and tide pool viewing. Based on these characteristics, the Exclusion Area meets all of these thresholds and can be considered eligible for sanctuary designation on the basis of its recreational value.

Table 19: Summary of Emergent Criteria Evaluation for Human Use (Fishing).

Emergent Criteria		Does the Exclusion Area fulfill this criterion?
West Coast sanctuaries	Commercial fishing represents a very significant human use—often the most significant human use of the area.	No
East Coast, tropical, and subtropical sanctuaries	While some sanctuaries do not support large commercial fishing operations, most support operations that are quite important to the local economy.	Partially

Historical, Cultural, and Archaeological Significance

Introduction

According to the National Marine Sanctuaries Act (NMSA), the presence of historical, cultural, and archaeological resources can justify the designation of a National Marine Sanctuary [5]. Past sanctuary designations indicate that historical resources can be highly influential in the sanctuary designation process and can stand alone in justifying an area as "nationally significant." Monitor National Marine Sanctuary, for example, was established in January 1975 after the discovery of the *Monitor* shipwreck two years prior [129]. Thunder Bay National Marine Sanctuary (TBNMS) was also designated solely due to the presence of historical resources. In fact, because these historical resources were so overwhelmingly important, TBNMS managers decided to overlook the potential biological value of the area and devote managerial resources to protecting cultural and historical artifacts. These examples represent just two of the many sanctuaries whose designation has been influenced by the presence of historical, cultural, or archaeological resources.

In addition to influencing the establishment of a National Marine Sanctuary, historical, cultural, and archaeological resources are highlighted in NOAA's Maritime Heritage Program. This program is intended to engage Americans in the stewardship and appreciation of the nation's maritime heritage [130]. It emphasizes the importance of artifacts, like shipwrecks, and the cultural history and traditions of people who historically used sanctuary waters.

The San Francisco-Pacifica Exclusion Area is historically significant. Our report will focus on the cultural history of the San Francisco Bay Area, the shipwrecks located within the Exclusion Area, the benefit sanctuary management would provide for these resources, and how the historical value of the Exclusion Area compares with that of other sanctuaries. For the purpose of this analysis, cultural resources will refer to physical artifacts linked to Paleo-Indians, Native Americans, and European explorers while shipwrecks will be referred to as historical resources.

Cultural History

Although there is currently no knowledge of cultural resources within the Exclusion Area, evidence suggests that physical artifacts may be present in this region [131]. Regardless of the physical presence of resources, the cultural history of the Exclusion Area has the potential to add value to NOAA's Maritime Heritage Program because it may enhance the public's appreciation of indigenous maritime cultures and traditional uses of the marine environment. In addition, the expansion of Monterey Bay National Marine Sanctuary (MBNMS) into the Exclusion Area would strengthen federal management of the Area and may lead to increased collaboration and research opportunities for both NOAA's Office of National Marine Sanctuaries (ONMS) and the National Parks Service (NPS). Expansion also has the potential to facilitate further research of the Area's cultural heritage and could support the discovery of new cultural artifacts.

Native American History

Paleo-Indians began inhabiting the San Francisco Bay Area over 10,000 years ago. However, many coastal areas have since been inundated by rising sea levels, making archaeological resources difficult to find [131], [132]. Sea level rise forced Paleo-Indians to move inland and evidence suggests that these people became less migratory and settled in established villages about 8,000 years ago [131]. Approximately 4,000 years ago, the Coast Miwok and Ohlone (also known as Costanoans) settled in the Bay Area. These Native American groups have historical ties to the areas now known as Sonoma County, Marin County, San Mateo County, Monterey County, and the City of San Francisco (Figure 36). Coast Miwok and Ohlone history may provide clues about Native American ties to the marine environment in and around the Exclusion Area.

Figure 36: Historical Native American Territories [133]**.**

About 14 Coast Miwok tribes traditionally lived north of the entrance to the San Francisco Bay in areas of southern Sonoma and Marin counties, while about 50 Ohlone tribes resided south of the Bay in the City of San Francisco and San Mateo and Monterey counties [134]. The Coast Miwok subsisted on seeds and roots, and supplemented their plant-based diet by fishing and hunting mammals like elk and deer [135]. Ohlone tribes also supplemented their plant-based diet with fish and marine mammals such as sea lions and seals [135]. Both groups are known to have used canoes made out of bound tule rushes for fishing and transportation [135].These historical ties to the coastal region in the San Francisco Bay Area suggest that there may be Paleo-Indian or Native American archaeological artifacts within the Exclusion Area that have been inundated by rising sea levels.

Current archaeological evidence in the San Francisco Bay Area reflects the types of sites that might exist within the Exclusion Area. The Golden Gate National Recreation Area (GGNRA) lies along the coast of much of the Exclusion Area, and is rich in archaeological history. The park's boundaries extend one quarter mile into the Pacific Ocean and San Francisco Bay, overlapping a small portion of the Exclusion Area. There are approximately 61 recorded archaeological sites within the 117 square miles of the park [136]. In addition, archaeological sites linked to the Coast Miwok and Ohlone people have been discovered in and around the Bay Area. Numerous archaeological sites linked to the Coast Miwok have been discovered at the Point Reyes National Seashore [137], while shell mounds sacred to the Ohlone have been discovered in San Bruno Mountain State Park and Emeryville [138],[139]. Given the amount and types of archaeological evidence in the Bay Area linking Coast Miwok and Ohlone to the region, there is a chance that artifacts from Native American or Paleo Indian groups may exist within the Exclusion Area.

Colonial History

Colonial history also plays a key role in understanding the historical significance of the Exclusion Area. Early Spanish exploration of the Pacific began in the sixteenth century as explorers like Cortez and Vizcaino began to show interest in the California coastline [140]. In the early 1700s, missions were established by the Spanish in Baja California, and by 1769 the first mission in present day California was established in San Diego [141]. The Spaniards went on to establish 21 missions in California; five of which are north of the city of Santa Cruz and located in the San Francisco Bay Area. Many Coast Miwok and Ohlone people in this area became members of nearby missions during these years [134].

In addition to the Spanish presence, Russians and Mexicans were also attracted to the San Francisco Bay Area. Russians began hunting sea otters for their furs in Alaska in the early 1700s and worked their way down the Pacific Northwest coast. By the early 1800's, they had established a permanent settlement at Fort Rossiya (Fort Ross)approximately 90 miles north of San Francisco Bay [142]. Mexicans also had an interest in the San Francisco Bay Area. After Mexico won independence from Spain in 1821, many foreigners settled in Yerba Buena (present day San Francisco), and the Mexican government temporarily opened many of California's ports to generate revenues from import duties [135].

The City of San Francisco and its port were incredibly important during these years of settlement. Russians and Spaniards relied on food imports to San Francisco during early colonization. Later, the city became a supply port for European and Yankee ships [135]. For hundreds of years, cargo and transportation ships have passed through the Exclusion Area in order to reach San Francisco and surrounding cities. The historical use of this area justifies its significance during the Colonial Period in California and provides evidence that archeological resources from this time period could be present in the Exclusion Area.

Modern Maritime History

In addition to its cultural history, the Exclusion Area is important because of the historical maritime resources located within its waters. There are over 60 known shipwrecks within the Exclusion Area that

were lost between 1849 and 1950 [131]. A table with each ship's approximate location, name, size, and date of construction and loss is available in Appendix F, along with a map indicating approximate shipwreck locations. Shipwrecks have been recognized in the establishment of other National Marine Sanctuaries including Monitor, Channel Islands, Florida Keys, Stellwagen Bank, Olympic Coast, Thunder Bay, Monterey Bay, and Gulf of the Farallones. These wrecks not only contribute to the significance of an area, but are also important for NOAA's Maritime Heritage Program, which promotes maritime heritage appreciation throughout the country. This discussion will address the importance of shipwrecks and current threats to shipwrecks in the Exclusion Area.

Importance of Shipwrecks

Shipwrecks are valuable for a number of historical and educational reasons. Wrecks accessible to research divers may contain evidence to help expose the cause of a shipwreck. Additionally, the types of materials used to build historical vessels may reveal the types of technology and resources that were used in ship construction in the past. Shipwreck preservation within the Exclusion Area has the potential to contribute to NOAA's Maritime Heritage Program and the Preserve American Initiative, which works to preserve the nation's heritage by improving federal stewardship of resources and promoting maritime appreciation. Preservation and resource documentation will help to provide important links to the historical use of the Exclusion Area. Information on the Exclusion Area's historical resources could be used to enhance sanctuary education programs. Likewise, shipwrecks have the potential to engage people who may not normally be interested in National Marine Sanctuaries. Shipwrecks can connect people who do not live in coastal areas because they tell stories about the historical relationship between people and the marine environment.

In addition to their importance as historical and educational research sites, shipwrecks are also ecologically significant because of their role as marine habitats. Shipwrecks can function as artificial reefs, providing substrate that can give rise to an entire marine community. While researchers are still debating whether artificial reefs actually help to produce marine life or simply attract it away from other habitats in the ocean, it is well known that the hard substrate that shipwrecks provide is important to many types of marine life [143].

Threats to Shipwrecks

Sanctuary management would provide additional protection for shipwrecks, which could be under threat from beachcombing, sport-diver collecting, professional salvage, and treasure-hunting [144]. These threats are more serious for wrecks that do not lie within the GGNRA boundaries and are not currently managed by the NPS. Sanctuary designation would provide an additional layer of protection for these resources because NOAA is legally responsible for the management of maritime heritage resources within sanctuary boundaries.

Benefits of Sanctuary Management

Sanctuary management would provide federal protection for resources located within the Exclusion Area and would enhance collaboration between state and federal agencies responsible for the

management of resources in the Area. Designating the Exclusion Area as part of MBNMS could provide the long-term coordinated and comprehensive management needed to protect important historical resources.

Mandated Resource Protection

Historical resources within the Exclusion Area will benefit from the Area's incorporation into MBNMS. NOAA has stewardship authority over historical resources within sanctuary boundaries. These resources are non-renewable, so responsible management and protection is needed to ensure that current and future generations can appreciate, enjoy, and learn from them [130]. Through the NMSA, Congress directs NOAA to comply with the Federal Archeological Program's collection of laws that address the protection of historical and archaeological artifacts on federal and federally managed lands. Of particular relevance to the ONMS is the National Historic Preservation Act, which requires federal agencies to protect historical and archaeological resources. Section 106 of this law requires agencies to consider all potential impacts of any action that may disturb archaeological resources. Section 110 requires agencies to search for archaeological resources and assess their significance and eligibility for inclusion in the National Register of Historic Places [130]. Sanctuaries have the potential to carry out, coordinate, or facilitate the stipulations in these various laws.

Enhanced Collaboration and Management

In addition to resource protection, sanctuary designation would allow for collaborative management of the Exclusion Area. In the 1980s, the NPS signed a lease with the California State Lands Commission (SLC) for the waters surrounding GGNRA lands from the mean high tide line to one quarter mile out to sea. The SLC has jurisdiction over waters up to three nautical miles from the coast while the Federal Government manages areas between three and 200 nautical miles from the coast. Management of the Exclusion Area would therefore be collaborative. ONMS would work with the SLC and the NPS to manage cultural, historical, and archaeological artifacts within the Exclusion Area [145]. The sanctuary would communicate with these agencies, share resources, and collaborate on research projects to efficiently manage sanctuary waters and resources. Collaboration with these agencies would allow the sanctuary to connect with a broader audience and engage more people in the work that the ONMS does.

Conclusions and Emergent Criteria Evaluation

Although no universal criteria for historical resources could be identified for all thirteen National Marine Sanctuaries, the Exclusion Area does share commonalities with each individual group of sanctuaries (Table 20). The first group of sanctuaries includes Monitor and Thunder Bay. These sanctuaries were designated because of the significant historical resources located within their waters. The second group of sanctuaries includes the five west coast sanctuaries. These sanctuaries have a range (from very few to up to 300) of historical resources present within their waters. Finally, the third group is made up of east coast, topical, and subtropical sanctuaries. Most of these sanctuaries contain, or are expected to contain, historical or cultural resources including Paleo-Indian artifacts, shipwrecks, or lighthouses. The Exclusion Area is comparable to these historically significant sanctuaries in that it has over 60 shipwrecks

located in its waters. Potential artifacts from Paleo-Indians, Native Americans, and European explorers may exist in the Exclusion Area as well. These resources may provide opportunities to enhance sanctuary education programs and may also provide research and dive opportunities for explorers. While the Exclusion Area does not contain as many known historical resources as some other sanctuaries do, the type and amount of resources found here is comparable to the emergent criteria from each grouping of sanctuaries and indicates that the Exclusion Area's waters are historically significant.

Table 20: Comparison of Ecological Qualities of the Exclusion Area with Emergent Criteria.

	Emergent Criteria	**Does the Exclusion Area fulfill this criterion?**
Historically Focused Sanctuaries	Contain up to 160 shipwrecks	Yes
West Coast Sanctuaries	Historical resources may or may not be present in sanctuary waters	Yes
East Coast, Tropical, Subtropical Sanctuaries	Contain (or are suspected to contain) historic and/or cultural resources	Yes

Educational Significance

Introduction

The sanctuary designation criteria in the National Marine Sanctuaries Act (NMSA) state that sanctuary status can be granted if an area has a significant educational value. Educational value has been cited as a reason for establishing numerous existing sanctuaries. For example, the designation of Channel Islands National Marine Sanctuary recognized the need to create education programs to enhance the public's awareness of the "value and sensitivity of the area's natural resources [146]." In addition, the designation documents from Hawaiian Islands Humpback Whale National Marine Sanctuary recognized the need for educational campaigns focused on specific subject matter [147].

The San Francisco-Pacifica Exclusion Area has significant educational value. If it were incorporated into Monterey Bay National Marine Sanctuary (MBNMS), it would allow for enhanced public awareness of the Area, the opportunity to deepen local appreciation of the outdoors, and further the development of sanctuary education programs, events, and lectures. This analysis will discuss the educational benefits of the proposed sanctuary expansion into the Exclusion Area, and explain how the educational value of the Area compares to that of other sanctuaries.

Enhanced Public Awareness

The expansion of MBNMS into the Exclusion Area will allow for enhanced public awareness of Sanctuary waters. Residents and visitors of both San Francisco and Marin counties would have coastal access to a National Marine Sanctuary if MBNMS was expanded. Likewise, the expansion would bring sanctuary designation to an area directly west of the densely populated San Francisco metropolitan area and would target not just local residents, but tourists who may not be aware of the existence or importance of the National Marine Sanctuary (NMS) System. Providing protection for the Area will increase the public's awareness of a water body that is recognized for its educational, cultural, archaeological, historical, ecological, recreational, and aesthetic significance. This expansion would also allow visitors and residents of the San Francisco Bay Area to learn more about the uniqueness of this region and how it is connected to the rest of the NMS System.

Deeper Connections

In addition to enhancing public awareness of the NMS System, the expansion of MBNMS will deepen the connection between nearby residents and the outdoors. Residents of San Francisco may establish a deeper connection with the NMS System, because the waters surrounding their City would be protected and recognized as "nationally significant." GFNMS Superintendent, Maria Brown, was quoted in the *San Jose Mercury News* stating that "People assume that the water around the Golden Gate is protected. It's not [12]." Providing sanctuary designation and protection for the Exclusion Area may help strengthen the connection that residents and visitors of both Marin County and the City of San Francisco have to this particular area of ocean. Knowing that their coastal waters are of special significance may attract more people to learn about this area either by taking advantage of the educational programs offered by

the Sanctuary or by exploring the area on their own. Establishing this connection to the Exclusion Area may increase the public's sense of responsibility for the marine environment and may encourage people to become better stewards of the ocean.

Education Programs

The expansion of MBNMS will also provide new content for educational programs, events, and lectures. Many school students and residents who participate in sanctuary education programs are concerned that their neighborhood beaches and rocky shores have not been recognized by the Office of National Marine Sanctuaries. They feel strongly that their shoreline should be protected by sanctuary designation [148]. Providing protection for these waters would respond to these community concerns and will provide additional content for sanctuary education programs.

Currently, GFNMS runs a variety of educational programs. Some of these programs are designed for school age children in grades K-12. Both in-school and after-school programs emphasize hands-on marine science activities and high school field science programs focus on beach monitoring in a variety of locations. Some of these beach monitoring locations are within the Exclusion Area. Programs open to the public include lectures and fieldtrips, in addition to the exhibits and interpretive signage along the coastline and at partner Visitor Centers. A variety of "citizen science" programs around the Bay Area such as Beach Watch, Rocky Shore Naturalists, and LiMPETS also conduct monitoring in and around the Exclusion Area [148]. Expansion of MBNMS into the Exclusion Area will provide greater context for GFNMS education programs by bringing volunteer and student activities into an area previously excluded from sanctuary designation. This expansion may deepen the connection that students and the public have with their local marine environment and may increase the utilization and awareness of these educational programs.

Conclusions and Emergent Criteria Evaluation

Although no universal criteria for educational value could be identified for all thirteen National Marine Sanctuaries, the Exclusion Area does share commonalities with each individual group of sanctuaries (Table 21). Monitor and Thunder Bay are historically focused sanctuaries recognized for fostering educational programs based on shipwrecks. Like these sanctuaries, the Exclusion Area is home to a number of shipwrecks and it is likely that these will enhance the historical education component of a number of sanctuary education programs. The east coast, tropical, and subtropical group of sanctuaries share very few commonalities with regard to educational value. Some had few to no education programs in existence at the time of designation, while others had up to 17. Like these sanctuaries, there are a variety of existing educational programs run by GFNMS and outside organizations that utilize the Exclusion Area for monitoring activities or wildlife viewing. Most important, is the comparison between the Exclusion Area and the other sanctuaries on the west coast of the United States. These sanctuaries may have had existing education programs at the time of designation but often did not have any programs that conveyed to the public the importance of the region or the scientific information available regarding the area's natural communities. This stands true for the Exclusion Area. The addition of the Exclusion Area to MBNMS presents significant opportunities for modifying and expanding

education programs to fully recognize the regional importance of this small, yet significant, 101-square-mile area of ocean.

Table 21: Comparison of Educational Qualities of the Exclusion Area with Emergent Criteria.

	Emergent Criteria	**Does the Exclusion Area fulfill this criterion?**
Historically Focused Sanctuaries	The area will foster educational programs based on shipwrecks	Yes
West Coast Sanctuaries	Some educational programs exist but no educational program conveys to the public the importance of this region	Yes
East Coast, Tropical, Subtropical Sanctuaries	Educational programs exist in this area	Yes

Adequacy of Existing Management

Introduction

One of the main purposes of a National Marine Sanctuary is to offer additional protections for unique areas through improved coordination between managing agencies. The sanctuary designation criteria in the National Marine Sanctuaries Act (NMSA) stipulate that in order for a site to become a National Marine Sanctuary, its existing management must be inadequate or require supplementation to ensure comprehensive and coordinated management [5].

In this chapter, we review the San Francisco-Pacifica Exclusion Area's existing management and identify any gaps and potential opportunities for improved coordination. We analyze the existing agencies with jurisdiction over portions of the Exclusion Area and agencies with jurisdiction over an immediately adjacent portion of shoreline that may have a stake in the management of the Exclusion Area.

A number of federal, state, and local agencies with potential interest in the management of the Exclusion Area are listed on the map of jurisdictional agencies in Figure 37. This map highlights the extent of overlap for those agencies that have only partial or adjacent authority over potential sanctuary resources. Table 22 describes the degree of overlap that these existing agencies have within the Exclusion Area. This table is useful for identifying agencies that already have jurisdiction over the entire Area. The map and table can be found at the end of this chapter.

Many jurisdictional zones have boundary limits at the "shoreline." There is significant ambiguity in the term "shoreline" as there are numerous definitions of what constitutes the interface between land and water, including "high tide" and "mean higher high water." Interpretation of the geographic limits of the "shoreline" is important in determining the extent to which many of these existing jurisdictions overlap with the Exclusion Area. For the purpose of this analysis we assume that the shoreline is coincident with the coastal boundary of the Exclusion Area: the mean high tide line. This boundary is consistent with the existing Monterey Bay National Marine Sanctuary (MBNMS) coastal boundary.

Because the NMSA highlights the management of sanctuary resources as a requirement for sanctuary designation, we focus our identification of management gaps according to the classification of resources set forth in the Act. A sanctuary resource is defined as "any living or nonliving resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, education, cultural, archeological, scientific, or aesthetic value of the sanctuary"[5]. The following sections examine the existing protections for resources that contribute to these value classes and describe current gaps in protection. However, neither educational nor scientific resources depend on regulated protection of the Exclusion Area. The values of these resources are derived from the degree of access to the Area and the potential for dedicated research within it. For investigations into these sanctuary resources, please see this report's chapters on Educational Significance and Scientific Significance.

