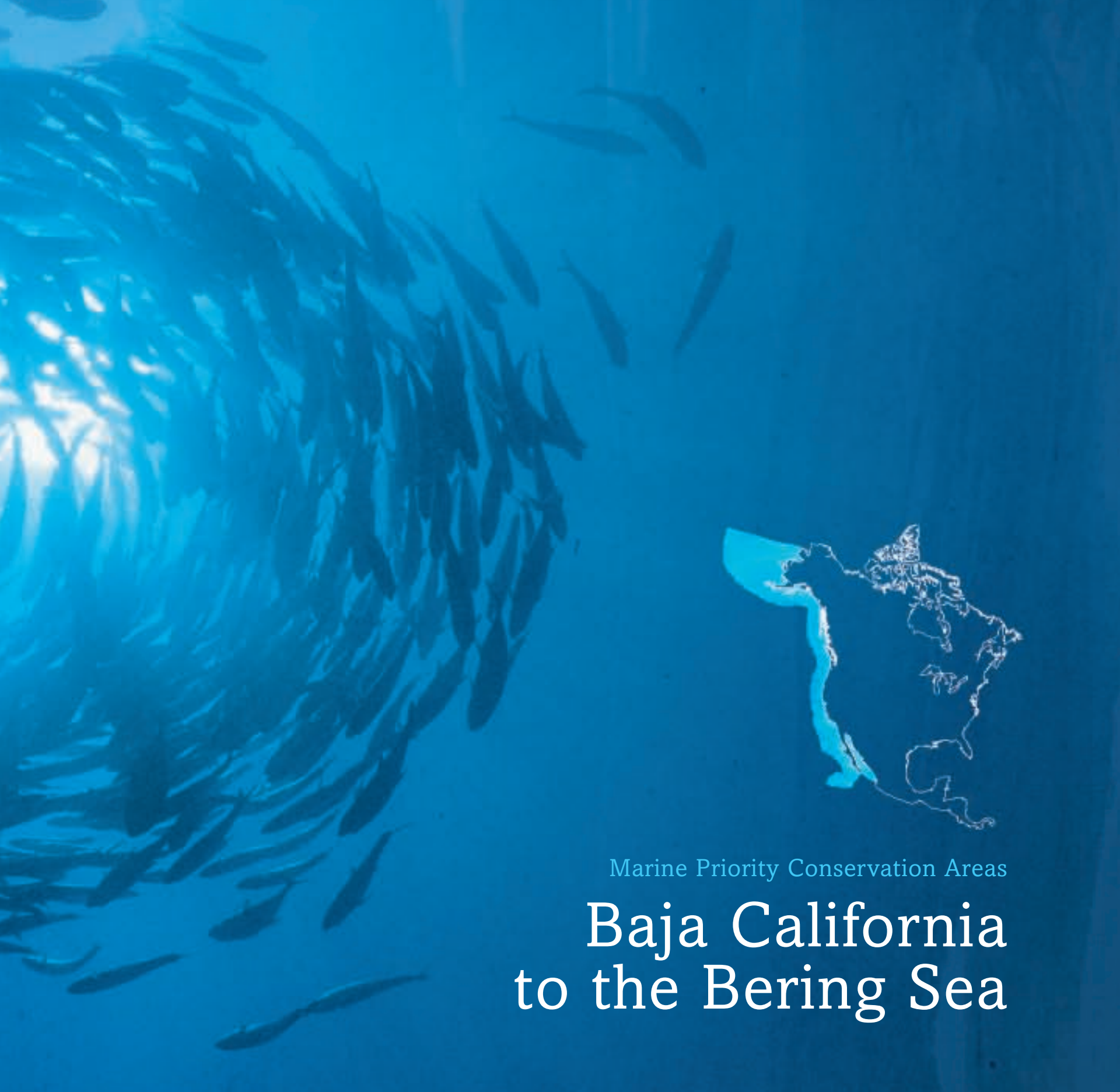

Marine Priority Conservation Areas

Baja California to the Bering Sea

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Baja California to the Bering Sea

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Tara A.C. Wilkinson
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Commission for Environmental Cooperation of North America
Marine Conservation Biology Institute

February 2005

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Executive Summary

From the Gulf of California, with its deep canyons, nutrient-rich upwellings and high levels of endemism, to the 20,000 kilometers of bays, inlets and inland drainage systems of the Pacific Northwest and the high productivity of the Bering Sea, the west coast of North America is home to unique and important shared marine environments. It is also home to a great number of shared marine species—such as Pacific gray and blue whales, leatherback sea turtles, bluefin tuna, black brant geese and Heermann's gulls—that migrate thousands of kilometers, moving across national borders without hesitation. Hence, be it through shared species or ecosystems, the marine environments of Canada, Mexico and the United States are intimately linked. Accordingly, action or inaction on one side of a border will have consequences for the shared living organisms occupying ecosystems with no definite boundaries.

Identifying priority conservation areas (PCAs) is one of several marine initiatives sponsored by the Commission for Environmental Cooperation (CEC) of North America as part of its *Strategic Plan for North American Cooperation in the Conservation of Biodiversity*. This report describes the process of identifying these PCAs—areas of trinational importance due to their ecological significance, threatened nature and opportunities for conservation—which are in need of bi- and trinational cooperative action for their successful conservation. Iteratively over the course of this project, the definition of PCAs was refined to reflect the goals of the CEC process, the variable nature of data available in the three nations, and the spatial scale of the Baja California to Bering Sea (B2B) region. Other initiatives advance a common framework for mapping marine ecoregions, identify and help protect species of common conservation concern, and work to provide a common understanding as well as a coordinated and complementary use of institutions, initiatives and tools in each country so as to implement an integrated Marine Protected Area (MPA) Network in North America. This PCA initiative seeks to detail where conservation action is immediately necessary. This identification charts a course for future conservation alliances and action in the B2B region.

The CEC, by convening and coordinating the North American MPA Network (NAMPAN), is developing the capacity for a network of MPAs to span the jurisdictions of Canada, Mexico and the United States. The aim of NAMPAN is to enhance and strengthen the conservation of biodiversity in critical marine habitats throughout North America by creating a functional system of ecologically based MPA networks that cross political borders and depend on broad cooperation. The identification of these PCAs is not intended as the MPA network design, but rather as a portfolio of continentally significant sites which can serve as nodes around which a network of reserves can be built. Networks of reserves are important tools for conserving biological diversity, and these PCAs should be viewed as places to begin building more comprehensive, effective MPA networks for North America.

The methodology for identifying PCAs relied on teaming experts' knowledge with the development of a geographic information system (GIS). The GIS included appropriate spatial data sets and selected analyses available for the entire B2B region at a common resolution, as well as smaller subsets of regional information. Analyses focused on translating several of these data sets to highlight regions where physical processes lead to unique features, high levels of biodiversity or high abundances of species. At the final PCA identification workshop, experts reviewed the aggregated data sets and analyses to inform their judgments of ecological value and conservation priority. Decisions on priority were based on the ecological significance of the areas to North America, threats to the areas and opportunities to advance conservation.

A total of 28 sites were identified as priority conservation areas (PCAs), totaling eight percent of the total area within the exclusive economic zones (EEZs) of the three nations. By country, these areas represent approximately 10 percent of the area in Canada's Pacific EEZ, seven percent of the B2B region in Mexico, and eight percent of the US EEZ (within the B2B defined region). Experts' criteria, outstanding ecological characteristics, threats and existing designations for

each area are detailed in this report in the section "Description of the Priority Conservation Areas by Marine Ecoregion," which places the PCAs within the geographic context of CEC ecological classifications.

These 28 priority conservation areas are those that marine experts consider essential to safeguarding the biological diversity of the B2B region of North America. These sites encompass unique areas (e.g., the Patton Seamount complex, the sponge reefs of Hecate Strait, and the upper Gulf of California, home to the only marine mammal endemic to North America, the vaquita), areas especially important as locations along migratory corridors (e.g., Unimak Pass, Channel Islands, Laguna San Ignacio), and areas particularly rich in biological diversity (e.g., Aleutian Archipelago, Queen Charlotte Strait, Monterey Bay, Corredor los Cabos). PCAs vary significantly in the degree to which they are threatened and in their protection status, but they represent a vision shared by experts on places critical for conserving North America's biological diversity.

Finally, there is a need for the human communities of the B2B region to stay connected and to embrace a common vision of our North American ocean heritage. It is the work of the many human institutions within the B2B region to coordinate their efforts, such as in the NAMPAN initiative, and work towards implementation of conservation strategies and a network of marine protected areas (MPAs), including marine reserves. This portfolio of PCAs should be a first step towards building this community, and points to the need for the CEC and other trinational and national forums, such as the Baja California to Bering Sea Marine Conservation Initiative, to foster the development of stewardship in the B2B region.