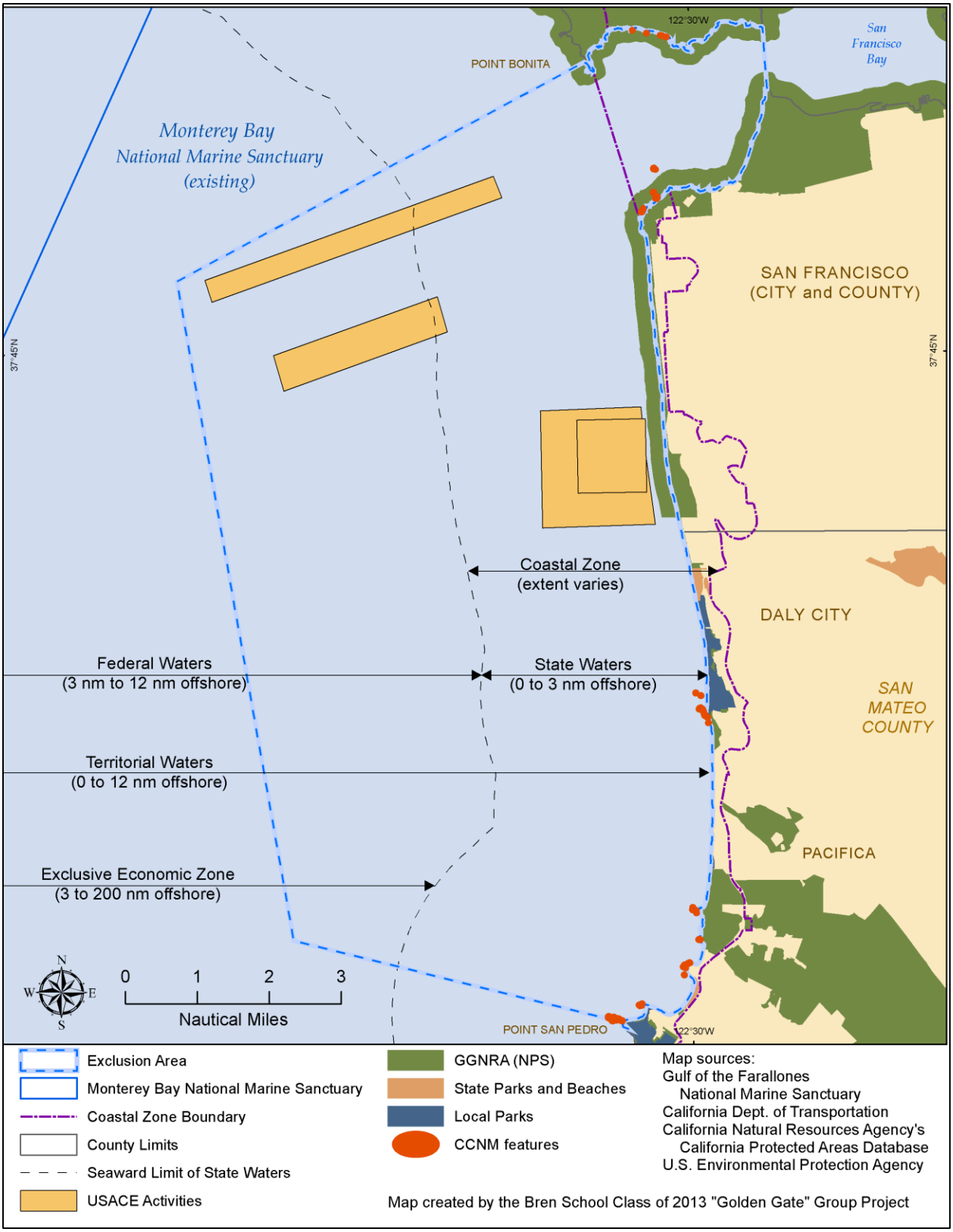

Figure 37: Exclusion Area Jurisdictional Areas.

Table 22: Exclusion Area Jurisdictional Agencies.

Level	Agency or Program	Jurisdiction	Level of Overlap with Exclusion Area
Federal	California Coastal National Monument (CCNM)	The Bureau of Land Management (BLM) manages the California Coastal National Monument (CCNM) that protects "islands, rocks, exposed reefs, and pinnacles" above mean high tide from the shoreline to 12 nm offshore. This encompasses the entire Exclusion Area. Its primary purpose is to protect the geological value of these lands, but this provides indirect protection for marine mammal haul outs and seabird habitat [77][149].	all portions of islands, rocks, and pinnacles above mean high tide in the entire Exclusion Area
	National Park Service's (NPS) Golden Gate National Recreation Area (GGNRA)	The National Park Service (NPS) operates the Golden Gate National Recreation Area (GGNRA), which is composed of a number of sites distributed throughout the Exclusion Area and makes up a significant portion of the Exclusion Area's coastline. The GGNRA's borders extend 1,000 feet offshore and its regulations cover the use of the seabed [77].	submerged lands one quarter mile off-shore to Exclusion Area high tide boundary
	National Marine Fisheries Program (NMFS)	NOAA's National Marine Fisheries Service (NMFS), under authority from the Magnuson-Stevens Act, regulates and protects living marine resources and habitats in the Exclusive Economic Zone (EEZ) beyond state waters (3nm to 200nm offshore). Fisheries management is a strong focus of NMFS, but the Service's implementation of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) also provides protection for all types of protected species (except otters) in marine ecosystems [77], [150]. NMFS operations as they relate to fishery resources within the Exclusion Area are informed by the recommendations of the Pacific Fishery Management Council.	federal waters
	Pacific Fishery Management Council (PFMC)	The Pacific Fishery Management Council (PFMC) is the regional council for the region containing the Exclusion Area. The PFMC develops plans for NMFS based on public input and the vote of the 14	federal waters

Level	Agency or Program	Jurisdiction	Level of Overlap with Exclusion Area
		member council composed of representatives from Oregon, Washington, California, and Idaho [77], [151].	
	Bureau of Ocean Energy Management (BOEM)	The Bureau of Ocean Energy Management (BOEM) manages the exploration and development of oil, gas, mineral, and alternative energy resources on the Outer Continental Shelf (OCS) while balancing protection for the environment [152]. There are no development leases in the Exclusion Area. If there were, the compliment to the BOEM, the Bureau of Safety and Environmental Enforcement (BSEE), would have regulatory oversight for the development activities [153]. The BOEM would offer protection for some sanctuary resources, but it is unclear how these would be implemented since the focus of the agency is on consumptive uses. These agencies may be irrelevant without active leases since sanctuary designation would preclude their oversight of the area.	mineral and energy resources within federal waters, including submerged lands
	U.S. Army Corps of Engineers (USACE)	The U.S. Army Corps of Engineers (USACE) maintains water infrastructure to support national economic interests [77]. The USACE has a number of operations in the Exclusion Area that are described in this report's assessment of dredging and dredged material placement activities (see chapter, "Dredging and the Placement of Dredged Materials").	discrete sites in territorial waters
	U.S. Environmental Protection Agency (USEPA)	The U.S. Environmental Protection Agency (USEPA), Office of Waters, implements laws and portions of laws covering dredging activities, water pollution prevention, and watershed management throughout Exclusion Area [77].	U.S. Army Corps of Engineers sites, any discharge to state and federal waters, adjacent watersheds
	U.S. Coast Guard (USCG)	The U.S. Coast Guard (USCG) is a maritime enforcement agency during peacetime and its jurisdiction covers the	entire Exclusion Area

Level	Agency or Program	Jurisdiction	Level of Overlap with Exclusion Area
		entire Exclusion Area. It is the only military branch in the Department of Homeland Security. The USCG has a station at Point Bonita [77], [154].	
	U.S. Fish and Wildlife Service (USFWS)	The U.S. Fish and Wildlife Service (USFWS) manages the implementation of the ESA and the Migratory Bird Treaty Act (MBTA). The Service complements NMFS's implementation of the MMPA in its responsibility for sea otters.	federally listed species throughout the Exclusion Area, some coordination with CDFW
State	California Department of Fish and Wildlife (CDFW)	The California Department of Fish and Wildlife (CDFW) manages living marine resources in state waters. Since the CDFW regulates fisheries that land catch to California ports its jurisdiction applies implicitly to areas beyond the 3 nm limit of state waters [77].	state waters, with some implied regulation of activities in all waters
	California Department of Parks and Recreation	The California Department of Parks and Recreation has numerous State Parks and Beaches in coastal areas adjacent to the Exclusion Area. Although there are no known state aquaculture leases under the purview of Parks and Recreation within the Exclusion Area, this agency would be required to coordinate with the California Fish and Game Commission on regulation of living marine resources if this proposed in the future [77].	adjacent lands
	Thornton State Beach	management and maintenance of park lands	shared boundary at Exclusion Area high tide boundary
	California State Lands Commission (SLC)	The California State Lands Commission is responsible for leasing state lands, including submerged lands [77] within the limits of state waters.	submerged lands in state waters
	California Coastal Commission (CCC)	The California Coastal Commission (CCC) regulates by permit the use of water, land, and submerged lands within the Coastal Zone. The Coastal Zone overlaps all the state waters within the Exclusion Area, except for at the mouth of the Golden Gate. The CCC's jurisdiction implicitly extends into federal waters because of the requirement for federal consistency under the Coastal Zone	state waters and submerged lands therein

Level	Agency or Program	Jurisdiction	Level of Overlap with Exclusion Area
		Management Act (CZMA) [77]. The CCC delegates the implementation of zoning and permitting to Local Coastal Programs (LCP) at the County or City level. See the "Local/State" level in this table for a list of approved LCP's within the Exclusion Area.	
	California State Coastal Conservancy	The State Coastal Conservancy "protects, restores, and improves coastal resources, and provides access to shore [77]."	adjacent lands
	State Water Resources Control Board (SWRCB)	The State Water Resources Control Board (SWRCB) regulates discharges into the Exclusion Area's state waters from point and nonpoint sources, including wastewater treatment plants.	implementation of EPA regulations for any discharge to state and federal waters, adjacent watersheds
	California Department of Water Resources (DWR)	The California Department of Water Resources (DWR) regulates California's water supplies in coordination with other agencies. "These activities directly impact water quality and quantity in estuaries and nearshore ocean environments [77]."	activities on adjacent lands
	California Ocean Protection Council	The California Ocean Protection Council coordinates the ocean-related activities among state agencies in order to protect ocean resources. The Council also uses its expertise to recommend legislative changes at the state and federal level that would improve protection in state waters [77].	state waters and submerged lands therein
	California Department of Boating and Waterways (DBW)	The California Department of Boating and Waterways (DBW) serves as the state's expert on recreational boating. It is involved in "public access, safety and education, marine law enforcement, and consumer and environmental protection [155]."	activities in state waters
Local/State	San Francisco City & County LCP	Under the authority of the Coastal Zone Management Act (CZMA), the California Coastal Commission (CCC) is a state agency that permits local development and reviews federal plans within the coastal zone The Coastal Zone extends from the seaward limits of state waters to several hundred feet inland, including submerged lands. However, the CCC	submerged lands from seaward boundary of state waters to Exclusion Area adjacent to county or city
	Olympic Club LCP (not filed as of 2005)		
	Daly City LCP		
	San Mateo County LCP		

Level	Agency or Program	Jurisdiction	Level of Overlap with Exclusion Area
		generally delegates implementation to local authorities based on Commission-approved Local Coastal Programs (LCP). In the Exclusion Area there are four LCPs: San Francisco City & County, Olympic Club (not approved as of 2005), Daly City, and San Mateo County [77]. South Marin County also has an LCP, but the portion of the coastline within the Exclusion Area is managed by the National Park Service and therefore is not covered by this LCP. Depending on how they are implemented; the permitting processes, LCPs, and review of federal lands provide indirect protection for many potential sanctuary resources within the Exclusion Area.	
Local	Pacific State Beach (managed by City of Pacifica)	management and maintenance of park lands	shared boundary at Exclusion Area high tide boundary
	Mussel Rock Park	management and maintenance of park lands	shared boundary at Exclusion Area high tide boundary
	Pedro Point Headlands	management and maintenance of park lands	shared boundary at Exclusion Area high tide boundary
	Sharp Park Beach	management and maintenance of park lands	shared boundary at Exclusion Area high tide boundary

Natural Resources Management

Much of what constitutes the potential natural resources of the Exclusion Area come from fisheries operating throughout the state and federal waters, the ecosystems that support such fisheries, and the quality of the water and marine sediments which impact these other resources. Though there are currently no aquaculture leases in the Exclusion Area, the protection of the ecosystem and the quality of supporting resources would also contribute to the value of possible aquaculture in the area. Similarly, the possibility of alternative energy development and oil, gas, or minerals mining could also be considered natural resources, though sanctuary status may limit the potential to extract these resources depending on how regulations are applied.

Many state and federal agencies have jurisdiction over each of these potential sanctuary resources; however, with the exception of fisheries management by National Marine Fisheries Service (NMFS) and

California Department of Fish and Wildlife (CDFW), there appears to be little coordination between the oversight of resources in state and federal waters. Even in the case of fisheries, though fish habitats are contiguous between state and federal waters, there is no comprehensive management that considers the connectivity of habits across this boundary. Sanctuary designation could provide additional protection for the value of fisheries by coordinating the management of natural resources between federal and state waters within the Exclusion Area.

Recreational and Aesthetic Resources Management

The value of potential recreational resources in the Exclusion Area depends largely on the maintenance of other sanctuary resources such as water quality, the integrity of beaches, and the conservation of species valued for fishing and wildlife viewing. Most recreational resources are experienced close to shore and entirely within state jurisdiction, which is comprehensively coordinated by the California Ocean Protection Council. However, to the extent that recreational resources depend on the continued maintenance of ecological and conservation resources, the recreational value of the Exclusion Area may not be comprehensively protected since the protection of these other resources is not fully coordinated between state and federal waters. Also, since many of the recreational activities that occur on lands adjacent to the Exclusion Area depend on the current aesthetic character of the Area, unimpeded views is an important component of the recreational value. Protection for the character of views from shore is not coordinated between federal and state agencies.

Ecological Resources Management

The potential ecological resources in the Exclusion Area include the various species within it, their habitats, and the greater ecosystem that supports them. Species within the Area, especially rare and protected species, receive fragmented consideration by different agencies. As with fishery species, management of broader ecological resources is conducted separately in state and federal waters. Specifically, habitats are protected separately in state and federal waters, though there is some indirect protection of the Exclusion Area through the requirement of federal consistency for the California Coastal Commission's regulation of development in state waters. Sanctuary status could provide more explicit comprehensive management of the Exclusion Area by bringing an ecosystem approach to the management of the Area and by facilitating coordinated management.

Historical, Cultural, and Archeological Resources Management

The potential historical, cultural, and archeological resources of the Exclusion Area are explicitly protected within the submerged lands of the Golden Gate National Recreation Area and the jurisdiction of the State Lands Commission. However, especially for resources that may be present in federal waters, there is no agency with dedicated protection authority. The Bureau of Ocean Energy Management would balance the protection of these resources with energy development and/or mineral mining; however, without active leases in the area, protection is not explicit. Sanctuary status would provide comprehensive protection for all of these resources throughout the Exclusion Area.

Conclusions and Emergent Criteria Evaluation

The degree to which existing management of a marine area must be lacking in order to qualify for sanctuary status is not set forth in the NMSA. However, our emergent criteria highlight the fact that previous designations have considered management across the potential sanctuary as a whole, and that resources have been recognized by at least two organizations prior to designation as a National Marine Sanctuary.

Potential sanctuary resources are found throughout the Exclusion Area and are generally not considered comprehensively by the federal, state, and local agencies and programs regulating their use. Explicit channels for coordination between these agencies do not exist in many cases. Therefore, sanctuary management can facilitate more comprehensive and coordinated management of the Exclusion Area. In addition, the area is partially recognized for some of its resources by at least two existing designations: the Bureau of Land Management's California Coastal National Monument (CCNM) and the GGNRA.

Our investigation of existing jurisdictional authorities concerned with regulation of the Exclusion Area finds that a common theme for the existing protection of potential sanctuary resources is a lack of coordinated management between state and federal waters. Sanctuary status could facilitate more comprehensive and coordinated protection for the variety of resources in the Area by providing a forum to communicate about resources that cross jurisdictional boundaries.

Table 23: Summary of Emergent Criteria Evaluation for Adequacy of Management.

Emergent Criteria		Does the Exclusion Area fulfill this criterion?
West Coast sanctuaries	At least 2 existing state or federal designations recognizing the value of the area.	Yes
	Existing management needs coordination/supplementation.	Yes
East Coast, tropical, and subtropical sanctuaries	Most regions warranted sanctuary designation in part because there was inadequate regulatory and management authorities dedicated to their special characteristics.	Yes
Historically focused sanctuaries	The site is already nationally recognized for its historic value in regard to the evolution of ship construction, including being registered in the National Register of Historic Places.	Partially
	State funding for protection of the site is limited.	Partially

Ease Of Management

Introduction

In addition to being nationally significant, the National Marine Sanctuaries Act (NMSA) states that an area must be of a "size and nature that will permit comprehensive and coordinated conservation and management" to be designated as a sanctuary. The Exclusion Area meets these requirements. Its size, nature, and current involvement in Gulf of the Farallones National Marine Sanctuary (GFNMS) management will promote sanctuary management of a more comprehensive and coordinated nature than the management currently in place.

Size

The Exclusion Area is 77 square nautical miles (nm^2). This small size can be considered manageable as other expansions have incorporated even larger areas. For example, in 2001 Florida Keys National Marine Sanctuary incorporated the 96 nm^2 Tortugas Ecological Reserve. Additionally, Monterey Bay National Marine Sanctuary (MBNMS) incorporated the 585-nm^2 Davidson Seamount Management Zone in 2009. Although the addition of the Exclusion Area would expand MBNMS to over 6,100 nm^2, the total area of the Sanctuary would still be smaller than other Sanctuaries. The Office of National Marine Sanctuaries' largest Sanctuary, American Samoa, encompasses 13,581 nm^2. Adding the Exclusion Area to MBNMS would not increase Sanctuary size to the point where manageability would be adversely affected.

Adjacent to the coast

Manageability of the Exclusion Area would be facilitated by its proximity to the coast. Unlike many other Sanctuaries that exist in remote environments, the Exclusion Area includes 20 miles of coastline and is next to the major metropolitan area of San Francisco. Because of this proximity to the shoreline, enforcement personnel and infrastructure, such as the Coast Guard, are located nearby and already patrol the coastal area [156]. Furthermore, bringing the boundaries of the Sanctuary closer to the coast will expand the Sanctuary's public visibility. The public may have greater sense of ownership of the Sanctuary, as it would be easier for them to visit. This sense of ownership makes management easier as more people are willing to accept regulations to protect the area and assume responsibility for caring for the marine environment.

Proximity to other Sanctuaries

The primary reason the nature of the Exclusion Area facilitates management is that it is surrounded by other sanctuaries. Sanctuary management could be improved by removing the gap created by the Exclusion Area. Several sanctuary designation documents point to the fact that comprehensive and continuous protection is ideal for conservation [69], [157]. Incorporating the Exclusion Area will allow the Sanctuary to regulate activities within the Exclusion Area that have the potential to impact the offshore waters of existing sanctuaries in the region. GFNMS and regional stakeholders could engage in joint management of vessel traffic, public utilities discharges, vessel discharges, dredged material

deposition, and coastal regional sediment management if the Exclusion Area receives sanctuary protections. This outcome helps ensure that human uses of the Exclusion Area are carried out in ways that minimize negative impacts to the region's marine resources, including those that already fall within existing Sanctuary boundaries. While this additional oversight would increase staff time dedicated to the review and management of activities in the Area, it would help the Sanctuary balance human uses and marine conservation. Additionally, the proximity to other sanctuaries has other benefits for management as existing management plans, regulations, and relationships with other agencies are already in place. GFNMS offices are located in San Francisco and are already engaged in coordinating management of the three existing sanctuaries with their counterparts at MBNMS offices and CBNMS offices in Point Reyes.

Current Sanctuary Management

GFNMS already manages several aspects of the Exclusion Area. First, GFNMS administers the Beach Watch program. This program trains citizen scientists to collect data from beaches between Bodega Head and Point Año Nuevo on bird and marine mammal resources, biological and physical changes of beaches over time, and early detection of human caused disturbances [158]. Also, GFNMS conducts oil spill surveys within the Exclusion Area [159]. Therefore, GFNMS's traditional role in managing certain aspects of the Exclusion Area could be extrapolated to more comprehensive, complete management should the proposed Sanctuary expansion take place.

Previous Sanctuary Expansions

Introduction

In addition to analyzing how the characteristics of the Exclusion Area meet emergent sanctuary designation criteria, we compared how the proposed expansion compares to previous sanctuary expansions. We reviewed the Environmental Impact Statements (EISs) for previous National Marine Sanctuary expansions and determined the justifications commonly cited for sanctuary expansions. This analysis can inform how the proposed expansion of Monterey Bay National Marine Sanctuary (MBNMS) to include the Exclusion Area compares to previous expansions.

Since the establishment of the National Marine Sanctuary Program (now Office of National Marine Sanctuaries) in 1972, thirteen Sanctuaries have been added to the system. In addition to several minor modifications of sanctuary boundaries over the years, there have been noteworthy expansions in the following Sanctuaries: Flower Garden Banks (FGBNMS), Florida Keys (FKNMS), Channel Islands (CINMS), Monterey Bay (MBNMS), and American Samoa (ASNMS). Table 24 summarizes these expansions [25], [69], [157], [160], [161].

Table 24: Summary of Previous Sanctuary Expansions.

	Flower Garden Banks	**Florida Keys**	**Channel Islands**	**Monterey Bay**	**American Samoa**
Year	1996	2000	2007	2009	2012
Size of Area Added	0.64 nm^2	96 nm^2	25 nm^2	585 nm^2	13480.75 nm^2
Total New Size of Sanctuary	42.45 nm^2	2896 nm^2	1138 nm^2	4500 nm^2	13481 nm^2
Primary Reason for Expansion	Incorporate Stetson Bank	Incorporate Tortugas Ecological Reserve	Define straight boundaries for a network of marine reserves	Incorporate Davidson Seamount	Create larger American Samoa NMS

The expansion justifications given in the EISs (Finding of No Significant Impact (FONSI) in the case of FKNMS) fall into four primary categories:

1) The area being incorporated into the sanctuary is unique.
2) The area deserves protection against increasing threats.
3) The expansion would facilitate comprehensive and coordinated management.
4) The expansion would increase opportunities for research, education, and outreach.

The Area is Unique

The documents for all five expansions establish how the area being incorporated is "special." Specific justifications include the presence of rare species, unique geological features, sensitive habitat types, Essential Fish Habitat, seabird foraging areas, and cultural and historic resources.

Protection Against Increasing Threats

All five expansion documents indicate that the area being incorporated into an existing sanctuary faces increasing threats and needs to be regulated. The primary reason cited for this increased threat is improved access to the area. Additionally, high fishing pressure in the area is identified in four out of the five expansions. FBNMS, now known as American Samoa NMS, also acknowledged that sanctuary status could provide a means to regulate non-point source pollution across American Samoa. All five documents also justify expansion stating that incorporation of the area will "ensure long term protection of Sanctuary resources" and protect spawning areas and biodiversity in general.

Facilitate Comprehensive and Coordinated Management

All five expansion documents recognize that the expansion would complement an existing network and provide more contiguous protection. Three of the five documents acknowledge that the expansion will allow for sustainable fisheries management and ecosystem-based management, while four of the five recognize improved cooperative management with other agencies. Another key justification within this category is that the expansion will create boundaries for the sanctuary that run along lines of longitude and latitude, which allows for better compliance and enforcement. This was the sole purpose of the CINMS expansion: it created straight boundaries for a network of marine reserves within the Sanctuary.

Increase Opportunities for Research, Education, and Outreach

All the expansion documents discuss how incorporating the area would foster stewardship and education. The expansion of FBNMS to become American Samoa NMS was largely justified because of the increased opportunities for education and engaging a greater population. Expanding research potential for a sanctuary is another frequently cited justification for expansion.

While most expansions focus on incorporating a unique area into an existing sanctuary, others have been approved to protect against threats, improve management, and/or increase public awareness. Sanctuary designation language is vague, but the above analysis helps reveal common threads for justifying past expansions. This information will inform our analysis of how the current expansion of MBNMS into the Exclusion Area compares to previous expansions. (See Discussion of Results.)

Discussion of Results

The analyses presented in this report indicate that:

1. The three reasons cited for the omission of the Exclusion Area from Monterey Bay National Marine Sanctuary (MBNMS) in 1992 do not currently constitute barriers to the proposed sanctuary expansion.
2. The Exclusion Area qualifies for sanctuary status because it meets a number of emergent sanctuary designation criteria.
3. The proposed expansion is comparable to previous sanctuary expansions.

Research Question 1

Our first research question addresses the three justifications for the Exclusion Area's removal from MBNMS boundaries in 1992: placement of dredged material, the combined sewer discharge from the City & County of San Francisco, and vessel traffic. We found that none of these activities would currently be barriers to the proposed sanctuary expansion. A summary of our results is provided below.

- The placement of dredged material within the Exclusion Area does not present a barrier to the proposed sanctuary expansion. Placement of dredged material occurs in other sanctuaries and the material dredged from the Main Shipping Channel (MSC) is considered "free" of toxins. Also, several sanctuaries have been designated despite the presence of dredging activities. However, regardless of whether SF-17 is designated as a beneficial reuse site or a regular placement site, if the Exclusion Area is incorporated into MBNMS, the Sanctuary would need to work with the U.S. Army Corps of Engineers and the Environmental Protection Agency (EPA) to ensure that sediment management activities are conducted with minimal impacts to the marine environment.

- The combined sewer discharge (CSD) from the City & County of San Francisco does not provide a compelling reason to block the proposed sanctuary expansion at this time. The annual number of times that water quality standards were exceeded has declined since the creation of the Exclusion Area in 1992. In addition, the installation of new infrastructure in the years following MBNMS designation has significantly decreased the number of CSD events. An offshore monitoring program has revealed no significant environmental impacts from the Southwest Ocean Outfall (SWOO). These findings indicate that the SWOO does not influence the Exclusion Area in a way that would preclude the Area from sanctuary status. Furthermore, the EPA's decision to reduce the intensity of the SFPUC's offshore monitoring programs in the Exclusion Area indicates that wastewater outflows are no longer of serious concern.

- Vessel traffic entering and exiting the San Francisco Bay along the MSC does not pose a barrier to the proposed sanctuary expansion. The level of vessel traffic in the Exclusion Area is comparable to the level of traffic in existing National Marine Sanctuaries, including Stellwagen

Bank, Channel Islands, and Monterey Bay. However, the Sanctuary needs to work with the EPA to ensure that Sanctuary and Federal vessel discharge regulations supplement the management of the California coast.

The future of each of these activities may include complexities and challenges that will necessitate careful, coordinated management to ensure that projects are conducted only when necessary and in the most environmentally beneficial way possible.

Research Question 2

Our second research question explores the qualities of the Exclusion Area that fulfill the sanctuary designation criteria in the National Marine Sanctuaries Act (NMSA). First, we confidently conclude that the Exclusion Area merits sanctuary designation under the NMSA. The NMSA states that a candidate site must have "special national significance due to its conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, *or* esthetic qualities; the communities of living marine resources it harbors; *or* its resource or human-use values" (emphasis ours) [1]. This language indicates that the Exclusion Area could qualify for sanctuary status if just one of these attributes is considered nationally significant. Because the language of the NMSA is broad and open to interpretation, we created the emergent sanctuary designation criteria to help determine which Exclusion Area qualities could be defined as "nationally significant."

Our report concludes that the Exclusion Area's traits fulfill a number of emergent sanctuary designation criteria, indicating that the Exclusion Area qualifies for National Marine Sanctuary status. While the Exclusion Area did not meet every emergent criterion, it met most of them. Since some degree of natural variation between sanctuary sites is to be expected, we have concluded that the Exclusion Area sufficiently meets the standards for sanctuary status that have been established over the 40-year history of the National Marine Sanctuaries System.

A table documenting the results of our second research question is provided below.

Table 25: Applying Emergent Sanctuary Designation Criteria to the Exclusion Area.

	Emergent Criteria
Ecological Significance	✓ Seasonal upwelling and high productivity ✓ Habitat and feeding grounds for a significant number of marine mammals and seabirds (some threatened or endangered) ✓ High abundance of fish X Confluence of major biogeographic regions, or unique topographic feature X Unusually high habitat diversity X Exceptionally high diversity of benthic organisms
Educational Significance	✓ Educational facilities currently have programs in this area
Scientific Significance	✓ Current research projects conducted in the area ✓ Major research facilities nearby ✓ High research potential X No major research facilities in the area
Human Use Significance	X Fishing in the area contributes a small amount to regional catch
Recreational Significance	✓ More than nine recreational uses ✓ More than two pre-existing recreation areas ✓ Recreational fishing exists ✓ Human activity intensity increasing ✓ Accessible to an urban population
Historical, Cultural, and Archaeological Significance	✓ Contains historical resources
Adequacy of Existing Management	✓ Many agencies dedicated to individual characteristics, but overall comprehensive management is inadequate and requires coordination ✓ Two existing government recognitions of the value of the area
Area's Size and Nature Requirement	✓ Smaller than other sanctuaries and other expansions ✓ Adjacent to three existing sanctuaries ✓ Would remove gap in management

The Exclusion Area has a demonstrated need for comprehensive, coordinated management. Currently, a variety of both state and federal agencies are responsible for the management of this Area (Figure 37 above). Sanctuary designation would facilitate greater collaboration between GFNMS and individual agencies to ensure that their actions do not detract from the "special national significance" of the Area. GFNMS could work with other agencies to efficiently manage the use of the Exclusion Area, as well as the resources it contains.

In addition to being comparable to existing Sanctuaries, the proposed expansion is also similar to previous sanctuary boundary expansions. Table 26 examines how the expansion into the Exclusion Area compares to previous expansions.

Table 26: Comparing the proposed expansion to previous National Marine Sanctuary boundary expansions.

Primary Justification	Secondary Justifications	Exclusion Area Characteristics
Area is Unique	Rare/Special Species	Endangered: brown pelican, humpback whale, leatherback sea turtle Threatened: Western snowy plover, Steller sea lion Special: Harbor porpoise, sevengill shark, white shark
	Unique Geologic Features	Within the widest stretch of shallow, flat continental shelf off California
	Sensitive Habitat Types	Essential Fish Habitat designation for groundfish, Coho Salmon, and Chinook Salmon
	Seabird Foraging Area	Clark's grebes, common murre, sooty and black-vented shearwater, white-winged and surf scoters, brown pelican, three species of cormorants, six species of gulls, and two species of terns use the area for foraging
	Cultural and Historical Resources	Native American cultural history of Coast Miwok and Ohlone Over 60 known shipwrecks within the Exclusion Area
	(New criterion)	The Exclusion Area has a unique oceanographic characteristic of significant upwelling.
Protection Against Increasing Threats	Improved Access to the Area	The GGNRA can host up to 14 million visitors a year Ocean Beach visitation alone is about 300,000 people per year Populations in adjacent counties are growing
	Increased Fishing Pressure	Commercial catch of key species, Dungeness crab and California halibut, is increasing Number of CPFV anglers is increasing
	Ensure Long Term Protection of Sanctuary Resources	Additional oversight of shipwrecks and cultural resources Additional protection for species and habitats within the

		Area Increase extent of continuous regional protection for marine areas Further coordinate sediment management and water quality issues to protect recreational resources
Facilitate Comprehensive and Coordinated Management	Complement an Existing Network	Located near CBNMS, GFNMS, and MBNMS
	Provide More Continuous Protection	Would remove gap between existing Sanctuaries
	Support Sustainable Fisheries Management	While NOAA currently defers fisheries management to CDFW, sanctuary managers could increase oversight for protection of marine species if necessary
	Improved Cooperation with Other Agencies	Opportunity to work with USACE, EPA, SFPUC, NPS, CDFW, and a variety of other agencies on many activities that could influence conditions in the Exclusion Area and in existing sanctuaries in the region
	Straight Sanctuary Boundary Lines	Gap between MBNMS, GFNMS, and CBNMS would be removed to create more continuous boundaries
Increase Opportunities for research, education, and outreach	Foster Stewardship and Education	Opportunities to expand educational programs within the area Opportunity to expand knowledge of Sanctuaries in a large metropolitan area Increased sense of stewardship for local communities as Sanctuary boundaries are brought to shore.
	Provide Increased Research Opportunities	Opportunities to increase research within the Exclusion Area

We find that the Exclusion Area meets the emergent criteria for sanctuary designation and is comparable to previous National Marine Sanctuary expansions. However, while the emergent criteria we identified are useful to evaluate what may qualify as "nationally significant," it is important to acknowledge that the NMSA was presumably written to allow considerable discretion in sanctuary

designation decisions. This flexibility allows NOAA (or Congress) to designate areas they identify as "nationally significant" and in need of protection. Our framework is not meant to be used as a definitive "check-box" for decision-making. Instead, we suggest using this framework as a model for identifying whether a marine area has characteristics of "special national significance." Through this analysis, we found that several characteristics of the Exclusion Area make it "nationally significant." We therefore recommend incorporating the Area into NOAA's National Marine Sanctuary System.

Recommendations

Overview

We recommend that GFNMS incorporate the San Francisco-Pacifica Exclusion Area into the National Marine Sanctuary System. The original reasons used to justify the Exclusion Area's removal from Monterey Bay National Marine Sanctuary (MBNMS) boundaries in the 1992 Federal Register Notice do not preclude the proposed sanctuary expansion. We find that the Exclusion Area's characteristics are nationally significant, in terms of the language of the National Marine Sanctuaries Act (NMSA) and the emergent criteria developed for our analysis.

While the former reasons given for exclusion are not barriers to the proposed expansion, human activities within the Exclusion Area will present Gulf of the Farallones National Marine Sanctuary (GFNMS) with unique management issues that will mostly relate to regional commerce, public health, and infrastructure protection. Specifically, existing MBNMS regulations have the potential to affect a number of regionally critical human use activities that occur within the Exclusion Area. These critical human uses include dredging activities, water pollution control, commercial and recreational uses, coastal erosion management, and climate change adaptation projects in response to sea level rise. If these activities are to continue under the proposed expansion of MBNMS, existing sanctuary regulations would need to be altered or special exemptions would need to be made.

We have two general recommendations for GFNMS with regard to these critical human uses of the Exclusion Area:

1. We recommend that GFNMS maintain a close working relationship with regional agencies and institutions that are involved in the planning, development, and implementation of these critical human uses within the Exclusion Area.
2. GFNMS should jointly develop management approaches and regulations with regional stakeholders that would be affected by the proposed expansion.

The alteration of existing sanctuary regulations and the implementation of new management approaches should balance critical human use activities in the Exclusion Area with the conservation of sanctuary resources.

It is important to note that the proposed expansion has a potential tradeoff. Incorporating the Exclusion Area into MBNMS will likely increase the complexity of management for GFNMS, which could impose additional administrative burdens on the agency. In the current fiscal environment, this may require the Sanctuary to shift resources away from other agency activities. Given the critical nature of certain human use activities in the Exclusion Area, the Sanctuary should be prepared to devote additional resources to the joint development of management plans or projects.

In addition to these general recommendations, we have specific recommendations for addressing potential management issues that may arise from ongoing and future human uses of the Exclusion Area. The following sections detail these recommendations for different human use activities.

Dredging Activities

A working relationship between GFNMS and the U.S. Army Corps of Engineers (USACE) will help ensure that marine resources receive adequate consideration in the planning and development of USACE projects in the Exclusion Area. Given the different mandates of GFNMS and USACE, an ongoing interagency dialogue will be crucial to creating greater consensus among managers on the appropriate balance between public engineering services and marine resource conservation.

We do not specifically recommend that GFNMS allow or prohibit the placement of dredged material at SF-17 due to the current uncertainty surrounding both the environmental impacts and the beneficial reuse potential of the site. Until the Environmental Impact Statement for SF-17 is issued, the potential environmental impacts of dredge material placement at SF-17 will not be clear. We therefore recommend that GFNMS carefully review the forthcoming EIS for SF-17 and establish the effectiveness of dredge deposition activities at the site for beneficial reuse.

Coastal Regional Sediment Management

The forthcoming Coastal Regional Sediment Management Plan (CRSMP) considers many engineered responses to coastal erosion that could be applied along the western shorelines of San Francisco and San Mateo Counties, which would fall within the management area for the proposed Sanctuary expansion. GFNMS may need to dedicate significant agency resources to developing new regulations and management approaches that will promote the implementation of effective coastal erosion controls with an acceptably low impact on sanctuary resources.

Sanctuary staff should continue to maintain a direct line of communication with the Coastal Sediment Working Group (CSWG) of San Francisco and CRSMP stakeholders. We also recommend that GFNMS staff closely follow the CRSMP's development. Although coastal communities are not legally required to follow the recommendations in the CRSMP, the plan could significantly influence their erosion management measures. If these measures have the potential to significantly impact marine environments, GFNMS may have to dedicate additional resources to public outreach and stakeholder engagement. Communicating with the CSWG and regional stakeholders will allow GFNMS to identify changes in regulations or management approaches that may be required for future coastal erosion management projects.

Wastewater Treatment & Water Pollution Control

We recommend exempting the San Francisco Public Utility Commission from sanctuary regulations that prohibit primary treated discharges into sanctuary waters. Under Section 922.132(f), GFNMS can exempt facilities from these regulations if the primary treated discharges were permitted under the

CWA's National Pollutant Discharge Elimination System prior to January 1, 1993. Primary discharges from the combined sewer system along San Francisco's west side were permitted by the EPA prior to 1993 and therefore meet the regulatory criteria for exemption. We find that the west side combined sewer system is a minor source of environmental impacts. Additionally, we also consider that further reductions in the number of combined sewer discharges from the Oceanside WPCP would be extremely cost prohibitive and technically challenging for the City & County of San Francisco.

We recommend that GFNMS exempt the SFPUC from certain regulations prohibiting alterations to the seafloor and coastline. These alterations would allow the SFPUC to protect and maintain wastewater infrastructure in the Exclusion Area. Our recommendation considers the public health implications of a deterioration of wastewater treatment infrastructure, and its potential effect on nationally significant levels of recreational use at Ocean Beach and other coastal regions along San Francisco's west side. Existing seafloor regulations may also prohibit the SFPUC from updating and maintaining offshore wastewater infrastructure, since these activities could alter the seafloor. More significantly, coastal erosion along Ocean Beach is a threat to wastewater transport structures beneath the Great Highway and outfall structures along the beach. The transport structures both convey and store wastewater destined for treatment at the Oceanside WPCP. During wet weather events, outfall structures located at Ocean Beach and other coastal points along San Francisco's west side serve as discharge points for the excess wastewater. Together, the transport and outfall structures prevent system overflows into densely populated districts of San Francisco.

The role that dredged material placement at SF-17 may play in protecting wastewater infrastructure provides an additional reason for GFNMS to carefully review the forthcoming EIS and determine the beneficial reuse potential for SF-17. The Ocean Beach Master Plan indicates that placing dredged material at SF-17 has the potential to protect coastal wastewater infrastructure along Ocean Beach [162]. This assumes that SF-17 is effectively functioning as a beneficial reuse site. Additional protections such as artificial reefs, revetments, and coastal armoring could also be needed to effectively protect SFPUC infrastructure over its full life. GFNMS and the SFPUC should work to jointly develop regulations and erosion responses that will help protect critically important infrastructure, while minimizing potential environmental impacts. The connection between water pollution control and marine conservation in the region provide strong reasons for the two agencies to collaborate.

Nationally Significant Historical Resources

We recommend that the Office of National Marine Sanctuaries work with the California State Lands Commission and the National Parks Service to manage cultural, historical, and archaeological artifacts within the Exclusion Area. GFNMS could further connect coastal communities in the region with historical-cultural resources in sanctuary waters by communicating with these agencies, sharing resources, and collaborating on research projects. The proposed sanctuary expansion would provide a rare opportunity to highlight the submerged historical resources in the Exclusion Area waters currently managed by the GGNRA. We recommend that GFNMS and the GGNRA work together to capitalize on this opportunity.

Commercial and Recreational Uses

We recommend that GFNMS engage with regional stakeholders at all levels, including the different groups of recreational users. Our analysis of recreational uses in the Exclusion Area highlights the need for management approaches that give due consideration to multiple and sometimes conflicting human uses of marine resources. Engaging and forming strong relationships with different groups of recreational users will support the Exclusion Area's recreational value, which depends heavily on the balanced provision of many regional resources. Therefore, we recommend that GFNMS consider how recreational users would be affected by regulations, management approaches, and the level of services provided by other agencies such as the SFPUC and USACE.

As with historical resources, collaboration and education can be key strategies for maintaining and enhancing recreational resource value. The sanctuary system's educational mission could play a key role in developing stakeholder relationships with the diverse range of recreational users that access the Exclusion Area. Many recreational uses of the area, such as wildlife viewing and beach- or pier-based fishing, are characterized by engagement with the ocean environment. Sanctuary programs that recognize the expertise of "small" stakeholders and leverage their knowledge to educate the wider public, like the Farallones Marine Sanctuary Association's Beach Watch program, could be effective paths to increasing stakeholder engagement.