Foreword

Canada, Mexico and the United States are inextricably linked by growing economic, social and cultural exchanges; nevertheless, our relationship does not begin or end with these exchanges. For millions of years, nature has united North America, influenced the development of our societies, and shaped our cultural identities, creating a complex living mosaic.

Whether this increasing economic relationship represents a threat or an opportunity for the conservation of biodiversity, particularly the species we share, will depend to a large extent on the value that North Americans attribute to the environment.

This understanding needs to go beyond appreciation of the richness and abundance of North American life forms and acknowledge that biodiversity on the continent is in crisis, be it by habitat alteration, or species loss. Changes in resource abundance generally manifest with a rippling effect, first locally, then nationally and ultimately regionally. Effects cascade to other species, ecosystems and economies. And since biodiversity crises have strong local impacts — hurting those closest to the source of biological wealth — the solutions also must involve participation of local communities and resource users, a point that is sometimes overlooked despite well intended plans for conservation.

There is growing awareness about marine issues in North America, thanks in part to high profile collapses of important fisheries as well as to public concern about highly endangered marine mammals and sea turtles. Environmental groups in all three countries have seized upon the ability of the more charming species to capture public attention, and have designated many of them as flagships that symbolize the plight of entire marine ecosystems. In addition to sharing some natural history traits that make them vulnerable to over-exploitation, they also share a reliance on a series of disparate intact habitats for their survival.

In an effort to better understand what is at stake in the Baja California to Bering Sea region, and as part of the CEC's *Strategic Plan for North American Cooperation in the Conservation of Biodiversity,* the CEC and the Marine Conservation Biology Institute (MCBI) convened a workshop to map conservation priorities for this region and to identify a new set of flagship spaces for North American cooperation.

The information presented in this report is the outcome of this successful event. It involved efforts of many stakeholders, the governments of Canada, Mexico and the United States, academics and NGO representatives, to identify priority conservation areas for the Baja California to Bering Sea region. This report and related initiatives are aimed at assisting the three North American countries in developing a coordinated, multinational, multisectoral approach for the conservation of linked habitats and shared species.

Hans Herrmann
Head, Conservation of Biodiversity Program
Commission for Environmental Cooperation

Acknowledgments

An endeavor such as this could not be possible without the dedicated efforts of many individuals, agencies and organizations. Among these are the Baja California to Bering Sea Marine Conservation Initiative, Sabine Jessen and Natalie Ban and the members of the steering committee. We also owe an enormous debt of gratitude to the participants and experts who attended the various workshops (listed on the next page) and provided their wisdom and knowledge. We thank the institutions and individuals who co-hosted workshops and meetings, including the US Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) MPA Science Center (Charles Wahle), Simon Fraser University's Centre for Coastal Studies (Patricia Gallaugher and Suzana Dragicevic) and Ecotrust (Ed Backus and Michele Dailey).

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Acronym List

AVHRR
advanced very-high-resolution radiometers

B2B
Baja California to Bering Sea

CCAR
Colorado Center for Atmospheric Research

CEC
Commission for Environmental Cooperation of North America

CITES
Convention on International Trade in Endangered Species of Wild Fauna and Flora

Conabio
National Commission for the Knowledge and Use of the Biodiversity (*Comisión Nacional para el Conocimiento y Uso de la Biodiversidad*)

Conanp
Mexican National Commission of Natural Protected Areas (*Comisión Nacional de Áreas Naturales Protegidas*)

COSEWIC
Committee on the Status of Endangered Wildlife in Canada

DFO
Department of Fisheries and Oceans Canada

EEZ
exclusive economic zone

ESR
ecologically significant region

GIS
geographic information system

INE
National Institute of Ecology (*Instituto Nacional de Ecología*)

IUCN
International Union for Conservation of Nature and Natural Resources (more commonly known as the World Conservation Union)

MCBI
Marine Conservation Biology Institute

MCSST
multi-channel sea surface temperature

MMPA
US Marine Mammal Protection Act

MODIS
moderate-resolution imaging spectroradiometer

MPA
marine protected area

MSCCC
Marine Species of Common Conservation Concern

NAFTA
North American Free Trade Agreement

NAMPAN
North American MPA Network

NASA
US National Aeronautics and Space Administration

NMFS
US National Marine Fisheries Service (now called NOAA Fisheries)

NOAA
US Department of Commerce, National Oceanic and Atmospheric Administration

NPP
net primary productivity

PAR
photosynthetically available radiation

PCA
priority conservation area

QCI
Queen Charlotte Islands

SeaWiFS
sea-viewing wide field-of-view sensor

SST
sea surface temperature

UNESCO
United Nations Educational, Scientific and Cultural Organization

US FWS
US Fish and Wildlife Service

WWF
World Wildlife Fund

Introduction

Overview

From the Gulf of California, with its deep canyons, nutrient-rich upwellings and high levels of endemism, to the 20,000 kilometers of bays, inlets and inland drainage systems of the Pacific Northwest, to the high productivity of the Bering Sea, the west coast of North America is home to unique and important shared marine environments. It is also home to a great number of shared marine species — such as Pacific gray and blue whales, leatherback sea turtles, bluefin tuna, black brant geese and Heermann's gulls — that migrate thousands of kilometers, moving across national borders without hesitation. Hence, be it through shared species or ecosystems, the marine environments of Canada, Mexico and the United States are intimately linked. Accordingly, action or inaction on one side of a border will have consequences for the shared living organisms occupying ecosystems with no such definite boundaries.

In recent years, conservation strategists, noting past failures to stem the tide of extinctions, have focused to a great degree on large-scale ecosystem approaches (e.g., Wildlands Strategy, World Wildlife Fund's Global 200). Efforts such as these recognize four critical aspects necessary to conserve species and processes: 1) conserving species and processes that require the greatest area to persist, 2) conserving widespread species and continental phenomena, 3) quantifying patterns of beta diversity and endemism, and 4) predicting the location and intensity of threats to biodiversity (Olson *et al.* 2002). Large-scale efforts also require the mapping of important areas for conservation, such as biodiversity hotspots and other conservation priorities, in order to set priorities for action (e.g., Hixon *et al.* 2001, Roberts *et al.* 2002).

Although many conservation efforts and sustainable development initiatives exist at different scales along the Pacific Coast of North America, they generally work independently of each other. Unless these efforts are coordinated, species numbers will continue to decline and ecosystem integrity will continue to be at risk. The successful conservation of the North American seascape, therefore, requires cooperative action from all three countries and from diverse sectors of society. The CEC is able to provide this coordinating role for the three countries, Canada, Mexico and the United States. The CEC was created to address common environmental concerns by the governments of Canada, Mexico and the United States under the North American Agreement for Environmental Cooperation, a side agreement to the North American Free Trade Agreement (NAFTA). The North American Marine Protected Areas Network (NAMPAN) represents one initiative to facilitate collaboration to safeguard ecological linkages, and conserve marine biodiversity and productivity throughout the exclusive economic zones (EEZs) of the three nations. Many organizations and agencies contribute to this initiative, including the Marine Conservation Biology Institute (MCBI). This initiative is also in line with the World Summit for Sustainable Development, where participating governments, including Canada, Mexico and the United States, committed to implementing networks of representative MPAs by 2012.

Goal of the Priority Conservation Areas Project

Defining priority conservation areas (PCAs) marks the fulfillment of a workplan by the three nations to identify opportunities to work collaboratively on marine conservation at the North American level. Over the course of this project, the definition of PCAs was refined to reflect the goals of the CEC process, the variable nature of data available in the three nations and the spatial scale of the Baja California to the Bering Sea (B2B) region. The PCAs project represents one of several marine initiatives sponsored by the CEC. Other initiatives advance a framework for mapping marine ecoregions, identify and help protect species of common conservation concern, and work to provide a common understanding as well as a coordinated and complementary use of institutions, initiatives and tools in each nation so as to implement an integrated Marine Protected Area (MPA) Network in North America. This PCA initiative seeks to detail where conservation action is immediately necessary, thereby charting a course for future conservation alliances and action in the B2B region.

History of the Process

In 2000, the CEC identified the Baja California to Bering Sea region as one of its Priority Regions for Biodiversity Conservation of North America[1] — this region is defined as the west coast EEZs of Mexico, the United States and Canada from 22°N latitude to 65°N latitude. The B2B region was also advanced as the first test case for the CEC to implement its strategic plan in the marine environment.[2] In May 2001, MCBI and the CEC convened a workshop in Monterey, California, United States, where scientific experts, resource users and marine conservationists from the three countries addressed the goals and identified the types of baseline data that are required for conservation in the B2B region.[3] They agreed on the need to identify PCAs as a step in a larger continental-scale conservation effort. They also reached a consensus that the overarching goal of a PCA is to conserve biodiversity as well as provide benefits to fisheries, cultural values, recreation and scientific research.