Recommendations for Future Research

The proposed expansion of Monterey Bay National Marine Sanctuary (MBNMS) presents a unique opportunity to identify needs for future research. In the course of this study we have discovered areas where Sanctuary management could be enhanced by further research. This research could provide long-term benefits to both the resources in the area and the people who use the area.

Sanctuary Designation and Expansion Process

We provide a unique review of existing National Marine Sanctuaries, identifying and summarizing the qualitative and quantitative characteristics that have emerged over time as standards for sanctuary designation. The National Marine Sanctuary System could use these emergent criteria to evaluate or guide future sanctuary expansions and designations.

We also found that a comprehensive evaluation of national marine environments is needed in order to identify optimal candidate sites for sanctuary designation. Currently, sites are simply nominated as sanctuary candidates based on (usually local) stakeholder and managerial interest. There is no system that ensures all potential sites are considered, and that those with the highest conservation value are selected for designation. Addressing this gap in the sanctuary designation process would enhance the effectiveness of the National Marine Sanctuary System.

Sediment Management

The Exclusion Area and surrounding sanctuaries could benefit from a long-term monitoring program to better determine whether dredged material placed at SF-17 actually qualifies as beneficial reuse. In addition, identifying other locations that could facilitate beach nourishment or host other beneficial reuse operations would be useful.

Wastewater Infrastructure and Climate Change Impacts

Management of wastewater's impact on the Exclusion Area and the surrounding sanctuaries could benefit from further study. Anticipated changes to regional precipitation patterns will influence the frequency and volume of combined sewer discharge (CSD) events from San Francisco Public Utilities Commission's (SFPUC) wastewater treatment operations. The uncertainty about shifts in regional wet weather patterns due to global climate change is significant, making it difficult to determine the impact these changes will have on wastewater flows. Additional research should be conducted to assess the effects that changes in regional rainfall could have on the volume and frequency of CSD events, and thus on local water quality. This research could consider the effects of new urban watershed infrastructure (upstream cisterns, rain gardens to collect precipitation and allow infiltration, permeable pavements, and the installation of larger pipes that can convey and store increased volumes of water) on the volume of storm water flows through San Francisco's combined sewer system [56].

Sea level rise also poses uncertain risks to wastewater infrastructure. The majority of SFPUC's internal climate change guidance documents focus on responses to sea level rise. Integrating new information

regarding projected sea level rise into decision-making processes should be central to effective management and planning.

Vessel Discharges

Further research must also be conducted to determine how National Marine Sanctuary vessel discharge regulations will interact with the California No Discharge Zone regulations. The EIS for the proposed expansion should address these primary questions:

1. How many vessels would be able to comply with both the National Marine Sanctuary regulations and the NDZ regulation if the Exclusion Area is incorporated into MBNMS?
2. Would vessels be more likely to discharge in the sanctuaries or within the NDZ if they do not have access to the Exclusion Area for permitted discharge?
3. Is the Exclusion Area the most appropriate location for vessel discharges or is there another area that may be more appropriate if exceptions to the prohibitions under existing regulations were made?

This information will inform how the Sanctuary may need to adapt regulations to allow for critical human uses of the Exclusion Area and supplement California water quality management.

Ecological Resources

The Exclusion Area is uniquely located between the biologically productive and relatively pristine GFNMS and MBNMS; the heavily impacted, dense urban environment of San Francisco; and the high nutrient outflow from the San Francisco Bay. It thus presents significant opportunities for research into human impacts on the marine environment, and the potential for mitigating those impacts through adaptive sanctuary management approaches.

A need exists for finer-scale surveys of species distributions and movements through the Exclusion Area. To date, the major surveys conducted in the region focus on the sanctuaries surrounding the Exclusion Area. While these surveys include the Exclusion Area, the scope is too large to understand the Area on a more detailed level. Additionally, while their findings indicate that the ecological qualities of the region should be considered nationally significant, thus supporting the proposed sanctuary expansion, opportunities remain for research at a finer scale.

For example, there is a need for coordinated population assessment and monitoring of great white sharks in and around the Exclusion Area. Further tagging and monitoring could help determine the migratory routes and locations of sharks in and just outside of the San Francisco Bay. The sharks' locations in and patterns of movement through the Exclusion Area are currently unknown, as this location has not yet been monitored [91], [92]. Other species, especially those that have wide-ranging migratory patterns such as whales and turtles, also could be studied further to learn about their movements through and within the Exclusion Area.

Historical Resources

Since there is ample evidence of historic (Paleo Indians, Native Americans, and European Explorers) use of the Exclusion Area, archaeological dives may provide additional information about these peoples. There are many archaeological sites on the shoreline of the Exclusion Area and it is highly probable that artifacts exist in the Area but have been inundated by rising seas. Concentrated research could expose these artifacts for study. Also, further exploration and documentation of shipwrecks in the area have the potential to contribute to the maritime history of the region. Shipwrecks may also be monitored to determine whether they provide habitat for any living resources in the Area.

Recreational Value

We have provided a sense of the recreational value of the area, and, where possible, reported use statistics of recreational sites throughout the Area. However, use statistics were not available for many sites and activities. Further studies on the use of particular sites and the relative value of various activities could help to prioritize future management options. The non-profit Ecotrust has studied a variety of human uses along the California coast and could be an important partner for developing information that can be used to weigh the relative value of recreational activities throughout the Exclusion Area over time.

Data from the National Ocean Economics Program and NOAA's Coastal Services Center on the economic impact of the ocean economy on California counties is aggregated by economic sector. Many industries contribute to the value of the "tourism and recreation" sector. Information on the contribution of specific industries would help the Sanctuary prioritize management options where tourism and recreational values need to be balanced with other concerns.

The topics discussed above represent just a sample of the possible directions for future research in the Exclusion Area. Sanctuary designation would likely facilitate such research, and provide protection for an important environment replete with research opportunities.

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Appendices

Appendix A – Emergent Criteria List

The thirteen sanctuaries fall into three categories for the purposes of this report:

US West Coast sanctuaries:

1. Monterey Bay
2. Gulf of the Farallones
3. Cordell Bank
4. Channel Islands
5. Olympic Coast

US East Coast, Tropical, and Subtropical Sanctuaries:

1. Gray's Reef
2. Florida Keys
3. American Samoa
4. Flower Garden Banks
5. Stellwagen Bank
6. Hawaiian Islands Humpback Whale

Historically focused sanctuaries:

1. Monitor
2. Thunder Bay

The thirteen Environmental Impact Statements (EISs) reviewed in this study varied significantly in terms of what information was presented, and whether that information was qualitative or quantitative. However, the purpose of the review was to deduce common characteristics between sanctuaries. Therefore, some emergent characteristics are quantitative while others are qualitative. Also, emergent criteria were listed even if the one or two sanctuaries did not report the characteristic. For example, if 5 out of 6 sanctuaries reported a certain characteristic, but the sixth did not report any information on the subject, the emergent characteristic was still listed, but with that caveat.

Please consult Appendix B for the sanctuary-specific information that gave rise to each commonality listed below.

West Coast sanctuaries

This sanctuary type is the most relevant to our analysis because the sanctuaries contain similar habitats as the exclusion area and were designated for similar reasons.

1 Ecological
    a Seasonal upwelling and high productivity.
    b Confluence of two major biogeographic regions, or a unique topographic feature.
    c Unusually high habitat diversity, defined either by varying substrates or by depth.
    d At least 14 species of marine mammals, as well as marine mammal breeding sites and feeding habitat. Typically, between 5 and 20 of these species are threatened or endangered.
    e 50 or more species of seabirds, along with sites for key seabird life history events, including breeding, rafting, and foraging. At least five of these species are endangered or threatened. The sanctuary is of paramount importance for at least one species, because, for example, it hosts the largest breeding population of the species or it contains the entire population of the species. The site contains significant general or species-specific seabird abundance, often representing the highest numbers within a particular region (the region sets a record on a particular metric).
    f High diversity and abundance of fish, including commercially important species such as rockfish or salmon.
    g Exceptionally high diversity of benthic organisms, with assemblages of algae and invertebrates that provide vital links in the area's food chains.
2 Recreational/Human Use
    a Increasing intensity of human activity.
    b Increasing accessibility to an urban population.
    c Commercial fishing represents a very significant human use-- often the most significant human use of the area.
    d Recreational fishing: Party boats are common.
    e 5-10 cited recreational uses of the area.
    f Number of pre-existing recreation areas: at least 2 in most cases.
    g Military use: Common for military operations to take place in the area. Sanctuaries often overlap with pre-established zones designated for specific military training operations.
    h It is common for visitors to sanctuaries to number in the millions.
3 Historical/Cultural/Archaeological
    a No commonality: Sanctuaries may contain little to no historical resources, or they may contain upwards of 300 of shipwrecks.
4 Scientific
    a High research potential due to pre-existing research projects and the interesting nature of the sanctuary's natural resources.
    b 5-21 research facilities or major research endeavors are being conducted or have been conducted in the area.
5 Educational
    a While some educational programs may exist (particularly in the case of Monterey Bay), in most cases no educational program exists that conveys to the public the importance of the region nor conveys the scientific information available regarding the area's natural communities.

6 Commercial shipping
    a Common for a sanctuary to be located near or in major shipping channels.
7 Dredging
    a No commonality: in some cases, dredging occurs because it is necessary to maintain access to important ports, but in other cases, no dredging-related operations occur within or near sanctuary boundaries.
8 Other discharges (not much wastewater is mentioned in EISs)
    a Only mentioned in two EISs, Channel Islands and Farallones: both contained offshore radioactive material disposal sites.
9 Adequacy of existing management
    a Existing management needs coordination/supplementation
    b There is an impending threat to the area. These sanctuaries were often protected by their distance from the mainland and relative inaccessibility, or by the relatively low intensity of human uses of the area. However, both commercial and recreational human uses of the area are increasing in intensity.
10 Prior acknowledgement of value
    a At least 2 existing state or federal designations recognizing the value of the area.

East Coast, tropical, and subtropical sanctuaries

1 Ecological
    a Sanctuaries usually harbor either communities living at or beyond their normal geographical limits, or a rare ecosystem or species life history event.
    b The sanctuary can often be split into at least 2 distinct habitat types either by substrate type, depth, or by distinctive topographical features.
    c All sanctuaries contain at least 2 marine mammal species, but some individual sanctuaries harbor up to 24 species. In about half the sanctuaries, marine mammals use the site for important life history events, including birthing, mating, and foraging. Marine mammals are often found in low abundances in these sanctuaries. Two to fourteen endangered marine mammals are reported in the sanctuaries.
    d When reported, most sanctuaries contain 20 and 40 seabird species.
    e Sea turtles are commonly reported in sanctuary waters, often including 2 to 5 species.
    f High abundance and diversity of fish is often reported, either because the ecosystem has high biodiversity by nature, or because the area is a transition zone between two marine regions. Usually fish species number in the hundreds.
    g Benthic fauna is usually highly diverse, often including a high number of algae and macro invertebrate species, along with many coral species if the sanctuary includes coral habitat.
2 Recreational/Human Use
    a Human use of the area is increasing, causing increases in anchoring, illegal taking of species, and other recreational uses.

b Accessibility of sanctuaries varies from low to high, but usually at least some degree of human use occurs in the area.
c Oil and gas development: Low to none.
d While some sanctuaries do not support large commercial fishing operations, most support operations that are quite important to the local economy.
e Recreational fishing in these sanctuaries is typically quite high, and both party and charter boat fishing is common.
f Water-based recreational activities are common in the area, and most sanctuary designation documents cite 3 to 10 major recreational activities that take place within the region.
g While military activities are not conducted in some sanctuaries, they are commonly conducted in predefined locations that overlap with most sanctuaries' boundaries.
h Tourism is often a key element of the economies near sanctuaries.

3 Historical/Cultural/Archaeological
   a Most sanctuaries contain (or are suspected to contain) some or all of the following historic or cultural resources: Paleo-Indian remains, shipwrecks, lighthouses, aircraft wrecks, or current practice of traditional activities by native cultures.

4 Scientific
   a Most sanctuaries have high research potential due to the presence of a unique habitat or a species of interest.
   b While most sanctuaries do not cite the number of institutions that conduct research in their waters, it is clear that most sanctuaries are commonly used in field research.

5 Educational
   a Two sanctuaries do not report educational programs, but the others report between 2 and 17 programs.

6 Commercial shipping
   a While some there is no significant vessel traffic in some sanctuaries, most sanctuaries are located in or near major shipping routes.

7 Dredging
   a Dredging occurs in about half of these sanctuaries.

8 Other discharges (not much wastewater is mentioned in EISs)

9 Adequacy of existing management
   a Most regions warranted sanctuary designation in part because there was inadequate regulatory and management authorities dedicated to their special characteristics.
   b There is an impending threat to the area: In most cases, human use of the sanctuary region was increasing, putting sensitive habitats at risk of associated damage. Such human actions included anchoring, shipping, and land-based pollution or habitat modification. Often, sanctuary waters were considered relatively pristine.

10 Prior acknowledgement of value
   a Some, but not all, sanctuaries had prior state or federal designations, and some are simply regulated by certain legislation.

Historically-focused sanctuaries

1. Ecological
    a. Not mentioned. In Thunder Bay's case, the ecological value of the area is purposefully left out of consideration. In both cases, the sanctuary was established solely to protect the shipwreck(s) in the area.
2. Recreational/Human Use
    a. Human use of the area is increasing
    b. No topical commonality: Monitor's site is unsuitable for recreational uses, whereas Thunder Bay cites at least 5 common recreational uses of the area.
3. Historical/Cultural/Archaeological
    a. One to 160 shipwrecks exist in the area.
4. Scientific
    a. Only the Thunder Bay EIS mentioned educational value of the area: 4 programs currently exist.
5. Educational
    a. The area will foster educational programs based upon shipwrecks though the current or future research in the site.
6. Commercial shipping
    a. Vessel traffic is both permitted and common in sanctuary waters.
7. Dredging
    a. Not mentioned.
8. Other discharges (not much wastewater is mentioned in EISs)
9. Adequacy of existing management
    a. There is an impending threat to the area: An increasing public interest in shipwrecks is putting the wrecks at risk of both legal and illegal salvage operations.
    b. State funding for protection of the site is limited.
10. Prior acknowledgement of value
    a. The site is already nationally recognized for its historic value in regard to the evolution of ship construction, including being registered in the National Register of Historic Places.

Emergent sanctuary criteria across all 13 sanctuaries:

Very few. Monitor and Thunder Bay are so different than the other sanctuaries that it was hard to find universal traits for all thirteen sanctuaries. The few I found include:

1. Existing management needs coordination/supplementation.
2. There is an impending threat to the area.
3. Vessel traffic is moderate to intense either within the sanctuary or nearby.
4. Almost all sanctuaries cite 3-10 major recreational activities commonly practiced in sanctuary waters.

Appendix B – Emergent Criteria Table

	Historically focused sanctuaries			West Coast Sanctuaries						East Coast, Tropical, and Subtropical Sanctuaries							
	Monitor	**Thunder Bay**	**EMERGENT CRITERIA**	**Channel Islands**	**Farallones**	**Cordell Bank**	**Monterey Bay**	**Olympic Coast**	**EMERGENT CRITERIA**	**Gray's Reef**	**American Samoa**	**Florida Keys**	**Flower Garden Banks**	**Stellwagen Bank**	**Humpback**	**EMERGENT CRITERIA**	**UNIVERSAL COMMONALITIES**
Year designated	1975	2000		1980	1981	1989	1992	1994		1981	1986	1990	1992	1992	1992		
Size	federal waters, circular area with a diameter of one mile	448 square miles		1252.5 square nautical miles (6 mile radius around the northern Channel Islands) C-6	1,282 square miles	397.05 square miles	2,539 square nautical miles	3,310 square mile	Sanctuaries sizes range from about 400 square nautical miles to over 3000.	22 square mile sanctuary	0.25 square miles	3,801 square miles	41.70 square nautical miles	638 square nautical miles; federal waters	1,370 square miles	Wide range of sizes: from less than one square mile to over 1000 square miles.	
Designated by	NOAA	NOAA		NOAA	NOAA	NOAA	NOAA	NOAA		NOAA	NOAA	Congress	NOAA	Congress	Congress		
Approximate location	South Atlantic	Great Lakes		Southern California Bight near Santa Barbara	Central and northern California coast	Central and northern California coast	Central and northern California coast	Washington state coast		Gulf of Mexico	American Samoa (South Pacific)	Gulf of Mexico	Gulf of Mexico	New England coast	Hawaii		
Unique characteristic	The first National Marine Sanctuary ever created. Designated to protect just one shipwreck, the Civil War-era ironclad *Monitor*.	First freshwater and Great Lakes National Marine Sanctuary, the only National Marine Sanctuary located entirely within state waters, and the first National Marine Sanctuary to focus solely on a large collection of underwater cultural resources.		Extremely high biodiversity and productivity, along with extremely high-value human uses such as research, fishing, recreation, and shipping.	Contains the widest part of the continental shelf, which provides a large, relatively shallow foraging habitat for birds, mammals, and fish.	High primary productivity due to upwelling and relatively clear water that allows light penetration.	The Monterey Submarine Canyon and Monterey Bay are unique geological features on the Californian coast. The area has high biological productivity and biodiversity.	"The marine ecosystem's diverse resources and rich productivity make it an area of regional and national significance."		Live bottom habitat (hard bottom upon which corals can grow) is relatively rare on South Atlantic Continental Shelf	Only American territory in Southern Hemisphere		Coral reefs isolated from other reef systems by over 300 miles, and living at margin of their typical range. northernmost living coral reefs on the US continental shelf p.15, Only known brine-seep community in the continental shelf in the Gulf of Mexico	Large offshore banks that support large, commerciall y-important fish populations: both forage fish and predators. Biodiversity is high because the region is a transition zone between Gulf of Maine and the Mid-Atlantic region.	Sanctuary targets the habitat of humpback whales, with some consideratio n of other natural resources. The Hawaiian Islands are the most isolated island chain the world, and as such it is home to many endemic species.		
Distinctive oceanographic or topographical feature that fosters biological productivity				Situated at the confluence of two major biogeographic regions, resulting in a unique and rich species assemblages. Upwelling highly variable substrate promotes biodiversity and biological productivity.	Situated over the widest portion of the continental shelf in California. Two major currents dominate the region, creating an upwelling season that provide nutrients that supports biological productivity. Outflow from San Francisco Bay estuarine complex also supplies nutrients to the area.	Cordell Bank is the northernmos t seamount on the California continental shelf, and substrate depth is highly variable, creating a high variety of habitats. Low particulate loading, high sunlight penetration, and upwelling provides conditions for high biological productivity.	Monterey Submarine Canyon contributes to upwelling, which fosters high productivity. Situated at the transition zone between the Oregonian Province to the north and the Californian province to the south, resulting in high biodiversity.	Numerous seastacks and rocky outcrops along the coast, a large tidal range and wave splash zone. Upwelling due to northwesterly winds during the spring and summer gives rise to high productivity and abundance of marine life.	Upwelling, high productivity; Either the confluence of two major biogeographi c regions or a unique topographic feature	Live bottom habitat is relatively rare on South Atlantic Continental Shelf, transition area between coastal freshwater-dominated regime and Gulf Stream-dominated regime; corals here are at limits of their environmen tal tolerance	Steep cliffs surround Fagatele Bay, making it relatively inaccessible; seabirds nest there. It island is part of a volcanic archipelago with fringing coral reefs that harbor high biodiversity.	Florida Keys separate Gulf of Mexico species from South Atlantic species, so it has a rich assemblage of both groups of species living at the limits of their ranges.	The banks themselves are domes (diapirs) formed by the intrusion of salt from Jurassic evaporite deposits. Area harbors 500+ acres of coral reefs	Overturn and mixing of coastal waters with deeper waters result in complex system of overlapping midwater and benthic habitats.	The bathymetry of the area represents a unique, semi-enclosed, shallow protected sea in the midst of an expansive ocean. - habitat for wintering humpbacks	Sanctuaries usually harbor either communities living at or beyond their normal geographical limits, or a rare ecosystem or species life history event.	
Existing recognition of value (other designations)	National Register of Historic Places	Qualifies for status as a National Historic Landmark and should qualify for the National Register of Historic Places. Established as the State of Michigan Great Lakes Bottomland Preserve in 1981.	The site is already nationally recognized for its historic value in regard to the evolution of ship construction. Site is registered in the National Register of Historic Places.	Channel Islands National Park; Channel Islands National Monument	12 state and federal designations exist from Bodega Bay to San Francisco.		36 sites are managed by the CA Department of Fish and Wildlife; The Sanctuaries and Reserves Division and the DFG manage the Elkhorn Slough National Estuarine Research Reserve; Several Areas of Special Biological Significance are designated. No designation provides comprehensiv e management.	Olympic National Park; USFWS offshore National Wildlife Refuges; Wilderness areas designated by local tribes; County and state parks.	At least 2 existing state or federal designations recognizing the value of the area.	None. Under the legal status quo, current legislation does not address the most direct threats to the live bottom; i.e., seabed alteration and construction , bottom trawling and specimen-dredging, anchoring, wire trap fishing, marine specimen collecting, damage to or removal of cultural/hist orical resources.	Fagatele Bay is designated a Marine Park under American Samoa Code.	24 Federal and State recreation areas, parks, refuges, historic sites, botanical sites, archaeologi cal sites, geological sites, and aquatic preserves within the Keys, accounting for nearly 10,000 km2 of land and water resources.	None are mentioned.	None are mentioned.	9 National Wildlife Refuges, 7 parks managed by the National Park Service, 1 Natural Area Reserve, 2 State Underwater Parks	Some, but not all, sanctuaries had prior state or federal designations, and some are simply regulated by legislation.	

	Historically focused sanctuaries			West Coast Sanctuaries						East Coast, Tropical, and Subtropical Sanctuaries							
	Monitor	**Thunder Bay**	**EMERGENT CRITERIA**	**Channel Islands**	**Farallones**	**Cordell Bank**	**Monterey Bay**	**Olympic Coast**	**EMERGENT CRITERIA**	**Gray's Reef**	**American Samoa**	**Florida Keys**	**Flower Garden Banks**	**Stellwagen Bank**	**Humpback**	**EMERGENT CRITERIA**	**UNIVERSAL COMMONALITIES**
Habitat diversity				Highly varied substrate, including abrupt changes in the depth provide a wide diversity of benthic habitats and other marine organisms. Depth is the strongest determinant of benthic assemblages. Also of note is the variation of substrate, including soft muddy deep-water trenches, sandy inland shelf flats, and rocky outcrops.	Sanctuary would encompass both the Farallones Islands and mainland estuarine shoreline with embayments. It will include rocky headlands, submerged reefs, salt marshes, eelgrass beds, tidal mud flats.	Habitat is stratified by depth: "Most of the flora and fauna live in densely packed masses near the tops of the ridges and pinnacles. However, because the species living on the Bank do not have the same environmental requirements or tolerances, there is a marked variation from one depth to another in the distribution of organisms"	6 major habitat types: submarine canyon, nearshore littoral, rocky intertidal, sandy beach intertidal, kelp forest, estuarine/slough	5 biogeographic zones with 12 associated habitats, including offshore islands and rocks; intertidal zones, rocky headlands, seastacks, and arches, river mouth inlets, submarine canyons and ridges; continental shelf, continental slope.	Unusually high habitat diversity, defined either by substrate or by depth	1 principle habitat type: hard bottom habitat, which is considered one of the five major habitat types in the South Atlantic Continental Shelf. Within this habitat are overhanging ledges, caves, troughs, and burrows	Two major habitats: open coastal nearshore and the embayment	5 distinct physiographic regions: Florida Bay, the Southwest Continental Shelf, the Florida Reef Tract, the Florida Keys, and the Straits of Florida. 4 Ecological Zones: 1) terrestrial and freshwater wetlands; 2) estuarine and saltwater wetlands; 3) Florida Bay and mangrove islands; and 4) the Florida Keys	6 major habitats defined by the dominant species: 1) Diploria-Montastrea-Porites zone, 2) Madracis Zone, 3) Lower Diversity Reef Zone, 4) Algal-Sponge Zone, 5) Nepheloid Layer, 6) Brine Seeps, an uncommon habitat	Two major habitats: basins and shelves: Stellwagen, Jeffrey, and Tillies Banks isolate three basins from the outer shelf.	Three distinctive zones: littoral, sublittoral, and the deep sea.	The sanctuary can often be split into at least 2 distinctive habitat types either by substrate type, depth, or by distinctive topographical features.	
Existing management needs coordination/supplementation	Wreck lies outside state waters and doesn't receive state protection.	State and local funding for management is limited, and interested in the area's cultural resources is growing. NMS status would provide comprehensive management of Thunder Bay's underwater cultural resources, including education and research initiatives.	State funding for protection of the site is limited.	Comprehensive program for research, assessment, coordination, and regulation does not yet exist, and there is a need to coordinate existing state, local, and federal authorities. Without a single authority, cumulative impacts to the area could be overlooked.	A Sanctuary would provide enforcement, surveillance, coordinated management, and a database of research done in the area. It would also invite input from local interest groups by forming a Sanctuary Advisory Council.	Several Federal agencies regulate specific activities, but none is concerned with the Bank environment as a whole. Because species that visit Cordell Bank to feed are also dependent on GFNMS, designation would provide better management, protection, and management-related research.	Several existing federal agencies protecting the area: NMFS, EPA, MMS, COE, Army and Navy, Coast Guard; State agencies include Coastal Commission, State Water Resources Control Board, Central and SF Regional Water Quality Control Board, State Lands Commission, Parks and Recreation, CA DFG.	No comprehensive management exists that would coordinate research and monitoring of all existing threats. Proposed satellite facilities and staffing are available for a potential Sanctuary office.	Existing management needs coordination and supplementation because it does not yet provide comprehensive management.	Area is located in federal waters, so federal statutes apply, but these statutes do not address most specific and direct threats to the area, such as bottom trawling, anchoring, or wire trap fishing.	Current management includes local village councils, which may regulate use of nearby reefs under customary Samoan law. Also, the American Samoa Coastal Management Program manages reefs and the Environmental Quality Commission regulates water quality. However, no comprehensive management exists and there is a lack of enforcement.	Many federal, state, and local managerial authorities currently exist, but a Sanctuary could coordinate and supplement those authorities.	There is no comprehensive, long-term assessment or management of the area. Mineral Management Service prohibits anchoring from vessels involved in oil and gas explorations, but doesn't regulate other vessels. The 1982 Fishery Management Plan for Coral and Coral Reefs does not prohibit anchoring.	The area currently lacks coordinated management.	Existing regulatory and management authorities are inadequate to provide for comprehensive and coordinated management, which can be provided through the NMSA.	Most regions warranted sanctuary designation in part because there was inadequate regulatory and management authorities dedicated to their special characteristics.	Existing management needs coordination/supplementation

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There is an impending threat to the area	The remains of the Monitor were discovered in 1973. After this event, a potential for salvage operations existed that could damage the integrity of the wreck, thus damaging its historical and research value.	There is increasing public interest in underwater cultural resources in the region, putting those resources at risk of damage or illegal salvage.	An increasing public interest in shipwrecks is putting the wrecks at risk of both legal and illegal salvage operations.	The islands' distance from shore used to protect them, but the demand for recreational and commercial uses of the area has increased, along with pressure to expand oil and gas operations in the channel. The Channel has become a major shipping lane. No single authority for regulating the impacts of these uses exists, so cumulative, long-term impacts may be overlooked.	The remoteness of the islands and generally rough seas used to protect them from intense human use, but now there are pending sale of tracts for oil exploration and growing recreational demands, and no single institution exists to manage all uses and prevent ecological harm. Research shows Stellar sea lions need protection from adverse human impacts if their population is to remain on the Farallones.	Threats to the area that are currently unaddressed include discharges of oil or materials from commercial shipping vessels, increased boat traffic from wildlife viewing vessels, and unrestricted diving.	Commercial shipping, nature observation, education, scientific research, national defense and law enforcement, and recreation have been occurring at low intensity levels. However, these and other potential human activities, such as oil and gas development, could pose a threat to the area's ecological integrity.	To date, human activities have been pursued at low intensity levels. However, these and other potential human activities are clearly capable of generating conflicts that could harm Sanctuary resources.	These sanctuaries were often protected by their distance from the mainland and relative inaccessibility, or by the relatively low intensity of human uses of the area. However, both commercial and recreational human uses of the area are increasing in intensity.	Fish are especially vulnerable to perturbation because they exhibit certain biological traits common in species living in isolated environments. Research suggests the habitat could be sensitive to many human uses such as, anchoring, trawling, dredging, and wire trap fishing.	Historically, the Bay was used only for subsistence fishing and remained pristine due to its inaccessibility. However, development is increasing, and the crown of thorns sea star threatens reef. Without a management plan to address these issues and regulate the area's use, the area's valuable resources may be lost.	In 1975 the Keys were designated as an Area of Critical State Concern because of increasing pressures associated with population growth and development. This trend continues today.	Damage to area is increasing due to unregulated anchoring and discharges from vessels. The number of oil and gas platforms is increasing nearby, and exploration is expected in the area itself.	Human activity in the region is high because the site is close to land and easily accessible.	Threats to humpback whales include water quality degradation, subsistence hunting, incidental entrapment or entanglement in fishing gear, collision with ships, disturbance or displacement caused by noise and other factors associated with various vessels, disturbance from fossil fuel or mineral exploration, coastal development, and competition with fisheries for prey species.	In most cases, human use of the sanctuary region was increasing, putting sensitive habitats at risk of associated damage. Such human actions included anchoring, shipping, and land-based pollution or habitat modification. Often, sanctuary waters were considered relatively pristine.	There is an impending threat to the area
Marine mammal diversity				30+ species.	23 species (5 pinnipeds, 1 fissiped, 17 cetaceans).	14 species (9 cetacean, 5 pinniped).	26 species: 5 pinnipeds, 1 fissiped, 20 cetaceans, constituting one of world's greatest diversities of marine mammals. All common California pinnipeds are found here.	30 species, including a population of reintroduced sea otters; Of these 30 species, 7 species are considered common.	14+ species.	2 species, but 25 species are found in the surrounding area.	2 species: humpback and sperm whales.	7 species.	1 species: the spotted dolphin.	13 species, along with 2 additional rare species.	24 species.	All sanctuaries contain at least 2 marine mammal species, but some individual sanctuaries harbor up to 24 species.	
Marine mammal life history				Migrations, feeding, hauling out occur in the area. The region is also only place in US where 5 breeding pinniped species are found together. Pinnipeds here have a major influence on food chain in Southern CA Bight: they consume 185,000 metric tons of food annually.	Pinnipeds are fairly dependent on islands for haulout, breeding, and pupping. The Farallon Islands are easily the most important breeding and pupping areas, but there are mainland haulout sites as well.	Humpbacks and blue whales are observed feeding directly over the Bank. Research suggests the area is important summer feeding grounds for humpbacks, and an attractive feeding ground for pinnipeds.	9 rookeries or colonies. The area contains the Afio Nuevo State Reserve, an important rookery and resting areas. Also, the proposed sanctuary would encompass one third of the California sea otter's range	The sea otter, harbor porpoise, and harbor seal are known to breed within the study area. The area also contains many haulout sites.	The area contains marine mammal breeding sites and feeding habitat.	There is little evidence this area is important to cetaceans. It may be important to the manatee, but this topic requires further research.	The Bay is an important to a group of endangered humpbacks, which breed and calve there from July to October.			The area includes marine mammal forage and nursery habitat.	Humpback whales migrate to Hawaii for the winter to give birth and mate.	In about half the sanctuaries, marine mammals use the site for important life history events, including birthing, mating, and foraging.	
Marine mammal abundance				Marine mammals in this region are often migratory. They support a lucrative whale-watching industry.	Marine mammals in this region are both resident and migratory.		Marine mammals are abundant due to the site's position at the Oregonian Province/California Province transition zone.			Only occasional sightings; more research is needed to determine whether the area is important to marine mammals.	Humpbacks are present July through October, and sperm whales are uncommon.		The only marine mammal commonly spotted in the area is the spotted dolphin.		Research indicates that 1,407 whales have visited the Hawaiian Islands from 1980 to 1983.	Marine mammals are often found in low abundances in these sanctuaries.	

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Marine mammal threatened/ endangered species				4 species: southern sea otter, blue whale, fin whale, and humpback whale.	7 species: Fin, humpback, gray, sperm, sei, and blue whales, and the southern sea otter.	2 species: Humpback and blue whales	11 species: Endangered species include the gray, finback, humpback, sperm, right, blue, fin, sei whales, and threatened species include the Guadalupe fur seal, stellar sea lion, and southern sea otter.	10 species: Gray, right, fin, sei, humpback, and sperm whales; Stellar sea lion, sea otter, harbor porpoise.	Between 5 and 20 threatened or endangered marine mammals usually occur in the area.		2 species: humpback whale and sperm whale.	7+ species.		14 species: humpback, northern right, fin, sei, blue, pilot, minke whales, along with orca, white-sided dolphin, white-backed dolphins, harbor porpoise, bottlenose dolphins, striped dolphins, Risso's dolphins, harbor seals.	2 species are mentioned: the humpback whale and the Hawaiian monk seal.	Two to fourteen endangered marine mammals are reported in the sanctuaries.	
Seabird diversity				64 species.	12 species: these species represent 12 out of the 16 species known to breed on the west coast, and they nest here.	47+ species.	94 species: 13 commonly breed here. Many here stop on the Pacific Flyway, and 4 are endangered.	87 species.	50 or more species	No survey has been conducted yet, but species include petrels, shearwaters, gannets, and terns.	19 species.	Many are listed, indicating diversity is high, but no overall count is given.	The site is too far offshore for typical occurrence of coastal seabirds other than the occasional tern or booby attracted to the oil platforms.	40+ species.	22 species: Of the 30 Native Hawaiian Birds, one is found near the Sanctuary: the Hawaiian dark-rumped petrel.	When reported, most sanctuaries contain 20 and 40 seabird species.	
Seabird life history				The region contains rookery sites for 9 out of the 12 species of seabirds that nest in the Southern CA Bight, along with rafting and foraging habitat. Both residents and migratory species occur.	The region contains over 100,000 breeding seabird pairs and many important nesting locations. Seabirds use the shallow waters of the continental shelf for foraging and wetlands and mudflats of the mainland estuarine systems for foraging and nesting.	10 of the 47species known to forage in this region also breed on the Farallon Islands.	As a prime location on the Pacific Flyway, the region contains 23 rookeries, resting and staging area for migratory birds, wintering habitat, and summer habitat.	This region constitutes the sole breeding area for the glaucous-winged gull. It contains important foraging area. In general, Washington coast has some of the US's largest seabird colonies.	Breeding, rafting, and foraging habitats, along with particular importance for at least one species.	None reported.	Seabirds use the cliffs around bay for nesting, and they use the bay itself and surrounding marine habitats for foraging.	Many life history events are reported species-by-species.	None reported.	Seabirds commonly forage in the area. Besides the Leach's storm petrel, all seabirds are migrants or non-breeding residents.	None reported.		
Seabird abundance				Santa Barbara Island is the largest seabird rookery in southern CA for species including brown pelican.	Almost all world's ashy storm petrels nest in the region. It also contains the world's largest colony of western gulls: current estimates of the number of breeding pairs exceed 100,000. It is the largest seabird rookery in contiguous US.	During winter, spring, and summer, seabird densities in this region are among the highest in all of California.	The region contains entire world population of Ashy Storm-Petrel.	The region contains some of the largest seabird colonies in the US, including 1 of the 10 largest colonies of rhinoceros auklets. Total estimates of seabirds in the Washington coast range from 108,530 breeding pairs to 240,000 individuals. It also contains one of the largest bald eagle populations in the continental US: 220 nesting pairs in 1985.	Significant general or species-specific seabird abundance, often representing the highest numbers in within a particular region (the region sets a record on a particular metric).	Not reported.	The Environmental Impact Statement characterizes seabirds as "abundant."	Not reported.	This region is too far offshore for typical occurrence of coastal seabirds other than the occasional tern or booby attracted to the oil platforms.	Not reported.	Not reported.		
Seabird endangered species				4 species: bald eagle, Belding's savannah sparrow, American peregrine falcon, brown pelican.	5 species: brown pelican, peregrine falcon, southern bald eagle, California clapper rail, California least tern.	2 species: brown pelican, short-tailed albatross.	4 species: California brown pelican, short-tailed albatross, American peregrine falcon, California least tern.	3 species.	Often about 5 endangered species of seabirds.			21 species.					

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Sea turtles							5 species: green, leatherback, pacific ridley, loggerhead.	3 species: loggerhead, leatherback, green.		3 species: loggerhead, Kemp Ridley's, green.	4 species: hawksbill, leatherback, green sea turtle, olive ridley.	5 species.	1 species: loggerhead	4 species: leatherback, Kemp's ridley, loggerhead, and green.	5 species. Hawksbill and green breed on the Hawaiian Islands.	Sea turtles are commonly reported in sanctuary waters, often including 2 to 5 species.	
Other notable species								There are 51 breeding territories along the coastal boundary of the Sanctuary for birds of prey			Endemic flying foxes			The vast majority of zooplankton species that occur in the region are endemic.			
Summary endangered species						4 species: humpback whale, blue whale, California brown pelican, short-tailed albatross.	4 terrestrial species: Santa Cruz long-toed salamander, SF garter snake, Smith's blue butterfly, Santa Cruz cypress.	A large number of threatened or endangered species.				Terrestrial, marine, and freshwater species: 4 inverts, 4 fish, 15 amphibians and reptiles, 21 birds, 13 mammals (both terrestrial and marine), 75 plants.					
Fish				CINMS has a near shore fish assemblage of 213 species (44% of all southern CA Bight species). The area has a higher density and diversity than mainland kelp beds because of the island effect. There are high abundances of baitfish to support marine mammals.	The wide continental shelf and configuration of the coastline makes this area vital to the health of salmon, northern anchovy, rockfish, and flatfish stocks. Current patterns support larvae and juveniles, ensuring recruitment of various species. The area serves as feeding, spawning, and nursery habitat.	38+ species were identified in 1987 including 14 species of rockfish.	345 species of fish are present in the area.	5 species of salmon (Chinook, sockeye, pink, chum, and Coho), steelhead, and cutthroat trout are present in the area. Each of the diverse habitats on Washington's coast is home to their own characteristic assemblage of fish.	The area has high fish diversity and abundance, particularly of commercially important species like rockfish and salmon.	Thousands of taxa are present in the area, similar to those present in the northeastern Gulf of Mexico. Many live at extensions or limits of their normal range. There is also high fish abundance and diversity in the area.	86 species were recorded in one survey. The area is highly diverse and the abundance of species is moderately high.	4 endangered fish species are present in the area.	175 fish species are present in the area.	Biodiversity is high in the area because the region is a transition zone between Gulf of Maine and the Mid-Atlantic region. The area experiences substantial seasonal variation and both resident and migrant species are found here.	450 species of inshore fish are present in this area. In some taxa, as many 29% of the species are endemic.	High abundance and diversity of fish is often reported, either because the ecosystem has high biodiversity by nature, or because the area is a transition zone between two marine regions. Usually fish species number in the hundreds.	
Fish life history														The area has some spawning areas for pollock, Atlantic cod, herring, and squid.			
Plants				Kelp beds are prevalent near the Islands. 40% of all kelp beds in the Southern California Bight occur around the Channel Islands.	Kelp beds, salt marshes, and eel grass beds present in the area provide food, shelter, nursery, and anchorage habitat for many species.						312 plant species are present in the area, including 10 endemic species.						