These experts agreed to develop a geographic information system (GIS) based on common physical data for the entire region to serve as a framework for integrating other information. The GIS includes benthic and pelagic physical data to be used as a tool for research and analysis of species diversity, incorporating information from ongoing CEC projects (Marine Species of Common Conservation Concern and Ecosystem Mapping), and integrating ongoing and existing protected area designation processes. Experts also addressed issues of size and spatial scale, incorporating previous priority-setting efforts and knowledge of anthropogenic threats (Morgan and Etnoyer 2002).

1. <http://www.cec.org/trio/stories/index.cfm?ed=2&ID=18&varlan=english>
2. <http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1088>
3. This workshop was part of a greater meeting on marine conservation and the development of a North American Marine Protected Areas Network, supported by the World Commission on Protected Areas' North American Marine Working Group, the US National Oceanic and Atmospheric Administration (NOAA), as well as MCBI and the CEC.

Methodology

In June 2002, MCBI, in collaboration with the CEC, Ecotrust and Surfrider Foundation, organized a "Data Potluck" workshop in Portland, Oregon, United States. In this workshop, nearly 80 representatives from 30 organizations offered and exchanged data sets that appeared relevant to the spatial scale of the B2B region. The participants agreed that the concept of conservation priority must include not only biodiversity value, but also threats to and opportunities for the area.

In January 2003, a technical review of the geographic information system, the data analyses and the overall methodology to define PCAs was conducted in San Francisco, California, United States. The CEC and MCBI held this review to seek input and advice from various governmental agencies and nongovernmental organizations as to what further information could be synthesized for the B2B region. This consultation reviewed data sets and analyses, as well as previous decisions and recommendations.

This process culminated in April of 2003 with an experts' workshop, held at Simon Fraser University in Burnaby, British Columbia, Canada, to map North American PCAs, summarized herein.

The methodology selected for identifying PCAs relied on teaming experts' knowledge with the development of a geographic information system. The GIS included appropriate spatial data sets and selected analyses available for the B2B region at a common resolution, as well as smaller subsets of regional information. Analyses focused on translating several of these data sets in order to highlight regions where physical processes lead to unique features or concentrations of species. At the final PCA identification workshop, experts reviewed the aggregated data sets and analyses to inform their judgments of ecological value and conservation priority.

Throughout all consultations, those involved in this process attempted to interact with the appropriate federal agencies in each of the CEC countries rather than directly involving state, provincial or regional governing bodies (though these offices were involved to differing degrees). This led to a number of significant restrictions on this project. For example, the use of local ecological knowledge was discussed and considered. During our consultative process it was agreed that this type of information was clearly an important component of local conservation efforts, but that at the continental scale it should be left to additional regional and local efforts. This constraint of top-down efforts highlights the necessity of eventually matching this project with a community-based action plan involving members of the communities within the PCAs.

What is a PCA?

Priority conservation areas are defined on the basis of high biodiversity and continental uniqueness, incorporating aspects of ecological value, anthropogenic threat, and opportunity for conservation (i.e., existing designations and conservation initiatives). No comprehensive measure of biodiversity exists for the B2B region. Experts were, therefore, asked to assess biodiversity indirectly, relying on their accumulated knowledge of species, habitats and ecological processes. This includes the diversity of many different factors: 1) subregional and regional physiographic and oceanographic features important for continental planning (features on the order of 10–1,000 square kilometers, Appendix 1); 2) high beta-level biological diversity (between-habitat diversity); 3) continental endemism; 4) key habitats — concentration areas such as breeding and feeding sites or migration routes — for Marine Species of Common Conservation Concern (Appendix 2); 5) critical habitats of other umbrella and charismatic species that require large areas to persist; 6) areas that provide whole-region benefits, e.g., seasonally productive areas, migration corridors; and 7) areas of high biomass and/or productivity, e.g., coastal upwelling centers.

These criteria are consistent with other approaches that suggest capturing areas that contain regional representation of major habitats, diverse types of habitats, rare and threatened species and habitats, and endemic species. At the same time, it is important to capture oceanographic processes and ecological linkages that interconnect these habitats.

The geographic scope of the project (EEZ from 22°N latitude to 65°N latitude) included estuaries and islands, but not upland areas or freshwater environments. We also emphasize transboundary areas, owing to the international aspect of this project.

Data Collection

We developed a geographic information system (GIS) based on common physical data for the entire region to serve as a framework for integrating other data sets. Five data sets — bathymetry, shoreline and satellite-derived measures of productivity (chlorophyll-A), sea surface temperature, and altimetry (sea surface height used to derive surface currents) — offered reasonable potential for a B2B-scale analysis. Based on the input of the experts at workshops held in Monterey in 2001 and Portland in 2002 and after consultations with other experts, we assembled additional physical, biological and social data sets. The mandate given to the project was to use existing sources. Thus, no new data were collected, although significant efforts to digitize certain data sets did occur. In several cases, we included previous priority-setting exercises conducted on regional scales. All data sets were compiled onto a CD-ROM, in GIS format (Etnoyer *et al.* 2002)[3] (Appendix 3).

3. This information is available online from MCBI at <www.mcbi.org>.

Marine Species of Common Conservation Concern

In an initiative parallel to the identification of PCAs, the CEC convened an advisory group to identify the first list of Marine Species of Common Conservation Concern (MSCCC). The 16 species selected are listed in Appendix 2. The goal of this project was to focus on key conservation actions and protected areas needed to support these populations. These umbrella species captured a different conservation perspective by shifting the focus to processes that affect species as well as the places they inhabit. Compulsory criteria focused the initiative towards species that were: 1) transboundary or migratory;[4] and 2) at high risk of extinction, given their current status or trends, their inherent natural vulnerability and their susceptibility to anthropogenic threats. Using secondary or recommended criteria, priority was then given to species: 1) deemed ecologically significant, e.g., umbrella, keystone, or indicator taxa; 2) officially listed as being of conservation concern by one of the three North American countries, by the World Conservation Union (IUCN), or by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); 3) whose recovery or management was feasible, including re-establishment potential, as well as the opportunity to strengthen management and learn from successes; and 4) which had a high potential for public engagement (i.e., flagship species). (Please see Wilkinson *et al. Species...,* in prep. for more information on the process and the 16 MSCCC.) Key habitats for these species, as identified in the CEC's report on Species of Common Conservation Concern (Wilkinson *et al.*, *Species...,* in prep.), were included as criteria for PCAs.

4. Later expanded to include species that were affected by actions of two or more countries, and were not necessarily migratory or transboundary, such as the endemic vaquita.

Data Analysis

Several data analyses were conducted in order to highlight the significance of selected data sets to the conservation priority-setting exercise. These analyses include: 1) benthic complexity — a measure similar to rugosity; 2) sea surface temperature fronts — areas known to aggregate a wide-variety of pelagic sealife including fishes, sea turtles, birds and mammals; 3) primary productivity; and 4) sea-surface height — a measure of currents and eddies which also serve to transport nutrients and aggregate ocean life.

Benthic Complexity

Benthic complexity is a unique measure related to both slope and roughness. Generally speaking, it is a measure of the intricacy of the seafloor, that is, how much it changes in a given unit of area. This is in many ways similar to "rugosity." However, unlike rugosity, complexity is not greatly affected by large unidirectional changes in depth, such as cliffs.

Methodology described by Ardron (2002) was initially used as a way to identify complex seafloor of the British Columbia coast that previous measures, such as slope and relief, had not. It differs from slope and relief by differentiating between uniformly steep features, such as fjords, and those features that display more topographic complexity, such as rocky reefs, seamounts, and archipelagos. The latter are especially known for their ecological significance.

For the purposes of our analysis, bathymetry with sufficiently high resolution was not uniformly available throughout the B2B region. High-resolution bathymetry was available for three areas: 1) British Columbia; 2) coastal California, Oregon and Washington; and 3) Baja California. The results of this analysis indicate that the areas of highest benthic complexity are the shelf slope, canyons, gullies, island archipelagos and seamounts (Figure 1).

Sea Surface Temperature Frontal Density

Oceanographic fronts can be some of the most persistent features in the pelagic realm, and they are known to perform vital habitat functions for fishes (Schick 2002), sea turtles (Polovina *et al.* 2000), seabirds (Decker and Hunt 1996) and marine mammals (Davis *et al.* 2002). Fronts are characterized by the interaction of two dissimilar water masses, such as cold water and warm water, freshwater and saltwater, or nutrient-rich water and nutrient-poor water. This interaction can bring deep-water nutrients to the surface, where sunlight and warm water stimulate a phytoplankton bloom, often followed by a zooplankton bloom, producing a pulse of resources for species at higher levels.

The multi-channel sea surface temperature (MCSST) data are derived from the five-channel advanced very-high-resolution radiometers (AVHRR) on board the National Oceanic and Atmospheric Administration's (NOAA) polar-orbiting satellites. Clouds hinder frontal detection by radiometry. Cloud-free, interpolated sea surface temperature (SST) data are available at coarse scales. We tested satellite-derived SST data at three different resolutions to examine the effect of scale upon edge-detection algorithms. We found that the coarse-scale, cloud-free MCSST-interpolated data underestimated the total linelength of frontal features from finer scale raw AVHRR at nine-kilometer resolution, and Coastwatch data at two-kilometer resolution. However, MCSST data can reliably detect the strongest, most persistent temperature fronts within the B2B extent. We examined monthly MCSST data over a four-year period, from 1996–1999. This "cloudless" temporal window captured a strong El Niño, a La Niña and two "normal" years.