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Benthic fauna				One of 12 known locations for the hydrocoral, Allopora californica. The Bureau of Land Management cited the Islands as one of Southern California's most important marine habitats because of the presence of this hydrocoral and the pristine intertidal habitat. The shoreline is primarily rocky, unlike mainland, which is about 20% rocky. The intertidal assemblages are relatively pristine.	Hundreds of species are present in this area, many of which are critical links in the food chain.	Exceptionally diverse in benthic organisms because of the mix of near shore and oceanic species present here, and because of high sunlight penetration. Rare species in the area include: Allopora californica (hydrocoral) and Pedicularia californica (pink snail). Previously undescribed species in the area include: Fosliella (red algae species) and some sponges. Some intertidal organisms are present in deep water.	450 out of 669 California algal species are present in this area. Harbors the only population of large understory kelp, Eisenia arborea, found between southern California and Canada. Has one of the most diverse invertebrate populations of any marine area of similar size in the entire world. There are about 33 phyla and 725 species of mollusks. This is the richest area in the world for limpets and chitons.	This area contains some of the most diverse intertidal communities in the world.	The area has exceptionally high benthic diversity, with assemblages that provide vital links in the region's food chains.	A variety of benthic invertebrates are present including hard and soft corals, sponges, hydroids, ascidians (tunicates), bryozoans, barnacles, attached bivalves, and tube-building worms.	Corals in the area contribute to one of the most biologically productive ecosystems with high biodiversity. The area's productivity has supported subsistence fishing for native populations	Benthic fauna are diverse, and vary by region within the Keys. In some regions, benthic organisms are considered diverse because of the particular conditions present in the region.	There are over 500 acres of coral reef present. There are 18 species of hermatypic corals, 80 species of algae, and 196 macro invertebrates present in this area.	There are 149 species present in the area. Macro benthic biomass is quite high due to the pebbly sand substrate. The area provides food for the many fish species.	40 species of 58 corals; 1000 mollusks (about 20% are endemic); 243 polychaetes; 200 bryozoans. About 20 percent of the shallow-water - asteroids and ophiuroids are endemic, and 40 percent of the Alpheid shrimps are endemic.	Benthic fauna is highly diverse and often includes a high number of algae and macro invertebrate species. If the area includes coral habitat, there are usually many coral species present in the area.	
Trend of human activity intensity	The EIS implies that sanctuary status and subsequent regulation, monitoring, and enforcement, is essential to prevent damaging salvage operations.	There is an increasing interest in underwater resources.	Human activity is increasing in intensity.	Human activity is increasing in the area.	Human activity is increasing in the area.	An increase in boating and scuba diving intensity poses a threat to the area.	Nearby metropolitan areas are growing.	Human use of the ocean and adjacent watersheds is increasing. This may increase discharges and deposits into the proposed sanctuary waters threatening the resources and qualities of the area. Human uses such as fishing and recreation depend on high water quality.	Human activity is increasing in intensity.	Human activity is increasing in the area.	Human activity is intensifying and without action, "continued increase in recreational use of the waters, illegal taking of endangered species, and destruction of coral reef areas may result in the permanent loss of valuable resources."		Anchoring by both large and small vessels is increasing in the area.	Human activity is increasing in the area.		Human use of the area is increasing, causing increases in anchoring, illegal taking of species, and other recreational uses.	
Accessibility to an urban population	No mention, but the area is considered inhospitable.			Urban populations are growing in nearby areas increasing the number of people with accessibility to these waters.	This area has high accessibility. The San Francisco population is growing.	This area does not border the mainland, but it is close to the major Oakland/San Francisco metropolitan area, which contains more than 5 million people.	This area is easily accessible because of the high amount of public lands on the coast. Adjacent metropolitan areas are growing.	This area is pristine due to lack of access. The adjacent area contains few roads, private property, tribal lands, and steep rocky terrain. Currently, 4 tribes use the area.	Accessibility is increasing.	This area is accessible year round and is one the most highly utilized natural reefs off Georgia's coast.	Accessibility is currently low, but increasing.	Access to the Keys themselves is limited because only one highway leads into them. However, the area still receives large numbers of visitors, and recreational areas in the region are very accessible.	The area is relatively far away from shore, so vessels that visit generally have the capability to stay at sea overnight. Most are sport fishermen and sport divers.	There is high human activity in the area because the site is close to land and easily accessible.		Sanctuary accessibility varies from low to high, but usually at least some degree of human use occurs in the area.	
Oil and Gas Development	Not mentioned.	Oil and gas development exists in the area.		Oil and gas development is likely to increase. Leases could occur in near shore habitat unless the area is protected. The area was ranked 7th out of 21 basins for oil reserves by USGS.	Tracts are currently up for bid in the area.	There is currently no oil or gas activity. A congressionally-imposed moratorium closed leasing from 1982-1985. The 1986 plan allows leasing outside Cordell Bank's 91 meter isobath.	Before designation, President Bush prohibited leases within the proposed sanctuary. Approximately 370 million barrels of oil and 580 million cubic feet of gas are estimated to exist in the proposed sanctuary.	Leases in the area are delayed until the year 2000. Drilling inside OCNMS would be prohibited.	No commonality with regard to oil and gas development in the area.	No activities currently exist within 46.3 km of the area. However, some leases are being planned for nearby waters.	Not mentioned.	EIS does not mention whether or not such sites exist in the Keys.	All activities in the area are currently subject to Minerals Management Service stipulations to protect sensitive biological resources. The banks contain natural gas and some oil reserves maybe subject to leasing.	No leases will be offered in the proposed sanctuary area in the foreseeable future.	This area has no natural oil, natural gas, or coal reserves.	Little to no development is proposed in the area.	

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Commercial fishing	Research shows that no significant concentration of commercial seafood is present here. However, fishing, other than trawling, is permitted in the sanctuary.			Both year round and seasonal fisheries are present in this area. The region supports Southern California's most productive kelp harvest.	Commercial fishing accounts for 30% of the port of San Francisco's tonnage. The are 5 main types of fishing in the area: bottom-fishing, crab fishing, salmon trolling, albacore trolling, and pelagic fishing for anchovy, herring, and other species. The study area only accounts for 0.1% of the tonnage and 3% of the value of total state catch.	Fishing is the biggest human use in the area.	1987 fish landings totaled 34 million pounds. Ex-vessel value is estimated to be $15 million (and value to the local economy is estimated at 2-3x that amount). Fishing is the most important economic activity in the area. There are 11 mariculture operations in the area. Approximately 5,000 pounds of kelp are harvested in the region each year.	Salmon, bottomfish, halibut, Dungeness crab, and pink shrimp are commercially fished in the area. Fishing is important to the state economy, but recently there has been a decreased number of fishing vessels due to overfishing and limited entry.	Commercial fishing represents a very significant human use-often the most significant human use of the area.	Gray's Reef does not support a full-time fishery because it lacks sufficient concentrations and reefs are too shallow to harbor significant populations.	Some commercial fishing operations exist in outer portions of the Bay.	Commercial fisheries are among the Keys' most valuable natural resources. The area is one of the richest fishing grounds in the Gulf of Mexico and commercial fishing is the fourth-largest industry in the region. Marine life collecting and aquaculture also occur here. There are 329 permitted artificial reefs in the area.	Snapper is the primary target fish in the area. Fishery Management Plan for Coral and Coral Reefs already prohibits use of gear could result in substantial damage to the area, like bottom trawlers.	The primary commercial use is fishing. 280 vessels use the area regularly. Most fisheries have FMPs.		While some sanctuaries do not support large commercial fishing operations, most support operations that are important to the local economy.	
Recreational fishing	Not mentioned.			Party boats use the area. They prefer to stay next to near shore kelp beds.	Party boats depart from San Francisco, Tomales Bay, and Bodega Bay and frequently fish the open ocean in Gulf of the Farallones. Party boats from San Francisco consistently catch over half the annual sport fish salmon catch. Shore-based recreational fishing is also common.	Department of Fish and Wildlife data indicates rockfish are most targeted species, followed by lingcod, jack mackerel, and king salmon.	There is recreational fishing in the area.	Salmon, bottom fish, and razor clams are commonly fished in the area.	Party boats are commonly used in these areas for recreational fishing.	Fish targeted by recreational fishermen are found here. 63% of charter boat fishermen go to Gray's Reef to fish.	Sport and subsistence fishing occur in this area.	The Sanctuary is among the nation's most popular recreational fishing destinations. In 1988, Rockland estimated that in 1986 the Keys' recreational fisheries generated $63.6 million in local output, $21.3 million in local income, and approximately 1,800 local jobs.	Sport fishing occurs in this area.	Recreational fishing is popular here and it is not unusual to see 15-20 party boats, 25-30 charter boats, and up to 200 private rentals fishing the Bank.	In 1992, about 1/7th of the fish consumed in Hawaii were caught recreationally.	Recreational fishing in these sanctuaries is typically quite high, and both party and charter boat fishing is common.	
Commercial shipping	Free passage of vessels through the sanctuary is allowed.	Commercially shipping is common in this area.	Vessel traffic is both permitted and common in sanctuary waters.	About 32 vessels cross the Channel per day. Vessels are mostly foreign, and traffic is likely to increase due to petroleum development in the region.	The area is located near the convergence of 3 major shipping lanes. In 1976, the San Francisco Bay commodity throughput was 48,390,345 tons.	The area is located near the northern shipping lane leading from San Francisco Bay ports.	4,500 commercial shipping vessels transit through the area. There are 4 harbors in the region.	Commercial shipping is common in this area.	Common for a sanctuary to be located near or in major shipping channels	Currently, little commercial shipping traffic passes through this area.	No commercial shipping nearby.	The area is one of the most heavily trafficked in the world because the Straits of Florida have historically been the access route for all vessels entering the Gulf of Mexico. It is estimated that 40 percent of the world's commerce passes within 1.5 days sailing time of Key West. Oil tankers also transit the coast daily.	A major fairway crosses 6 miles south of the area. Vessel traffic usually originates from Morgan City and Cameron.	Vessel traffic from Boston Harbor and Cape Cod Canal pass through this area. In 1989, 2,700 ships crossed the Bank, mostly carrying petroleum. Threats from these shipping operations include: oils spills, refuse discharge, and marine mammal strikes.	In 1992, 2,104 overseas vessels and 3,207 inter-island vessels arrived at Honolulu Harbor. Commercial shipping is essential in this area because it delivers about 80% of Hawaii's goods.	While there is no significant vessel traffic in some sanctuaries, most sanctuaries are located in or near major shipping routes.	Vessel traffic is moderate to intense either within the sanctuary or nearby.

	Historically focused sanctuaries			West Coast Sanctuaries						East Coast, Tropical, and Subtropical Sanctuaries							
	Monitor	**Thunder Bay**	**EMERGENT CRITERIA**	**Channel Islands**	**Farallones**	**Cordell Bank**	**Monterey Bay**	**Olympic Coast**	**EMERGENT CRITERIA**	**Gray's Reef**	**American Samoa**	**Florida Keys**	**Flower Garden Banks**	**Stellwagen Bank**	**Humpback**	**EMERGENT CRITERIA**	**UNIVERSAL COMMONALITIES**
Number of recreational uses	The area is unsuitable to recreational activities, including diving, so sanctuary designation will have little to no effect on recreational uses of the area.	5 common recreational activities: Fishing, boating, scuba diving, hunting, and camping.	No commonality: Monitor's site is unsuitable for recreational uses, whereas Thunder Bay cites at least 5 common recreational uses of the area.	10 common recreational activities: charter aircraft flyovers, sportfishing, pleasure boating, diving, nature observation, charter boating, camping, guided tours of the islands, whale	8 common recreational activities.	1 common recreational activity: sport fishing.	11 common recreational activities: sport fishing, boating, hiking, skin diving, sightseeing, nature observation, surfing, personal watercraft, fishing, intertidal collecting, and scuba diving.	5 common recreational activities: hiking, camping, whale watching, wildlife viewing, and tide pooling.	5-10 cited recreational uses of the area.	3 common recreational activities: diving, fishing, and boating.	3 common recreational activities: diving, swimming, and boating.	10 common recreational activities: boating, fishing, scuba diving, snorkeling, beach activities, historical tourist attractions, walking, jogging, biking, and swimming.	2 common recreational activities: sport fishing, and scuba diving.	40 vessels are used for whale watching in the area. These vessels transport 1.25+ million tourists per year.	6 common recreational uses: surfing, swimming, tour boats, thrill craft, canoe racing, and kayaking.	Water-based recreational activities are common in the area, and most sanctuary designation documents cite 3 to 10 major recreational activities that take place within the region.	Almost all sanctuaries cite 3-10 major recreational activities commonly practice in sanctuary waters.
Number of pre-existing recreation areas	No pre-existing recreation areas exist.			2 pre-existing recreation areas lend themselves to whale watching and spearfishing.	6 pre-existing recreation areas: Point Reyes National Seashore (which has 1.6-1.7 million visitors per year), Tomales Bay State Park, Stinson State Beach, Mt. Tamalpais State Park, Sonoma County State Beach, and Point Reyes Headlands.		Some of the 36 existing parks in the study area are devoted to recreational use along with conservation.	Multiple pre-existing recreation areas: Olympic National Park and USFWS offshore National Wildlife Refuges.	At least 2 pre-existing recreation areas are present in most cases.			There are 24 federal and state recreation areas, parks, refuges, historic sites, botanical sites, archaeological sites, geological sites, and aquatic preserves within the Keys that account for nearly 10,000 km2 of land and water resources.					
Research potential	This site has excellent research potential because it is undisturbed. It will fill the existing research gap for naval historians caused by lost records. The Monitor wreck is one of the most valuable mid-nineteenth century marine sites available for scientific investigation.			A considerable amount of research has already been done in this area.	This area has significant research potential. Several studies, including a biological inventory, are currently taking place.	Research in the area is increasing.	Research potential in this area is extremely high due to the Monterey Canyon's proximity to shore and the habitat diversity and accessibility of the area. There is a long history of research in the area so there is already a bank of baseline data.	This area has significant research potential because the habitat is pristine, high in biodiversity, and representative of typical habitats within the Oregonian Province.	High research potential due to pre-existing research projects and the interesting nature of the sanctuary's natural resources.	Has high research potential because the area could serve as a biological baseline for other studies of live bottom habitats. The dynamics of live bottom benthic communities and their importance to marine fishery resources of the South Atlantic haven't been fully explored or interpreted.	Area has research potential because crown of thorns sea star devastated the reef, so the site presents an opportunity to monitor and study the recovery process.	The area has high research potential. Various studies have been conducted in this area in the past.	This area has significant research potential. Dissolution of salt from the salt plug beneath the bank percolates down to the basin floor, where it becomes highly charged with sulfides and becomes anoxic. Mats of bacteria live here, along with an assemblage of organisms similar to deep sea hydrothermal vents. It has served as a study area for at least 15 dissertations from regional universities and many other studies have been conducted there.	This area has significant research potential. Several institutions already use Stellwagen Bank as a research site. The sanctuary could coordinate these efforts and serve as a repository for their findings.	The area has significant research potential.	Most sanctuaries have high research potential due to the presence of a unique habitat or a species of interest.	

	Historically focused sanctuaries			West Coast Sanctuaries						East Coast, Tropical, and Subtropical Sanctuaries							
	Monitor	**Thunder Bay**	**EMERGENT CRITERIA**	**Channel Islands**	**Farallones**	**Cordell Bank**	**Monterey Bay**	**Olympic Coast**	**EMERGENT CRITERIA**	**Gray's Reef**	**American Samoa**	**Florida Keys**	**Flower Garden Banks**	**Stellwagen Bank**	**Humpback**	**EMERGENT CRITERIA**	**UNIVERSAL COMMONALITIES**
Number of research facilities	North Carolina Department of Cultural Resources, Duke University, Massachusetts Institute of Technology, and the University of Delaware partnered and discovered the Civil War ironclad *Monitor* before the Sanctuary's designation.	5 research facilities are present in the area: NOAA Great Lakes Environmental Research Laboratory - zebra mussels study; Alpena Community College - zebra mussels study; Alpena Community College - zebra mussels study; Great Lakes Visual/Research, Inc.; Michigan State University Department of Anthropology		21 research facilities are present in the area.	5 research facilities are present in the area: Point Reyes Bird Observatory, U.S. Fish and Wildlife Service, Bureau of Land Management, Bodega Maine Laboratory, College of Marin Bolinas Field Station	3 research facilities have conducted studies in the area: in 1950 California Academy of Sciences studied substrate; since 1978, Cordell Bank Expeditions, a non-profit, has done hi-res depth surveys and dives to obtain biological specimens (450 species); NOAA conducted a survey in 1985	13 research/education facilities are in the area. Of note is the Moss Landing Marine Laboratory.	2 research facilities are present in the area: the Olympic National Park and the USFWS offshore National Wildlife Refuges	Between 5-21 research facilities exist in the area and/or major research endeavors are being conducted or have conducted their research in the area.	3 research facilities exist in the area including Coastal Resources Division of Georgia.	Current research in the area includes on-going research regarding coral re-colonization and changes in the composition and structure of inshore fish communities within the area.	Many research institutions are conducting research in the area on a variety of topics. The current and future research potential of the area is great.	Regional universities conduct research in the area.	At least 17 institutions and agencies have conducted research in the vicinity of Stellwagen Bank.	A number of research facilities are present in the area.	While most sanctuaries do not cite the number of institutions that conduct research in their waters, it is clear that most sanctuaries are commonly used in field research.	
Number of educational facilities	All research permits will require research findings to be made public for the purposes of education.	At least 2 educational facilities are present in the area: Michigan Science Teachers Association and the Great Lakes Leadership Camp	The area will foster educational programs based upon shipwrecks though the current or future research in the site.	Public education is limited in the area and therefore reduces public awareness of the value and sensitivity of the area's natural resources.	Some educational facilities take trips to the Islands for wildlife viewing.	No organized educational program focused on sanctuary waters currently exists within this region.	There are 13 research/education programs including Stanford's Hopkins Marine Station.		While some educational programs may exist (particularly in the case of Monterey Bay), in most cases no educational program exists that conveys to the public the importance of the region nor conveys the scientific information available regarding the area's natural communities.	2 educational facilities are present in the area.	Not reported.	Many educational facilities exist in this area.	The site has been used for a number of university dissertations but no mention is made of additional education facilities in the area.	17 educational facilities are present in this area.	12 well-known private and non-profit groups have humpback whale-focused education programs.	Two sanctuaries do not report educational programs, but the others report between 2 and 17 programs.	
Dredging and dredge spoils disposal	Only mention of dredging in the EIS is under Prohibited Activities in future regulations.	Dredging occurs in the area and materials are deposited in the open waters of Thunder Bay.		Five dredge material disposal sites have been established in the Southern California Bight. The closest one to the Channel Islands is near Port Hueneme, about 16.6km (9 nmi) from Anacapa Island.	New harbors are being constructed which could increase the need for material deposition in the area. Currently no discharges are placed in the area.	No materials are presently transported to Cordell Bank for the purpose of dumping and no such operations are likely in the future.	Dredging in the area is required to maintain access to Santa Cruz, Moss Landing, and Monterey Harbors.	No dredge disposal occurred in or near the Sanctuary at the time of designation.	No commonality: in some cases, dredging occurs because it is necessary to maintain access to important ports, but in other cases, no dredging-related operations occur within or near sanctuary boundaries.	Dredging may increase in nearby areas as traffic to ports increases. It is unknown how this will affect Gray's Reef.	Not mentioned in EIS but would be prohibited in the sanctuary.	Dredging activities in the Keys are usually limited to small, private projects, usually for dock or seawall construction at private residences. There are no federal dredging projects in the Keys, but dredging to maintain the Key West Ship Channel may take place in the future.	Not mentioned.	3 million cubic yards/decade is deposited near the sanctuary.	There are five EPA-designated deep water ocean disposal sites in the area.	Dredging occurs in about half of these sanctuaries.	
Other disposal activities				"Prior to 1972, munitions, toxic wastes, and radioactive materials were dumped in the vicinity of the Channel Islands, but more than 18.5km (10 nmi) from the Islands."	Offshore radioactive disposal sites were active in the area from 1946-1965.									During the 1940s - 1970s, general industrial waste was dumped in the area. Fish processing wastes and incinerated trash have also been dumped in the area.			