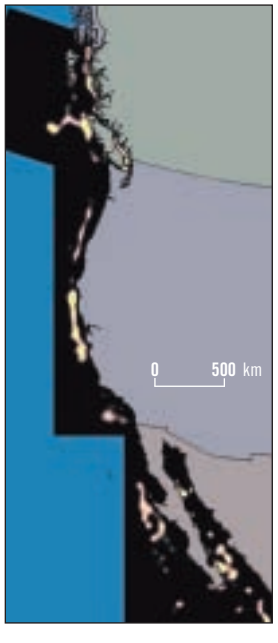


Figure 1. Results of B2B benthic complexity analysis; yellow indicates areas of high benthic complexity. In black are those areas for which sufficiently high-resolution bathymetry was available. High-resolution bathymetry was not available for Alaskan waters or for offshore regions. Courtesy Jeff Ardron, Living Oceans Society.

Using new analysis methods to detect temporal variation in SST frontal concentrations (Etnoyer *et al.* 2004), we found less than one percent of the Northeast Pacific shows active temperature fronts across seasons and between years. We identified three of these large features — offshore Los Cabos (Mexico), Point Conception (United States), and the southern California Channel Islands (United States). The frontal density signature off northern Baja California (Ensenda Front) appeared weaker and closer to shore in an El Niño year, and stronger and more offshore during a normal year. Satellite telemetry data and fisheries statistics demonstrate that these pelagic habitats are important to migrating blue whales (*Balaenoptera musculus*) (Figure 2), swordfish (*Xiphias gladius*) and striped marlin (*Tetrapturus audax*).

Sea Surface Height: Currents, Gyres and Eddies

At the scale of an ocean basin, the sea surface is not flat. Warm water expands, producing higher than average surface heights (hills), while cool water contracts, registering lower than average surface heights (valleys). Orbital satellites such as TOPEX/Poseidon use pulses of radar to measure minute differences in sea surface height. This is known as "altimetry." In an altimetry map, wind and waves are averaged, and sea surface height is expressed as an "anomaly" — a negative or a positive difference from the mean sea surface height.

These small differences in water height translate into current movement. Warm-core eddies, areas with higher than average sea surface heights, spin clockwise or anti-cyclonically. Lower than average sea surface heights, or cold-core eddies, spin counterclockwise or cyclonically. Furthermore, cold-core eddies create upwelling conditions that bring nutrients to the surface, and may result in trophic cascades and plankton blooms. Eddies can form when large freshwater flows from terrestrial rivers spill into the saline waters of the sea. The Haida Eddy (Pacific Canada) is a three-dimensional "swirling freshwater tornado" about the size of Lake Michigan that transports coastal nutrients (such as iron) to nutrient-poor offshore waters, fertilizing the environment and creating a plankton bloom (Crawford and Whitney 1999). The Haida Eddy appears strongest in El Niño winters off British Columbia. The footprint of the Haida Eddy varies within El Niño Southern Oscillation cycles, and appears weakest in La Niña years.

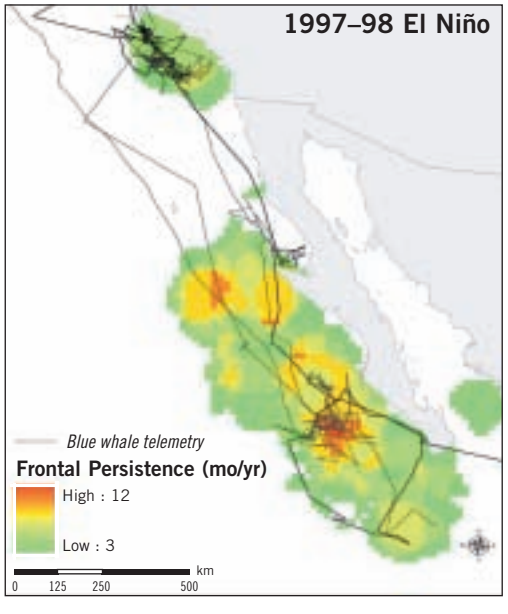


Figure 2. Results of one frontal density analysis for the El Niño of 1997–98, overlaid with blue whale tracks. Most persistent areas (red) coincide with high residence times for southward migrating blue whales. These are interpreted as key feeding areas for migrating whales (Etnoyer *et al.* 2004). Whale data courtesy B. Mate, Oregon State University.

For this analysis, we used altimetry to study surface current patterns in the Gulf of Alaska. The Colorado Center for Atmospheric Research provided four years of biweekly averaged surface current magnitude and velocity, derived from a blended product of TOPEX/Poseidon, and ERS-1 and ERS-2 satellites. We masked all but the highest waters or the greatest slope and sequenced the data to reveal the location and trajectory of warm core rings in the Gulf of Alaska.

We identified the 1998 Haida Eddy and tracked it from Gwaii Haanas (Queen Charlotte Islands) in a southwesterly direction to beyond the Canadian EEZ. The feature persisted for more than a year, beginning at a size of 100 kilometers in diameter, then dissipating down to 75 kilometers for much of the year (Figures 3a–3c). We identified an equally impressive anti-cyclonic feature that seemed to originate in Shelikof Strait and to propagate westward along the Aleutian Archipelago, gaining strength as it passed. This feature traveled more than 400 kilometers in the course of six months. Several Sitka Eddies came and went in the Gulf of Alaska throughout the four-year investigation period. These eddies represent a transboundary export of nutrients and larvae between British Columbia, Canada, and Alaska, United States. It is also possible that these retentive eddies could concentrate and transport inorganic pollutants and contaminants to rare and delicate seamount ecosystems.

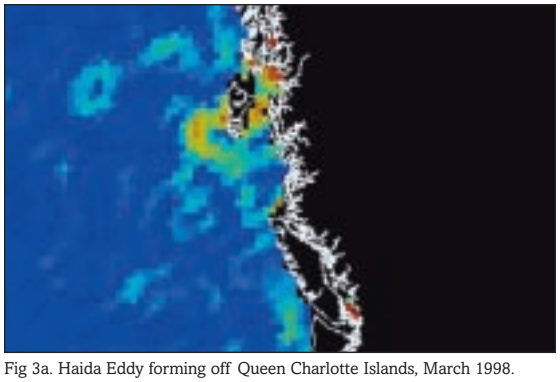


Fig 3a. Haida Eddy forming off Queen Charlotte Islands, March 1998.

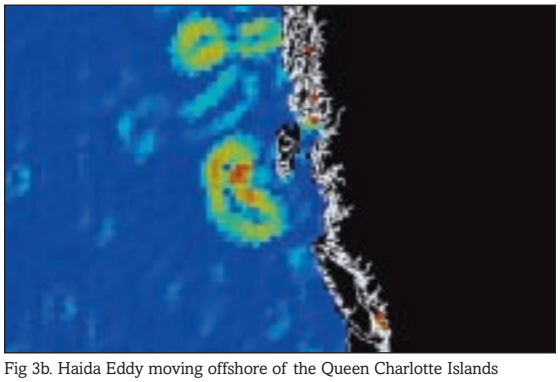


Fig 3b. Haida Eddy moving offshore of the Queen Charlotte Islands in southwesterly direction, July 1998. Note similar eddy to the north.

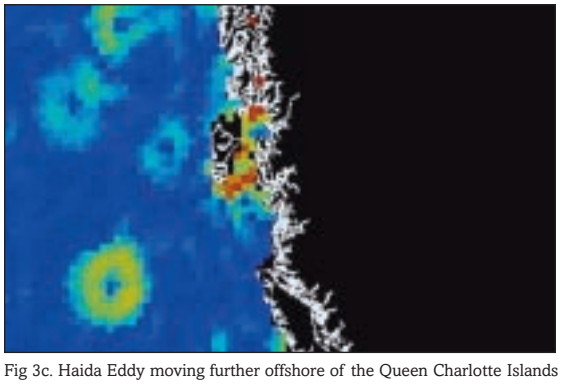


Fig 3c. Haida Eddy moving further offshore of the Queen Charlotte Islands in southwesterly direction, November 1998.

Primary Productivity

Measuring synoptic chlorophyll distribution in the global ocean is only possible with satellite ocean color sensors. Sea-viewing wide field-of-view sensor (SeaWiFS) and moderate-resolution imaging spectroradiometer (MODIS) satellites provide one- to two-day coverage of the entire earth, allowing study of regional and global ocean color patterns. The primary data product from the sensors is the surface chlorophyll concentration (in mg/m^3). Combined with the SST data obtained from satellites with an AVHRR, primary production can also be estimated from empirical models.