	Historically focused sanctuaries			West Coast Sanctuaries						East Coast, Tropical, and Subtropical Sanctuaries							
	Monitor	Thunder Bay	EMERGENT CRITERIA	Channel Islands	Farallones	Cordell Bank	Monterey Bay	Olympic Coast	EMERGENT CRITERIA	Gray's Reef	American Samoa	Florida Keys	Flower Garden Banks	Stellwagen Bank	Humpback	EMERGENT CRITERIA	UNIVERSAL COMMONALITIES
Military	Not mentioned.	Note mentioned.		Both the Navy and Air Force utilize this area.	Military operations zone overlaps with proposed sanctuary.	An “Airspace Warning Area” and a “Submarine Diving Area” overlap the Bank. Submarine diving exercises occur about 10 times/ month. Regular US Navy submarine, surface, and air operations occur in the Bank including trial exercises, checkouts, vessel overhaul, and aircraft exercises.	US Army restricted firing range and US Navy operating area are in this region.	Subsurface, offshore surface, and aerial operations all take place within the sanctuary, including activities such as hull integrity tests, minesweeping , and air combat maneuvering.	It is common for military operations to take place in the area. Sanctuaries often overlap with pre-established zones designated for specific military training operations.	Few operations are conducted in close proximity to this area.	This area is not used for military operations.	The Navy has a strong presence in the Keys. The navy is internationa lly significance because it maintains the closest military installation in the continental United States to Cuba, Central and South America, and the Caribbean.	The area just southwest of the site is used for missile testing, rocket firing, pilot training, air-to-air gunnery, air-to-surface gunnery, minesweeping, submarines, and air combat.	Military exercises are routinely conducted at Stellwagen Bank. The Boson Operating Area is located here.	The U.S. Army, Air Force, Navy and Marines all have extensive personnel and equipment based in the Hawaiian Islands, and many trials and exercises are conducted here.	While military activities are not conducted in some sanctuaries, they are commonly conducted in pre-defined locations that overlap with most sanctuaries' boundaries.	
Other human uses of the area	Not mentioned.	Not mentioned.		Not mentioned.	Not mentioned.	Not mentioned.	Not mentioned.	Not mentioned.		Not mentioned.	Not mentioned.	Not mentioned.	Not mentioned.	Sand/gravel mining takes place here. An extensive number of deposits are accessible.	Not mentioned.		
Historical resources	The Monitor Shipwreck is located here.	Approximatel y 160 shipwrecks and hundreds of other underwater cultural resources are known, or suspected to exist within the boundaries of the Thunder Bay National Marine Sanctuary. This collection of shipwrecks, and at least eight individual vessels, are believed to have national historic significance.	Between 1 and 160 shipwrecks exist in the area.	32 shipwrecks exist in the area.	There are existing resources on the Farallon Islands, and there may be unidentified resources in the area.	It is unlikely that the area will contain historical resources of national significance. Human remains will have eroded away, and there is no evidence of shipwrecks in the area.	There are 311 shipwrecks inside sanctuary boundaries. 718 prehistoric remains (from Coastanoan Native American groups) have been reported and verified in MBNMS and in the adjacent coastal zone.	There are extensive historical resources in the region including: Indian village sites, ancient canoe runs, petroglyphs, Indian artifacts, and numerous shipwrecks.	Sanctuaries may contain few to no historical resources, or they may contain upwards of 300 of shipwrecks.	Preliminary studies suggest that Paleo-Indian remains, shipwrecks, and other relics could exist in the area.	The Samoan way of life is mentioned throughout the EIS indicating that there may be some cultural significance to the site.	There is potential for the discovery of submerged Paleo-Indian sites (between 12,000 and 15,000 years old) in the area. There are 16 lighthouses in the region and many shipwrecks along trade routes. The inaccessibilit y of underwater sites and the environmen tal conditions have ensured that many delicate artifacts remain undisturbed .	It is unlikely that any historical cultural resources exist here.	No prehistoric cultural resources have been identified, but they may exist. Only 7 shipwrecks are known in the area. Some aircraft wrecks exist in the area.	This region was historically used, and is currently used, by native Hawaiians. The number of shipwrecks inside the sanctuary is unknown.	Most sanctuaries contain (or are suspected to contain) some or all of the following historic or cultural resources: Paleo-Indian remains, shipwrecks, lighthouses, aircraft wrecks, or the current practice of traditional activities by native cultures.	
Tourism	This area is inhospitable and therefore there is no tourism in this area.			Potential for tourism is high and increasing.	Tourism is extremely prevalent in adjacent areas, especially in mainland parks.	Not mentioned.	18 million tourists visit Monterey every year.	There are 3.5 million visitors/year to the nearby Olympic National Park.	It is common for visitors to sanctuaries to number in the millions.	Not mentioned.	Not mentioned.	Not mentioned.	Not mentioned.	There is significant whale watching in the area.	Tourism dominates Hawaii's economy. In 1991 Hawaii hosted 6.87 million visitors. In 1990 the ocean recreation industry generated an estimated revenue of $509 million and created 5,788 jobs.	Tourism is often a key element of the economies near sanctuaries.	

Appendix C – Supplementary Methods for Wastewater Analyses

Combined Sewer Discharge Events

The average number of annual discrete CSD events was calculated for pre- and post-infrastructure update periods. The pre-infrastructure update period ran from 1992 through 1997, while the post-infrastructure update period ran from 1998 through 2011. The analysis only considered discrete CSD events, which are separated by at least 6 hours from all other CSDs leaving the Oceanside WPCP system, because non-discrete CSD events issuing from different outfalls structures during the same time period are less likely to be independent events [40].

Differences in the average number of annual discrete CSD events were tested for statistical significance using a Student's t-test. The null hypothesis for the Student's t-test assumed that the average number of annual discrete CSD events would be equal for pre- and post-update periods. Due to the different sample sizes and unequal variance across the pre- and post-infrastructure improvement periods, an unbiased estimator of standard deviation was used in the t-test. The Welch–Satterthwaite equation was used to calculate degrees of freedom and obtain unbiased critical values. The null hypothesis for the Student's t-test assumed that the average number of CSD's would be the same for the pre- and post-infrastructure update periods.

Statistical analysis for differences in the average number of discrete CSD events per year used an alpha level of 0.05. This means that there is a 5% chance of incorrectly rejecting a null hypothesis that is true. If the test statistics calculations yield a t-score above the critical value corresponding to the 95% confidence bounds, the null hypothesis is rejected. The statistical test was two-tailed.

Empirical Basis for Comparisons Across Different Fecal Indicator Bacteria (FIB)

For data running from January 2, 1992 to September 25, 2003, the SFPUC used membrane filtration methods to test beach monitoring samples [40]. Membrane filtration is a culture-based method that uses a specific growth substrate and quantifies the number of distinct bacterial colonies formed over the defined culturing period [163]. The number of distinct colonies that grow during a given culturing period are used to estimate the concentration of pathogenic bacteria in beach water samples. Membrane filtration results are reported in colony forming units (CFUs) per 100 mL of water.

From 2003 to present, the SFPUC has used chromogenic substrate methods in its beach monitoring program [40]. This technique measures the microbial metabolism of substrates that are selectively consumed by the specific indicator bacteria *Escherichia coli* and *Enterococcus*. The metabolism of the chromogenic substrates causes the release of a chromogen that fluoresces under shortwave ultraviolet light and allows an estimation of the pathogenic bacteria concentrations in water samples based on the number of wells that fluoresce. Chromogenic substrate testing has become the preferred method for assessing pathogenic bacteria concentration in water samples over the last decade, as this method returns results more rapidly, has greater logistical simplicity, and has a lower cost than the previous

testing approaches [60]. Results from chromogenic substrates tests are reported in statistical units of MPN per 100 mL of water.

Several peer-reviewed studies have compared the number of exceedances per year that were indicated under multiple filtration and chromogenic substrate methods. The goal of these studies was to determine the extent of agreement between the two methods and if this agreement was sufficient for valid comparisons to be made across membrane filtration and chromogenic substrate results. The research found that the test results of chromogenic substrate methods are highly correlated with membrane filtration test results. Consequently, comparisons across the two different water quality testing methods were deemed valid [60], [164], [165]. Additionally, CFU/100 mL units are roughly equivalent to the MPN/100 mL units, so no conversions were necessary.

Research comparing chromogenic substrate methods with membrane filtration and multiple tube fermentation methods indicates more than 90% agreement with regard to whether or not State of California Beach Water Quality Standards were exceeded [60].The past analysis that obtained this result compared field samples that were collected from the intertidal zone of California beaches after a wet weather event, meaning that their results are likely to have a high degree of validity for the beach monitoring conducted by the SFPUC along the Exclusion Area's coastline.

Variability in Temporal Extent of FIB Data & Data Processing Steps

The temporal extent for the different fecal indicator bacteria (FIB) differs because testing did not take place continuously for *Enterococcus* and *E.coli* between 1992 and 2012. For total coliform measurements, data was continuous for the entire temporal scope of our analysis. However, from September 6 to September 13 of 1996, all test results for indicator bacteria were reported in micrograms per liter (µg/L), which is equivalent to parts per billion. The part per billion data was omitted from the beach monitoring analysis.

Total coliform data for our pre-infrastructure update period spanned from January 2, 1992 to December 30, 1997, while data for the post-update period ran from January 6, 1998 to December 27, 2011. An agreement analysis across the two methods found that membrane filtration results were approximately 62% of the bacterial concentrations returned from chromogenic substrate methods; however, this difference was marginally below the threshold set for statistical significance in the study [60]. Our group conducted two separate analyses of total coliform data in response to this empirical research. In our first analysis for total coliform, membrane filtration results from 1992 to 2003 were transformed by multiplying the reported CFU/100 mL by a coefficient of 1.613, which increased the CFU/100 mL concentrations for total coliform by approximately 38%. Our second analysis of total coliform results was conducted without the original CFU/100 mL results. This approach allows us to evaluate the sensitivity of our results to the transformation of CFU/100 mL measurements described above. We only report TC results for data with unmodified CFU/100 mL measurements in our final report because the results of the analysis were not sensitive to the correction (i.e. the analysis that used corrected CFU/100 mL data was also highly significant).

The pre-update period for the *E.coli* indicator spanned from January 2, 1992 to July 29, 1997. Data for *E.coli* were not available for this period, but *E.coli* concentrations are estimated from measurements of fecal coliform. No data for fecal coliform or *E.coli* was available from July 30, 1997 to October 7, 2003. The SFPUC began chromogenic testing for *E.coli* on October, 8, 2003. The post-update period for *E.coli* runs from that start date to December 27, 2011.

The pre-update period data for *Enterococcus* spanned from January 2, 1992 to March 28, 1997, and post-update period data spanned from October 8, 2003 to December 27, 2011. No data was available from between the end date of the pre-update period and the start date for the post-update period because *Enterococcus* was not tested for during this time. Comparisons across the chromogenic substrate and membrane filtration methods for measure of *Enterococcus* concentrations in water samples showed no statistically significant differences in past empirical research [60]. As a result, CFU/100 mL for *Enterococcus* measurements that were obtained through membrane filtration methods were not transformed, and were compared directly with MPN/100 mL measurements generated through chromogenic substrate methods.

Calculating the Number of Exceedances per Year

The annual number of exceedances for all three FIB were calculated using Microsoft Excel. The program's 'IF' function was used to identify the samples that were above the California standards for water contact recreation. Samples that were above the state standards were denoted with a '1', while samples that were below the state standards were assigned a '0'. The number of samples was then summed within each year.

Proportion Testing for the Number Beach Monitoring Samples Exceeding State Standards

The total number of samples exceeding state water contact recreation standards within a period was put over the total number of samples taken within the period to calculate proportions for the pre- and post-infrastructure update periods. The proportions for the two periods were compared within each of the three different indicators (total coliform, *E.coli*, and *Enterococcus*). Any differences observed in the proportions across the two periods were tested for statistical significance.

We would like to stress that the results of our statistical analysis for differences in the proportion of exceedances across the pre- and post-update periods are sensitive to the approach that is used. If the annual proportions for each year in our analysis are used to calculate the average pre- and post-period proportions, the results indicate an increase in the post-update proportion for exceedances. Our group chose to use an absolute proportion that is not calculated from annual proportions for the pre- and post-update periods. We feel this approach provides a more accurate reflection of differences in water quality across the two periods.

Statistical Testing of Differences in Proportions

Our statistical analysis of differences for the proportion of samples with bacteria concentrations above water contact recreation standards for pre- and post-update periods had a null hypothesis (H_o) that assumed no significant difference between the two periods. The alternative hypothesis (H_1) held that there was a significant difference between the two proportions. Differences in the proportion of tests returning results above state standards were assessed for all three indicator bacteria were assessed individually. The standard error for the difference in proportions (SE_{diff}) was calculated for total coliform, *Enterococcus*, and *E.coli* data sets. In order to estimate SE_{diff}, we first calculated an estimate of pooled proportion (p_{pooled}) from the pre- and post-update period proportions (p_1 and p_2, respectively). The pre- and post-update proportions were weighted by the number of samples for each period (n_1 and n_2), as shown in Equation 1 below. The pooled proportion was then used to estimate the standard error for the difference in proportions (Equation 2).

Eq. 1

$$p_{pooled} = (p_1 * n_1 + p_2 * n_2)/(n_1 + n_2)$$

Eq. 2

$$SE_{diff} = SQRT\ [p_{pooled} * (1 - p_{pooled}) * (n_1^{-1} + n_2^{-1})]$$

Distributions for the proportions were assumed to be normal. This assumption was supported by the large sample sizes for the pre- and post-update periods. The test statistic (z) for each was estimated for differences in the pre- and post-update proportions of each indicator (Equation 3). A standard z-table was used to estimate critical values (z_{crit}) corresponding to the alpha-level ($\alpha = 0.05$).

Eq. 3

$$z = (p_1 - p_2)/SE_{diff}$$

Test statistics obtained for differences in the proportion of test with bacteria concentrations above the state water contact recreation standards were evaluated with respect to their estimated 95% confidence bound. The null hypothesis was rejected if the estimated test statistics were greater than critical values. The probability of a Type I error (p-value), where a true null hypothesis is incorrectly rejected, was estimated to reflect the level of confidence for statistical test results.

Statistical analysis for differences in the proportion of samples that tested above water contact recreation standards applied an alpha level of 0.05. This means that there is a 5% chance of incorrectly rejecting a null hypothesis that is true. If the test statistics calculations yield a t-score above the critical value corresponding to the 95% confidence bounds, the null hypothesis is rejected. All statistical tests were two-tailed.

Non-consideration of 1986-1997 Offshore Monitoring Program Data

The SFPUC has been monitoring the Southwest Ocean Outfall (SWOO) since 1986 and was updated in 1997. Our analysis did not consider offshore data collected prior to the 1997 update due to problems issues of experimental design. Specifically, confounds made it difficult to separate the SWOO's effect on receiving marine environments from the effects of seasonal variability in the region [40]. Summary findings from the first decade of monitoring (1986-1996) compared outfall sites with only one reference site and observed extensive seasonal variability that influenced the biological and physical parameters of interest. This variability represented a significant explanatory confound for differences observed across outfall and reference sites [40]. The SWOO's proximity to the mouth of the San Francisco Bay was identified as an additional confound to differences observed in the earlier offshore monitoring program, with certain parameters showing high sensitivity to effects of the Bay Area's outflow plume [81].

Current Offshore Monitoring Program

The current monitoring program was designed to control for the effects of seasonal variability and the Bay Area outflow. To mitigate the influence of these variables on monitoring program results, both the number of reference sites and the spatial extent of the monitoring program were increased. Additionally, the current monitoring program includes the mouth of the San Francisco estuary in its study area, allowing the effects of Bay Area outflow to be detected [40].

Sampling frequency under the SFPUC's current offshore monitoring program was scaled back relative to the earlier monitoring program. The current program's sampling regime consists of a single annual event, which reduces the potential for seasonal variability to influence the monitoring program's results across successive years [40]. Seven stations around the outfall site (01, 02, 04, 06, 25, 28, 31) that were part of earlier 1986-1996 monitoring programmed continue to be monitored in the revamped approach [40].

The offshore monitoring program collects samples from between 47 and 55 sites each year [40]. A minimum of three grab samples are collected for each sampling site. One of the three grabs was used for a benthic infauna community analysis; the remaining two samples are used for physical-chemical sediment analyses [40]. From 1997 to 2001, the number of stations sampled for organic priority pollutants was gradually increased. As of 2001, all stations in the offshore monitoring program were sampled for organic priority pollutants. Different minimum sample depths are instituted for different parameters. For sediment samples subjected to physical-chemical testing, a minimum grab sample depth of 5 centimeters is enforced [40]. Any sample that does not penetrate down to this sediment depth is discarded. For benthic infauna analysis, a greater minimum sample depth of 7 centimeters is enforced.

Methods for Analysis of Offshore Sediment Grain Size and Quality

Sediment grain size data is converted into phi units, which transforms the particle size diameter (in millimeters) by negative $\log_2$ [40]. Skewness, medians, and means are calculated for offshore monitoring

stations from the grain size phi unit data, in addition to standard deviations and measures of kurtosis (i.e. peakedness). Dry weight conversions are calculated for inorganic and organic pollutant data to describe sediment pollutant loading [40]. Box plots are used to describe the distribution of sediment characteristics for different sediments groups that are differentiated through cluster analysis. Physical grain size, phi size, sediment chemistry measures, and biological community results are then geospatially mapped to the study area.

Community Analysis Methods for Benthic Infauna, Demersal Fish, & Epibenthic

Biological community measures for benthic infauna, demersal fish, and epibenthic invertebrates include estimates of abundance (measured as the number of individuals), species richness (as the number of different species present), Shannon-Weaver diversity index, Pielou's evenness index [40]. Abundance is measured as total count of individuals for combined 0.5 mm and 1.0 mm sieves of each 0.1 m^2 sample. All taxa are identified and counted for taxonomic community analyses, save for higher or incompletely identified taxa that could result in artificially inflated estimates. As a result, the reported taxonomic community measures are conservative according to the SFPUC's summary report [40].

Methods for Analysis of Physical Anomalies and Bioaccumulation of Contaminants

Estimates of bioaccumulation for organic and inorganic pollutants in sampled organism tissues are generated through different statistical analyses that use wet weight values [40]. The use of wet weights allows comparison of the results with regulatory guidelines and other data sets. Any tissue samples that test below detection limits for the contaminants of interest are assumed to have a contaminant concentration equal the detection limit [40]. This is a conservative assumption that is likely to overestimate the body burden of pollutants for the region's marine organisms. A Student's t-test is used to evaluate mean difference across outfall and reference areas and estimate the effect of SWOO discharges on bioaccumulation. Both one- and two-tailed t-tests were used, depending on the parameter evaluated. A 0.05 alpha-level corresponding to the chance of a Type I error, or the probability of finding a difference in means when there is none, was applied in the Student's t-tests. Correlations between bioaccumulation and other data sets (e.g. sediment characteristics) are generated through linear regression, which applies the same alpha-level of 0.05. The Pearson product moment coefficient is used in these linear regressions [40].

Data Processing & Statistical Methods for Offshore Monitoring Program

According the SFPUC, ordination and cluster analysis are used to distinguish groups of stations by degrees of similarity for assessed attributes such as grain size and community composition [40]. Ordination analysis represents each station as a point in multidimensional space, with the distance between points being proportional to the similarity or dissimilarity across stations. The different dimensions (referred to as separate axes) of the ordination space represent independent gradients of change in the data. Each individual dimension is ordered, creating a gradient of separate axes that moves from the maximal level of change to the minimal level of change.

Cluster analysis is used to define groups of stations that shared similar grain size and community composition [40]. Results from cluster analysis are generally visualized as a hierarchical tree-like structure called a dendrogram. Stations that cluster together are indicated as being more similar to one another than stations in other cluster groups.

Principal component analysis (PCA) with varimax rotation is used as the analytical ordination technique for physical grain size and metals data at all sediment monitoring stations in the study area [40]. The analysis creates different axes that define the main independent gradients of change for sediment data. The axis scores are then used as independent variables in multiple regression analysis for trawl station and infauna ordination scores [40].

Non-metric multidimensional scaling (NMDS) maps data in two- or three-dimensional space. The data are mapped according to their similarity using the Bray-Curtis index. The generated maps are compared with PCA ordination scores from the SFPUC's monitoring program for geo-physical-chemical parameters [40]. These comparisons reveal patterns of similarity across different offshore stations.

A Biota and Environmental Stepwise Test (BEST) is used to determine the relevance of patterns revealed through the PCA and NMDS comparisons. All taxa observed over the twelve-year study period, including rare species, are considered in the SFPUC's testing [40]. The square root of data is taken and used in the BEST calculations to reduce the stress coefficient for plots and the effect of rare species on NMDS plots for. The reduction in stress coefficients decreases the measure of significance in these analyses.

Correlations of community patterns with sediment grain size, sediment chemistry, Bay Area outflow data, and oceanographic conditions were are calculated and used to generate hypothesis about the cause of observed patterns in community characteristics in ordination and cluster analyses [40]. 2005 Bay outflow data from the Interagency Ecological Program and oceanographic conditions as documented by NOAA are used [40]. Past analysis indicate that community gradients defined through ordination analysis are generally correlated with external environmental factors [40]. This indicates that changes in benthic infauna community composition may be caused by shifts in oceanographic conditions of Bay outflow characteristics.

An analysis of similarity (ANOSIM) method is used to assess the similarity between ordination axis scores and the data on environmental parameters. The Primer v6 program was used in past ANOSIM testing, which compares the similarity of indices in the distributions of two parameters [40]. The statistical relevance of similarities is determined in these comparisons. The SFPUC compares parameters for grain size, sediment organic content (i.e. TOC, TKN, and PAH contaminants), and trace metals with benthic infauna data.

Reference-Envelope Analysis (REA) compares parameters at stations that were indicative of potential impacts with the population of parameters at individual reference stations. According to the SFPUC (2010), "reference envelope analysis is a method by which indicators from potentially impacted sites (e.g. outfall stations) can be compared to a range of indicators from the reference sites" [40]. Tolerance-

interval bounds are calculated in Reference Envelope Analysis and are used as the defining limits for distinguishing reference conditions from non-reference conditions. Any measures for outfall station parameters that fall outside of the defined tolerance intervals represent a potential effect from SWOO discharges on the receiving marine environment. The use of REA avoids the "pseudoreplication" inherent in common analysis of variance (ANOVA) methods that can reduce the statistical power and confidence in measures of statistical significance [40]. Typical ANOVA methods compare indicator variable means for reference and outfall stations, but comparing the indicator value to a quantile of the tail for the population distribution is useful when assessing measure from potentially impacted stations relative to reference stations [40].