Net primary productivity (NPP) can be estimated from three parameters: chlorophyll, photosynthetically available radiation (PAR) and SST. We estimate the NPP in $g\ C\ m^{-2}\ month^{-1}$ (Behrenfeld and Falkowski 1997). Monthly chlorophyll data for the region bounded by 12°N–72°N and 180°W–100°W between September 1997 and June 2002 were obtained from the US National Aeronautics and Space Administration (NASA) Distributed Active Archive Center,[5] PAR data from SeaWiFS,[6] and monthly SST data from NASA's Jet Propulsion Laboratory.[7]

5. <http://daac.gsfc.nasa.gov>
6. Frouin, R., B. Franz, and M. Wang. Algorithm to estimate PAR from SeaWiFS data <http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/PDFs/seawifs_par_algorithm.pdf>
7. <http://podaac.jpl.nasa.gov/sst>

Atmospheric effects were removed and chlorophyll concentration was estimated. To estimate primary production, the model takes into account the depth-dependent chlorophyll and light profile, and estimates the primary production per unit chlorophyll from SST, using an empirical relationship. Based on the NPP monthly results for each location, we estimated the number of occurrences (frequency) in a year when NPP exceeded a predefined number (10 g C m^{-2} $month^{-1}$). The number was chosen according to visual examination of the difference between oligotrophic and productive waters, but is somewhat arbitrary. The results serve as an index to describe how long enhanced productivity exists at a location.

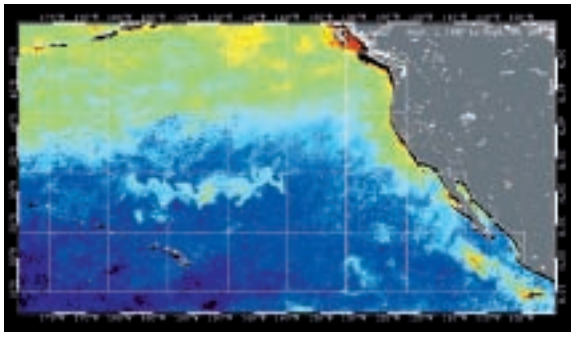


Figure 4. Primary productivity across the B2B region, September 1997. Note high productivity in the coastal waters of British Columbia, California and Baja California. Courtesy of Chuanmin Hu and Frank Muller-Karger, University of South Florida.

Priority Conservation Areas Workshop/ Consensus Mapper

In April 2003, MCBI and the CEC led a three-day workshop at Simon Fraser University, Burnaby, British Columbia, Canada, where marine experts from government agencies, nongovernmental organizations, academia, and regional organizations in Canada, Mexico and the United States met to identify PCAs in the B2B region. These experts represented interests from resource use, science, management and conservation. The experts were supported by a team of GIS experts from MCBI and from the geography departments of Simon Fraser University and McGill University, which provided technical assistance for the mapping workshop.

For the experts at the identification workshop, we reviewed the appropriate rationale for continental-scale PCAs, in accordance with the goals of the initiative and the consultations at previous meetings. Experts were asked to identify those areas that met the most criteria (i.e., had the most "bang for your buck"). We briefed experts on the history of the B2B initiative, goals of the workshop, definitions of key terms and criteria for selecting priority conservation areas. The organizers also informed the participants that the end product of this workshop would guide the three nations' governments in their joint conservation collaborations, as well as provide a framework for regional conservation efforts and programs.

Workshop organizers presented the assembled data and analyses, and individual experts made presentations on a range of species and areas of concern. These presentations were on topics such as the natural history of seamounts, benthic complexity, sea surface temperature frontal regions, species hotspots, fisheries, threats from human activities, and ongoing conservation activities in each of the three nations.

Next, experts participated in a round table mapping exercise. Consensus Mapper is a software program and methodology that allows exploration of spatial data, discussion of decision priorities, and mapping of selected areas. Individual maps are overlaid to show areas of overlap, or consensus, between different working groups. The round table permits experts from different fields of expertise to uncover their commonalities, while those with divergent interests can clarify their points of disagreement and work towards compromise. This system was developed by Community-Based Environmental Decision Support at McGill University (Faber 1996, Balram and Dragicevic 2002). The advantages of collaborative mapping include the following (Balram *et al.* 2003, Balram *et al.* 2004):

- facilitating collaboration and consensus building within a dynamic social setting,
- providing structure and documenting the stakeholder participation process,
- incorporating inputs and policies at various levels of spatial aggregation,
- encouraging spatial thinking and exploration of environmental issues,
- providing feedback into the decision-making process,
- integrating data from expert sources,
- managing the technical and social network of the participation process, and
- facilitating collaborative monitoring of decision actions.

Following an overview of the data available and instructions from the workshop facilitators, experts learned how to use the Consensus Mapper software, a simplified version of the ArcView software. Finally, participants were assembled into expert working groups. The workshop was conducted as a series of break-out sessions for mapping and plenary discussions to review progress.

During the workshop, experts engaged in several exercises to identify PCAs. In order to do so, the experts first identified ecologically significant regions (ESRs) in the B2B extent. The experts were asked to base ecological significance on the data available, and on their personal knowledge of species, habitats, and physical and oceanographic features in the B2B region. Experts reached consensus on ESRs by overlaying individual team maps to show areas of agreement between expert working groups. In subsequent exercises, experts were asked to review the specific criteria for each ESR and rate it according to their knowledge of regional threats (e.g., resource extraction, pollution, coastal development) and opportunities for collaboration (e.g., previous designation as a priority or site of conservation interest, existing protected status, sustainable practices, local support) relative to the other ecologically significant regions. The resulting map of ESRs served to highlight places of high ecological significance. PCAs are a subset of ecologically significant regions that have become priorities based on significant threats and/or opportunities. These mapping exercises are described below.

Mapping Exercises

Exercise One: Thematically Identify Ecologically Significant Regions

The participants were divided into six groups according to their expertise: benthic environment (one group), pelagic environment (two groups), and planning and management (three groups). Within each group there were six to 10 participants and at least one representative from each of the four B2B subregions: Mexico, the lower United States, Canada and Alaska. Each group identified areas that they knew to be ecologically significant, and discussed and debated these with others in their group. These areas were drawn on a digital map using the Consensus Mapper program. For each place identified, they noted the rationales in a spreadsheetz, stating the physiographic, oceanographic and biological features, species diversity, endemism or other criteria they believed relevant to the site's ecological significance. Pelagic groups were also asked to focus on migratory species (including the CEC's list of Marine Species of Common Conservation Concern, Appendix 2). In this exercise, each group was allowed to select up to 40 percent of each nation's EEZ within the B2B extent. They were also asked to refrain from selecting areas smaller than one degree square. At the end of this exercise, all the groups' selections were superimposed in one consensus map, with areas shaded in accordance with the degree of overlap among the six groups. In a plenary session workshop, participants were able to review and comment on the overlaid map of ESRs.

Exercise Two: Review and Refine Ecologically Significant Regions

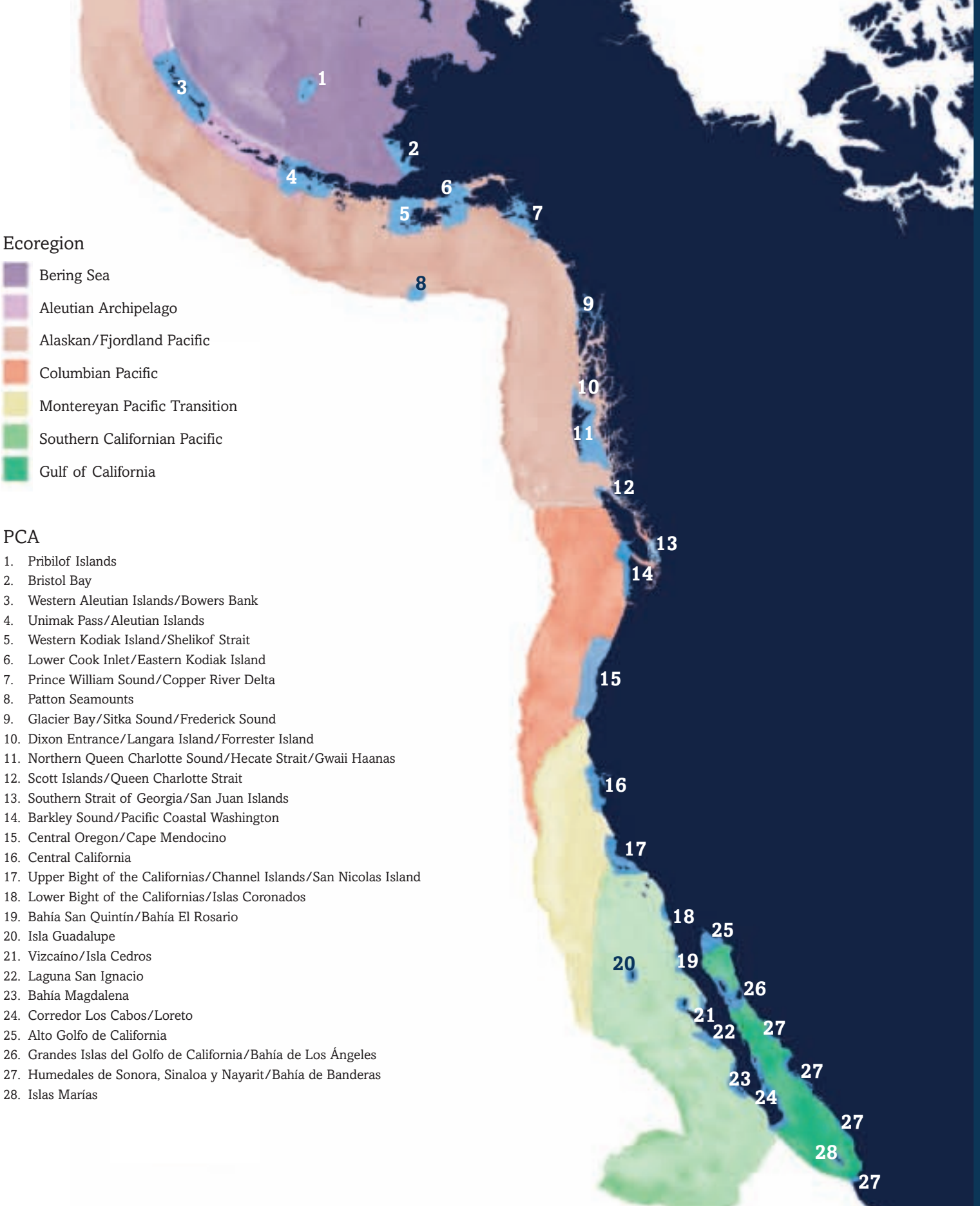
We divided experts into four groups by region: Mexico, the lower United States, Canada and Alaska. Within each group, members had differing expertise. They reviewed the results of the previous exercise, seeking to refine the coarser scale analysis. They either modified the boundaries of those high-consensus regions from Exercise One and adopted them as ESRs or added new selections. In this exercise, the groups also documented the rationales for each ESR they identified. Each group was allowed to identify up to 40 percent of its respective EEZ as ecologically significant. At the end of this exercise, all the groups' selections were combined and shown on a map in a plenary session. The participants saw the final ESRs from Baja California to the Bering Sea. Each group had an opportunity to explain their selections to the other groups.

Exercise Three: Identify Threats and Opportunities

In addition to ecological significance, threats and opportunities are crucial factors in assigning priority. In this exercise, the participants were again divided into regional groups to rate the relative level of threats and opportunities in each of the ESRs previously identified. The workshop organizers categorized threats into the following types: 1) non-renewable resource extraction, 2) exploitation of renewable resources, 3) coastal land use change, 4) pollution, 5) damaging recreational use, and 6) physical alteration of coastlines. Opportunities were categorized as: 1) existing legal protection, 2) available management, 3) local and/or regional support, 4) funding available for information management and/or conservation, and 5) sustainable business practices. Each group of experts received a list of these categories. Group members discussed the relative significance of the types of threats and opportunities existing in their ESRs. Where applicable, experts provided additional details pertaining to the threats, ranked their relative intensity (high, moderate or low) and assessed the current trend (conditions improving, unchanged, or worsening). The description, intensity and trend were all recorded in a spreadsheet.

Exercise Four: Identify Priority Conservation Areas

The final step in the workshop was to identify PCAs. The participants were divided into six trinational teams with at least one expert from each of the four B2B subregions. In this exercise, the goal was to select not more than 20 percent of the area within the ESRs from Baja California to the Bering Sea as PCAs. The group members used Consensus Mapper to digitally map their selections, and specified their rationales for every PCA. At the end of this exercise, the six sets of PCAs selected by the six groups were overlaid and shown to all workshop participants in a plenary session. The selected areas were colored according to the degree of overlay. The participants saw the level of consistency across the groups. Each group had the opportunity to explain the reasoning behind their selection and to point out unique features they had taken into consideration.

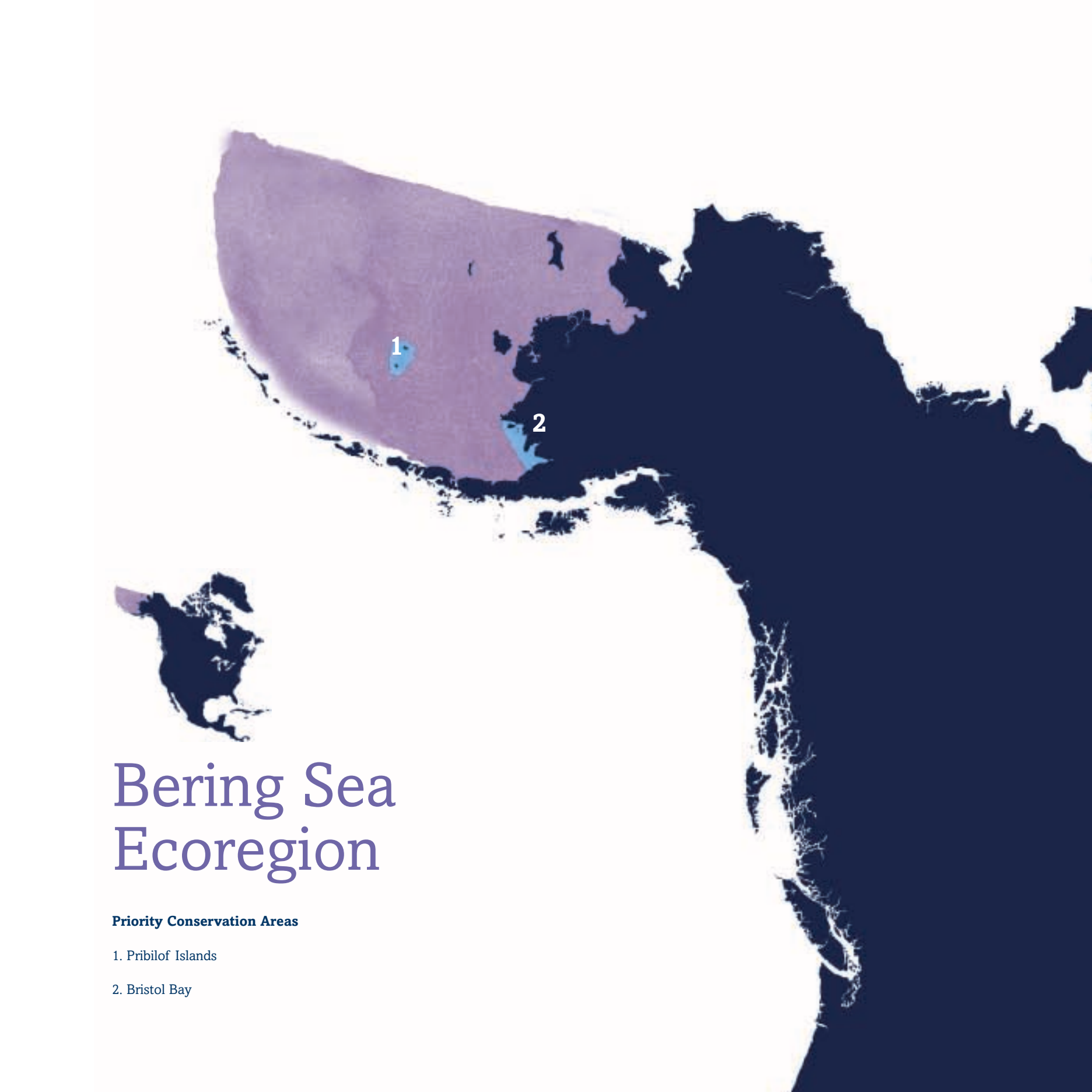


PCA

1. Pribilof Islands
2. Bristol Bay
3. Western Aleutian Islands/Bowers Bank
4. Unimak Pass/Aleutian Islands
5. Western Kodiak Island/Shelikof Strait
6. Lower Cook Inlet/Eastern Kodiak Island
7. Prince William Sound/Copper River Delta
8. Patton Seamounts
9. Glacier Bay/Sitka Sound/Frederick Sound
10. Dixon Entrance/Langara Island/Forrester Island
11. Northern Queen Charlotte Sound/Hecate Strait/Gwaii Haanas
12. Scott Islands/Queen Charlotte Strait
13. Southern Strait of Georgia/San Juan Islands
14. Barkley Sound/Pacific Coastal Washington
15. Central Oregon/Cape Mendocino
16. Central California
17. Upper Bight of the Californias/Channel Islands/San Nicolas Island
18. Lower Bight of the Californias/Islas Coronados
19. Bahía San Quintín/Bahía El Rosario
20. Isla Guadalupe
21. Vizcaíno/Isla Cedros
22. Laguna San Ignacio
23. Bahía Magdalena
24. Corredor Los Cabos/Loreto
25. Alto Golfo de California
26. Grandes Islas del Golfo de California/Bahía de Los Ángeles
27. Humedales de Sonora, Sinaloa y Nayarit/Bahía de Banderas
28. Islas Marías

Description of Priority Conservation Areas by Marine Ecoregion

A total of 28 sites were identified as PCAs, spanning seven marine ecoregions in the B2B region, totaling eight percent of the total EEZ area of the three nations. By country, these areas represent approximately seven percent of the B2B region in Mexico, 10 percent of the area in Canada's Pacific EEZ and eight percent of the US EEZ (within the B2B defined region). Summaries of the experts' discussions and selection criteria, and descriptions of the outstanding ecological characteristics of, threats to and opportunities for each area follow. The ecoregions are derived from the CEC ecosystem-mapping project and delineate the marine realm of North America based on oceanographic, physical and biological characteristics (Wilkinson *et al.*, *Spaces...*, in prep.).