To conduct the REA for reference and outfall the stations, the SFPUC first calculates the quantile of interest for reference areas for all parameters evaluated. Quantiles of 0.10 and 0.90 have been used in past REAs. The lower quantile is used for indicators that are expected to increase with outfall impacts (e.g. fine particle sediment size or total organic content) and the higher quantile is used for indicators that are expected to decrease with outfall impacts (e.g. individual abundance). The alpha-level used in all REA analysis is set at 0.05. The choice of quantiles and alpha-level is intended to balance the results in a way that would be sufficiently sensitive to environmental impacts while avoiding false positives [40]. Under the selected quantiles and alpha-level, measures that exceeded the tolerance interval bounds calculate for reference stations could reflect a potential impact, since only 10% of the reference population would exceed the tolerance bounds in the absence of outfall effects. This would be true 95% of the time, as determined by the 0.05 alpha-level used in the SFPUC's REA testing [40].

A paired before-after experimental design with controls is used to assess changes in outfall station characteristics after the SWOO came online in 1986. Reference stations are controls in the analysis. The SFPUC uses the acronym 'BACIP' (Before-After-Control-Impact Paired) as short form for this experiment design [40]. A change in indicator values at stations in the vicinity of potential impacts from the SWOO does not necessarily mean that the SWOO has changed a station's characteristics. Indicators can change naturally over time with shifts in oceanographic conditions and Bay outflow. Under the BACIP design, these large-scale environmental phenomenon are assumed to influence indicator values at both control (reference stations) and potentially impacted (outfall stations) areas. Consequently, the tests assess changes that take place after the SWOO came online (in 1986) that do not take place in both the control and impact areas [40]. The SFPUC's null hypothesis for the BACIP test assumes no difference in averages across reference and outfall areas for the before- and after- periods. Comparisons in the paired design are made between a single reference station control and a single outfall station. This single-comparison approach was adopted due to the fact that a "point source impact (such as an outfall) will create gradients of change in the vicinity of the impact, and the severity of the impact at different locations on the gradient is of interest rather than the impact to the larger area" [40]. BACIP analyses assume that the differences in the distribution of each group - in this case, stations - are normally distributed.

A log transformation is to normalize data that are positively skewed, such as measure of abundance. Testing the logarithms for data in BACIP analysis is equivalent to testing for the same ratio of abundance in before-after impact periods. Student's t-tests are used to evaluate the difference in log values prior to

discharge and after discharge. The City & County of San Francisco began monitoring benthic infauna in 1982, meaning that data for the before-impact period run from that year to 1985. Over that time, one outfall station and on reference station were consistently tested. These stations (01 and 06 respectively) continue to be sampled as part of the SFPUC offshore monitoring program. A BACIP analysis of infauna abundance at these two stations is conducted as a part of the SFPUC's monitoring program to assess the impact on wastewater discharge on marine organisms in the outfall's vicinity.

Appendix D – Nearshore Habitats in the Exclusion Area

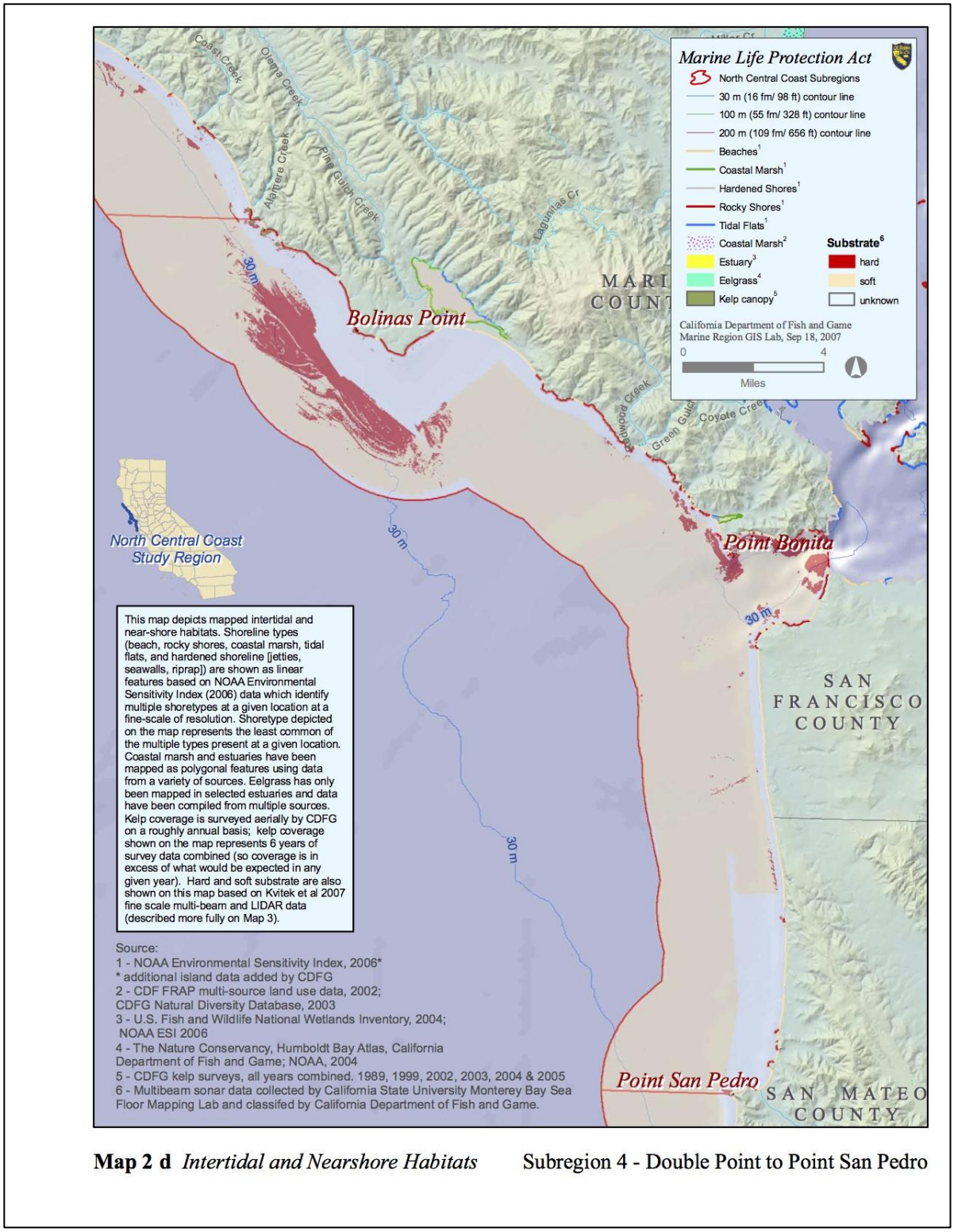

Figure 38: Intertidal and Nearshore Habitats in the Exclusion Area
(source: "California Marine Life Protection Act Initiative" [77])

Appendix E – Documented Species Occurrences in or near the Exclusion Area

Note: species only listed in the ESI may not occur *in* the Exclusion Area, but are listed as "common in coastal waters" on the two ESI maps that cover the Exclusion Area.

Species	Source
Birds	
Western and Clark's grebes	BGA, ESI
Eared and horned grebes	ESI
Sooty, black-vented, and pink-footed shearwaters	BGA
Shearwaters (including sooty)	ESI
White-winged and surf scoters	BGA, ESI
Brown pelican	BGA, ESI
Brandt's, double-crested, and pelagic cormorants	BGA, ESI
Gulls: Glaucous-winged, western, California, ring-billed, mew, Heermann's	BGA, ESI
Caspian/elegant and Forster's terns	BGA
Common murre	BGA, ESI
Pacific loon	ESI, BGA
Cassin's auklet	ESI
Phalaropes	ESI
Pigeon guillemot	ESI
Rhinoceros auklet	ESI
Marbled murrelet	ESI
Western snowy plover	ESI
Black oystercatcher	ESI
Mammals	
Bottlenose dolphin	ESI, RP, GGCR
Long-beaked common dolphin	ESI
Pacific white-sided dolphin	ESI
Risso's dolphin	ESI
Short-beaked common dolphin	ESI
Harbor porpoise	ESI, RP, GGCR
Dall's porpoise	ESI, BGA
Fin whale	ESI
Humpback whale	ESI, BGA, GGCR
Gray whale	ESI, BGA, GGCR
Minke whale	ESI, BGA, GGCR
Killer whale	ESI
Northern right whale	ESI
Short-finned pilot whale	ESI
Blue whale	ESI

Southern sea otter	ESI, RP
Harbor seal	RP
Seals	ESI
California sea lion	RP
Steller sea lion	RP, BGA
Sea lions	ESI
Fish	
Salmon	ESI, RP
Barred surfperch	ESI, RP
Calico surfperch	ESI, RP
Pacific herring	ESI, RP
California grunion	ESI
California halibut	ESI
Halibut	RP
Jacksmelt	ESI
Redtail surfperch	ESI
Striped bass	ESI
Walleye surfperch	ESI
White seabass	ESI
White seaperch	ESI
Shark	RP
Skate	RP
Ray	RP
Great white shark	Jorgensen
Sevengill shark	Slager, Ketchum
Other (reptiles, invertebrates)	
Leatherback sea turtle	RP, ESI, NMFS
Dungeness crab	ESI, RP
Rock crab	RP
Pacific littleneck clam	ESI

Sources:

BGA: NOAA National Centers for Coastal Ocean Science (NCCOS), "A Biogeographic Assessment off North/Central California: In Support of the National Marine Sanctuaries of Cordell Bank, Gulf of the Farallones and Monterey Bay. Phase II – Marine Fishes, Birds, and Mammals.," Silver Spring, MD, 2003.

ESI: National Oceanic and Atmospheric Administration; Office of Response and Restoration, "Environmental Sensitivity Index: Central California," 2006.

RP: California Marine Life Protection Act Initiative and California Department of Fish and Game, "Regional Profile of the North Central Coast Study Region (Alder Creek/ Point Arena to Pigeon Point, California)," Sacramento, CA, 2007.

GGCR: Golden Gate Cetacean Research, "Comment letter from Golden Gate Cetacean Research re. MBNMS Expansion." 2012.

Jorgensen: S. J. Jorgensen, C. A. Reeb, T. K. Chapple, S. Anderson, C. Perle, S. R. Van Sommeran, C. Fritz-Cope, A. C. Brown, A. P. Klimley, and B. A. Block, “Philopatry and migration of Pacific white sharks,” *Proceedings of the Royal Society of Biological Sciences*, vol. 277, pp. 679–688, 2009. and Email communication (Jan. 13, 2013).

Slager: C. Slager, “Personal communication (Aug. 15, 2012).”

Ketchum: J. T. Ketchum, C. Slager, M. Buckhorn, and A. P. Klimley, “Movements and residency of sevengill sharks (Notorhyncus cepedianus) in San Francisco Bay. DRAFT.”

NMFS: NMFS Southwest Fisheries Science Center, “Final Biological Report: Final Rule to Revise the Critical Habitat Designation for Leatherback Sea Turtles,” 2012.

Documented Shipwrecks: Point San Pedro To Point Lobos

Name Official Number	Year Lost/Built	Tonnage Gross	Length Feet	Rig
Robert Henderson	1850/1838	368		Wooden Sailing Bark
J. Sarkie	1851			Wooden Sailing Bark
Cornelius W. Lawrence	1851/1848	144	96.5	Wooden Revenue Cutter
Julia Castner	1859/1858	509	142.0	Wooded Sailing Bark
F. W. Bailey	1863/1854	711	160.0	Wooden Sailing Ship
Beeswing	1863			Wooden Sailing Schooner
Ann Parry	1865/1825	348	107.0	Wooden Sailing Bark
Brignardello	1868/1865	543		Wooden Sailing Bark
Aimer 1885	1871/1870	96	86.0	Wooden Sailing Schooner
Eliza 8001	1871/1868	10		Wooden Fishing Sloop
Josephine Willcutt 13555	1872/1860	86	80.0	Wooden Sailing Schooner
King Philip 14026	1878/1856	1194	186.6	Wooden Sailing Bark
W. H. Gawley 26655	1880/1861	483	147.0	Wooden Sailing Barkentine
Dublin 6418	1882/1839	706	139.0	Wooden Sailing Bark
Atlantic 628	1886/1851	291	116.2	Wooden Sailing Bark

Parallel 20168	1887/1868	148	98.0	Wooden Sailing Schooner
William Frederick 26783	1887/1863	42	63.6	Wooden Sailing Schooner
Bessie Everding 3007	1888/1876	73	73.5	Wooden Sailing Schooner
William L. Beebe 80559	1894/1875	296	134.7	Wooden Sailing Schooner
Neptune 130227	1900/1882	184	106.0	Wooden Sailing Schooner
Reporter 110298	1902/1876	351	141.4	Wooden Sailing Schooner
Eureka 8436	1902/1868	295	134.3	Wooden Sailing Schooner
Gifford 99822	1903/1892	2245	281.6	Steel Sailing Bark
Drumburton 84131	1904-1881	266.7	266.7	Iron Sailing Ship
Mystery 17704	1907/1868	31	48.5	Wooden Sailing Schooner
James Rolph 77361	1910/1899	586	169.1	Wooden Sailing Schooner
Signal 116160	1911/1887	475	150.0	Wooden Steam Schooner
Aberdeen 107593	1916/1899	499	169.8	Wooden Steam Schooner
Yosemite 202806	1926/1906	827	193.0	Wooden Steam Schooner
Ohioan	1936/1914	5154	407.7	Steel Freighter

212314

Documented Shipwrecks: Lands End

Name Official Number	Year Lost/Built	Tonnage Gross	Length Feet	Rig
Caroline Amelia	1850			Wooden Sailing Bark
Syren	1861/1851	1064	189.0	Wooden Clipper Ship
Schah Jehan	1867			Wooden Sailing Ship
Viscata	1868/1864	1065	204.0	Iron Sailing Ship
Confidence 125698	1880/1878	81	84.0	Wooden Schooner Pilot
Elko 8849	1881/1868	147	96.5	Wooden Scow Schooner
George Louis 10730	1882/1863	40.68	60.7	Wooden Sailing Schooner
Tano 216668	1921/1918	32	59.8	Wooden Gasoline Vessel
Lyman Stewart 212860	1922/1914	5919	408.8	Steel Oil Tanker
Coos Bay 206620	1927/1909	5149	386.0	Steel Freighter
Frank H. Buck 212090	1937/1914	6077	408.8	Steel Oil Tanker

Documented Shipwrecks: Fort Point

Name Official Number	Year Lost/Built	Tonnage Gross	Length Feet	Rig
Samoset	1852/1847	734		Wooden Sailing Ship
Aberdeen	1852/1847	719	154.0	Wooden Sailing Ship

Golden Fleece	1854/1852	968	173.0	Wooden Clipper Ship
Chateau Palmer	1856	800		Wooden Sailing Ship
Lafayette	1857			Wooden Sailing Sloop
General Cushing	1858/1856	681	150.0	Wooden Sailing Ship
Granada Steamer	1860/1855	1058	227.0	Wooden Side-Wheel
Isaac Jeans 12417	1876/1854	813	157.0	Wooden Sailing Bark
Frank Jones 120103	1877/1874	1453	199	Wooden Sailing Downeaster
City of Rio de Janeiro 110346	1901/1878	3548	315.0	Iron Passenger Steamship

Documented Shipwrecks: Lime Point To Point Bonita

Name Official Number	Year Lost/Built	Tonnage Gross	Length Feet	Rig
Crown Princess	1849			
Mersey	1850/1840	393		Wooden Sailing Bark
San Francisco	1853/1853	1307	198.0	Wooden Clipper Ship
Susanita	1853			
Zenobia	1858/1838	630	143.9	Wooden Sailing Ship
Jenny Ford	1864/1854	397	133.4	Wooden Sailing Barkentine
H. L. Rutgers	1868/1865	491	167.0	Wooden Sailing Bark
Rescue 21645	1874/1865	139	100.0	Iron Steam Screw Tug
Pet	1888/1868	49	67.5	Wooden Sailing Schooner

20092				
City of New York 125460	1893/1875	3019	339.0	Iron Passenger Steamship
Samson 116375	1895/1890	217	109.0	Wooden Sailing Schooner
Daisy Rowe 6977	1900/1879	122	94.5	Wooden Sailing Schooner
Pathfinder 150887	1914/1900	86	81.0	Wooden Pilot Schooner
Eureka 136808	1915/1900	484	142.5	Wooden Steam Schooner
Three Sisters 218372	1929/1917	28	56.3	Wood Motor Fishing Vessel
Silver Fox 260039	1950/1945	10		Wooden Motor Vessel

Documented Shipwrecks: Exclusion Area Offshore

Name Official Number	Year Lost/Built	Tonnage Gross	Length Feet	Rig
Benevolence AH-13	1950/1944	11000	520.0	Steel Navy Hospital Ship

Table Source [131]

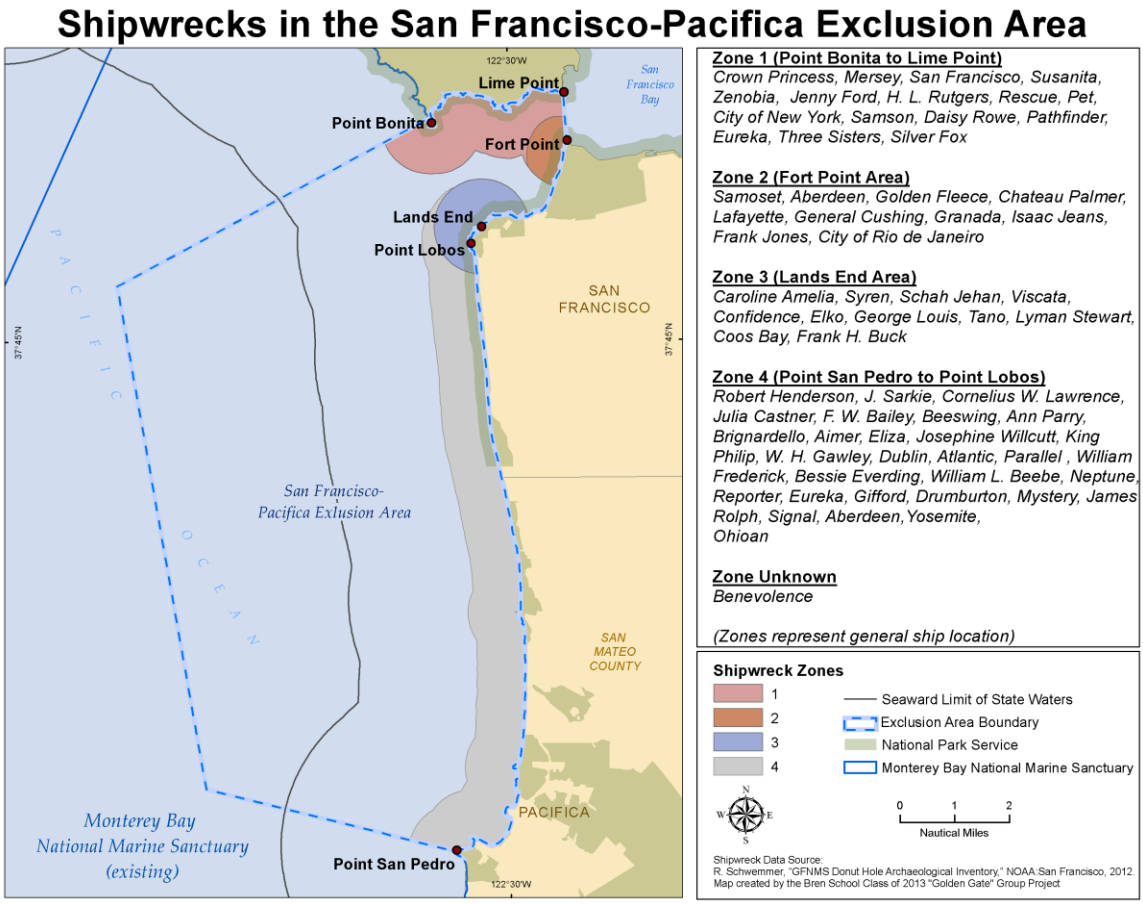

Figure 39: Shipwrecks in the San Francisco-Pacifica Exclusion Area

Appendix G – Port Complexes

Table 20: Ports with Landings Caught in the Exclusion Area (Each complex consists of small ports unnamed in the DFG data, though landings are still recorded and reported. Source: DFG Commercial Landing Reports [124]**)**

San Francisco	Bodega Bay	Monterey Bay
Alameda Alviso Berkeley China Camp Emeryville Oakland Petaluma Pinole Princeton-Half Moon Richmond San Francisco San Leandro San Rafael Sausalito South San Francisco Vallejo	Bodega Bay Bolinas Dillon Beach Inverness Marconi Cove Marshall Point Reyes Tomales Bay Other Ports	Baig Creek Mill Creek Monterey Moss Landing Santa Cruz