Bering Sea Ecoregion

Priority Conservation Areas

1. Pribilof Islands

2. Bristol Bay

Threats:	PCA: Pribilof Islands	PCA: Bristol Bay
Extraction of nonrenewable resources	=	=
Exploitation of renewable resources	↓	=
Coastal land use change	=	=
Pollution at coast/ at sea	=	=
Damaging recreational use	↓	↓
Physical alteration of coastline	=	=

Intensity: low moderate high

Trend: ↑ improving = unchanged ↓ worsening

Northern fur seals (*Callorhinus ursinus*) on beach outside St. Paul, Pribilof Islands, Alaska
Photo: John Hyde, Alaska Stock

Regional Setting

The Bering Sea is characterized by two unique features, a large continental shelf and a seasonal ice cover. The Bering Sea includes a broad eastern shelf, gently sloping westward away from North America. At its northern boundary, the Bering Sea is significantly influenced by the Bering Strait. This is the second largest continental shelf in the world, after the Arctic shelf, and is bounded on the south by the Alaska Peninsula and on the north by Alaska and Siberia. It exceeds 500 kilometers (300 miles) in width at its narrowest, and extends over 11 degrees of latitude. The shelf deepens gradually to about 170 meters (560 feet) at the shelf break. The continental slope is incised with many canyons and drops to a generally flat abyssal plain, nearly 4,000 meters (13,000 feet) deep. Ice cover is seasonal, varying from none, between late June and November, to almost 80 percent at its maximum, in March (Niebauer 1980).

Currents in the eastern Bering Sea flow in a generally counterclockwise direction, with the Aleutian North Slope Current flowing northeast along the eastern Aleutian archipelago and curving northwest at the shelf edge to form the Bering Slope Current. A northeast drift current flows over the nearshore shelf. Net flow through the Bering Strait is from the Bering Sea to the Chuckchi Sea. The annual formation and retreat of sea ice over the northeast shelf is a major determinant of the distribution of many species. The Yukon River is the largest river flowing into the eastern Bering Sea. The region is of special conservation importance to marine mammals and fisheries and is a unique subpolar ecosystem.

Biological Setting

The Bering Sea is a very productive high-latitude sea, supporting a large biomass of invertebrates, fishes, birds and marine mammals. The southeast Bering Sea contains two fairly distinct communities. The first consists of an outer shelf pelagic group of fish, mammals and birds that consume small fish—primarily juvenile walleye pollock (*Theragra chalcogramma*) and krill. The second is an inshore group of fish, crabs and other bottom-dwelling fauna that consume mainly seafloor animals. In the outer shelf, pollock dominates the biomass and represents a keystone species in the system. Pollock are important to nesting seabirds (Springer 1996) and seals (Lowry *et al.* 1996). The Pribilof Islands are an important spawning area for pollock. The region is also productive of halibut (*Hippoglossus stenolepis*), rockfish (*Sebastes* spp.), capelin (*Mallotus villosus*) and herring (*Clupea pallasi*), among others. The Bering Sea shelf break is highly productive, and a number of fish concentrate for all or part of the year here, including chinook salmon (*Oncorhynchus tshawytscha*), salmon sharks (*Lamna ditropis*), Pacific Ocean perch (*Sebastes alutus*), sablefish (*Anoplopoma fimbria*), Pacific cod (*Gadus macrocephalus*), Greenland turbot (*Reinhardtius hippoglossoides*), arrowtooth flounder (*Atheresthes stomias*) and halibut.

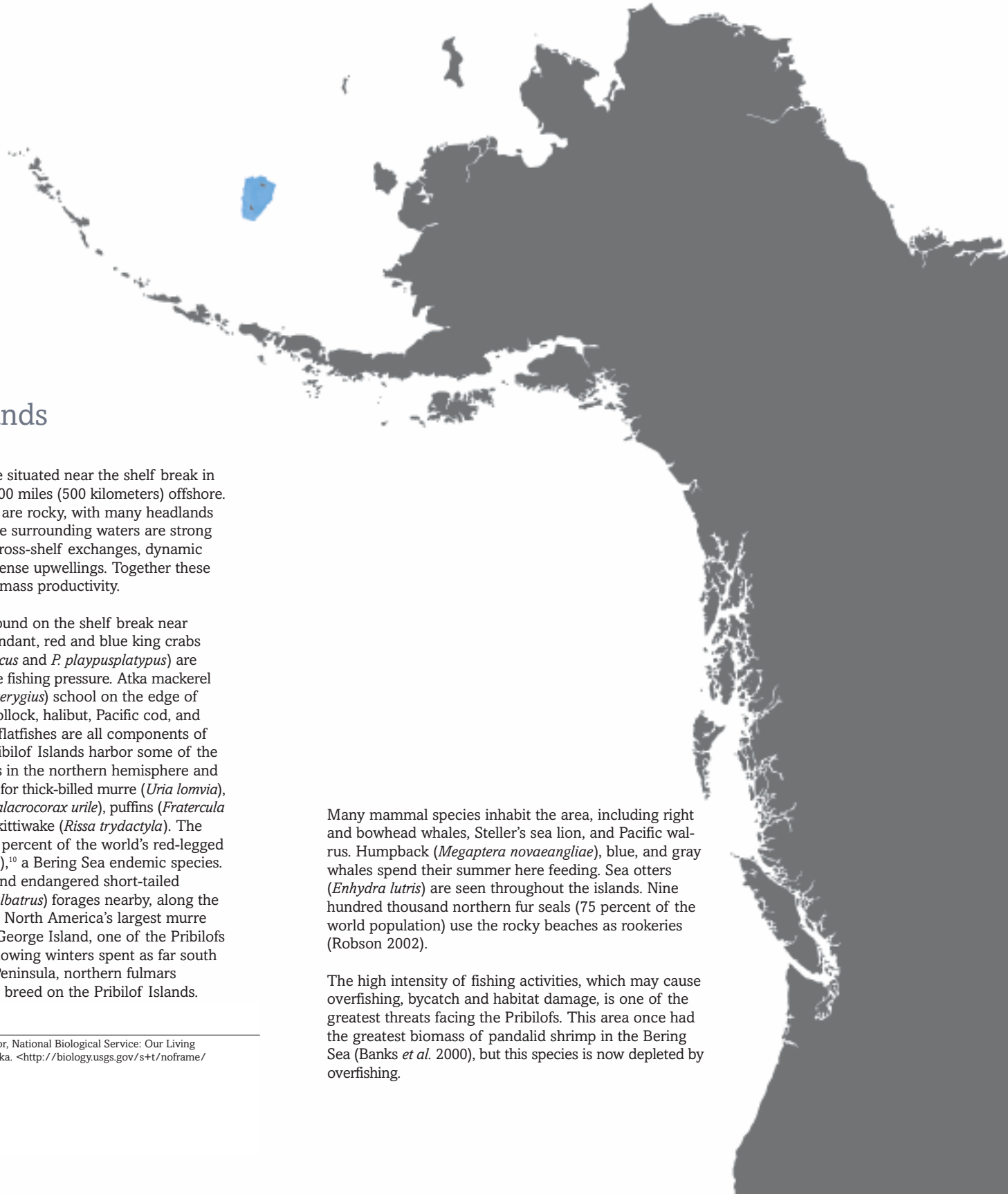
Over the last decade, significant changes have occurred in the Bering Sea marine ecosystem from intensive fishing and whaling (Springer *et al.* 2003), and possibly from shifts in climatic regimes (Sugimoto and Tadokoro 1998). The character of the seasonal icepack has recently changed from the "warm" phase that persisted since the regime shift of the late 1970s to one that exhibits rapid buildup in winter, but earlier retreat in spring (Luchin *et al.* 2002). Many species move seasonally with the advance and retreat of sea ice, including many fishes, Pacific walrus (*Odobenus rosmarus*) and seals. Spring primary production is determined predominately by the timing of ice retreat. The distribution and abundance of pollock, Pacific cod and other commercially important fishes have varied with these fluctuations in sea ice, and the ability of these large predatory fish populations to sustain fishing pressure is expected to vary between warm and cold regimes (Hunt *et al.* 2002).

Approximately 50 million seabirds breed in Alaska each summer[8] (87 percent of the seabirds in the United States are found in Alaska), including murres (*Uria* spp.), kittiwakes (*Rissa* spp.) and auklets (*Aethia* spp.) in the Bering Sea. Species such as the Canada goose (*Branta canadensis*) and black brant (*Branta bernicla*) breed in the area and move to Baja California, Mexico, to overwinter, while the pigeon guillemot (*Cepphus columba*) moves through British Columbia on to coastal California. Other species use the area to feed, but reproduce elsewhere, especially oceanic seabirds such as some species of shearwaters (*Puffinus* spp.) and albatrosses. The northern fur seal (*Callorhinus ursinus*) is listed as "vulnerable" on the IUCN Red List of Threatened Species, and the Pribilof Islands/Bogoslof Island stock is designated as "depleted" under the US Marine Mammal Protection Act (MMPA). The species is protected in Canada by the 1993 Marine Mammal Regulations, except for hunting by indigenous peoples. The western population[9] of the Steller's sea lion (*Eumetopias jubatus*) is listed as an endangered species under the US Endangered Species Act. The western Alaskan stocks of Steller's sea lion have undergone a continuous decline since the 1970s, and management measures, including no-fishing buffer zones around rookeries and alternatives to mitigate potential effects of commercial fisheries on important prey species, are at present being developed. A variety of great whales, including blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*), northern right (*Eubalaena glacialis*) and the eastern north Pacific stock of gray whale (*Eschrichtius robustus*), are visitors to the Bering Sea ecosystem during the summer feeding season. Blue, fin and gray whales are all known to travel to Mexican waters to overwinter, whereas 8,000 bowhead whales (*Balaena mysticetus*) spend the winter in the Bering Sea (Shelden and Rugh 1995).

8. US Fish and Wildlife Service: Migratory Birds http://alaska.fws.gov/mbsp/mbm/seabirds/seabirds.htm>
9. West of 144°W (Cape Suckling, Alaska) including part of the Gulf of Alaska, the Aleutian Islands and the Bering Sea.

Human Activities

Several small towns and numerous native villages sparsely populate the Alaskan coast of the Bering Sea. Subsistence use of coastal resources in the region includes nearshore fishing of salmon (*Oncorhynchus* spp.) and other fishes, invertebrates and marine mammals, including seals, Steller's sea lion, walrus and polar bear (*Ursus maritimus*). Subsistence hunting of northern fur seal on the Pribilof Islands is limited by quota and other regulations under the MMPA. Offshore, commercial fisheries in the region are of major importance—Bering Sea fish and shellfish constitute almost five percent of world's and 40 percent of US fisheries' landings (Macklin 1999). Pollock, salmon, halibut and crab generate several hundred million dollars each year in fisheries revenue. Populations of several species—such as king (*Paralithodes* spp.), tanner and snow crabs (*Chionoecetes bairdi* and *C. opilio*); Pacific Ocean perch; and Greenland turbot—have experienced steep declines in the past two decades (North Pacific Fishery Management Council 1998, 2000).



PCA 1
Pribilof Islands

The Pribilof Islands are situated near the shelf break in the Bering Sea, some 300 miles (500 kilometers) offshore. The islands' shorelines are rocky, with many headlands and embayments. In the surrounding waters are strong current fronts, strong cross-shelf exchanges, dynamic nutrient mixing and intense upwellings. Together these factors lead to high biomass productivity.

Gorgonian corals are found on the shelf break near the Pribilofs. Once abundant, red and blue king crabs (*Paralithodes camtschaticus* and *P. playpusplatypus*) are now targets of intensive fishing pressure. Atka mackerel (*Pleurogrammus monopterygius*) school on the edge of the continental shelf. Pollock, halibut, Pacific cod, and various rockfishes and flatfishes are all components of this ecosystem. The Pribilof Islands harbor some of the largest seabird colonies in the northern hemisphere and are major nesting areas for thick-billed murre (*Uria lomvia*), red-face cormorant (*Phalacrocorax urile*), puffins (*Fratercula* spp.) and black-legged kittiwake (*Rissa trydactyla*). The islands are home to 75 percent of the world's red-legged kittiwake (*R. brevirostris*),[10] a Bering Sea endemic species. The highly migratory and endangered short-tailed albatross (*Phoebastria albatrus*) forages nearby, along the Bering Sea shelf break. North America's largest murre colony is found on St. George Island, one of the Pribilofs (Banks *et al.* 2000). Following winters spent as far south as the Baja California Peninsula, northern fulmars (*Fulmarus glacialis*) also breed on the Pribilof Islands.

10. US Department of the Interior, National Biological Service: Our Living Resources—Seabirds in Alaska. <http://biology.usgs.gov/s+t/noframe/b023.htm>

Many mammal species inhabit the area, including right and bowhead whales, Steller's sea lion, and Pacific walrus. Humpback (*Megaptera novaeangliae*), blue, and gray whales spend their summer here feeding. Sea otters (*Enhydra lutris*) are seen throughout the islands. Nine hundred thousand northern fur seals (75 percent of the world population) use the rocky beaches as rookeries (Robson 2002).

The high intensity of fishing activities, which may cause overfishing, bycatch and habitat damage, is one of the greatest threats facing the Pribilofs. This area once had the greatest biomass of pandalid shrimp in the Bering Sea (Banks *et al.* 2000), but this species is now depleted by overfishing.

Federal and International Designations

- Alaska Maritime National Wildlife Refuge, US Fish and Wildlife Service (US FWS)
- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, blue whale, gray whale, humpback whale, northern right whale
- seabirds: short-tailed albatross

Continental Uniqueness:

- high endemism
- North America's largest murre colony on St. George Island
- important pollock spawning area
- 75 percent of northern fur seals breed in the area

Ecological Linkages:

- largest colonies in the northern hemisphere for many cross-boundary migratory seabirds (e.g., thick billed murre, red-legged kittiwake, auklets)

Physical/Oceanographic Uniqueness:

- offshore islands (with high endemism)
- large, productive continental shelf

Parakeet auklet (*Aethia psittacula*)
Alaska
Photo: Bob Wilson

PCA 2
Bristol Bay

Bristol Bay is located at the southeastern corner of the Bering Sea's large continental shelf, bordered by the mainland of Alaska and the Alaska Peninsula. Several estuaries are located around and feed freshwater into this coastal embayment. The Bristol Bay waters are high in nutrients, and experience strong mixing and current fronts. The waters in this area are highly productive areas for red and blue king crab, tanner crab and snow crab.

Soft corals are widely distributed across the bay (Heifetz 2002). Pollock are present in the outer half of the bay. Bristol Bay is a nursery ground for halibut and many flatfish species and has a large population of red king crab and salmon. Pacific cod also inhabit this area. This is home to the largest spawning area for eastern Bering Sea herring and the world's largest run of sockeye salmon (*Oncorhynchus nerka*) (Banks *et al.* 2000). Extensive coastal cliffs, wetlands and lagoons support migrating and breeding birds. Abundant forage fish in the bay support black-legged kittiwake, common murre (*Uria aalge*), pelagic cormorant (*Phalacrocorax pelagicus*) and many other seabirds that nest here. Bristol Bay is a wintering area for the Bering Sea population of 200,000 Pacific walrus.[11] Steller's sea lion also haul out on the Bay's north shore. Gray, blue and northern right whales migrate through these biologically diverse waters. A beluga whale (*Delphinapterus leucas*) stock, numbering between 1,500 and 2,000, spends the summer here after overwintering in the Bering Sea (Angliss and Lodge 2002).

11. US Fish and Wildlife Service. Pacific walrus <http://alaska.fws.gov/fisheries/mmm/walrus/nhistory.htm>

Federal and International Designations

- Togiak National Wildlife Refuge, US FWS
- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions.

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: blue whale, northern right whale, gray whale

Continental Uniqueness:

- world's largest sockeye salmon run

Ecological Linkages:

- largest spawning area for eastern Bering Sea herring
- important winter area for Pacific walrus
- important summer area for 2,000 beluga whales
- diversity of soft corals

Walrus (*Odobenus rosmarus*) haulout on Round Island, Bristol Bay
Photo: Bob Wilson

Aleutian Archipelago Ecoregion

Priority Conservation Areas

3. Western Aleutian Islands/Bowers Bank

4. Unimak Pass/Aleutian Islands

Threats:	Western Aleutian Islands/Bowers Bank	Unimak Pass/Aleutian Islands
Extraction of nonrenewable resources	=	=
Exploitation of renewable resources	↓	↓
Coastal land use change	=	=
Pollution at coast/ at sea	=	=
Damaging recreational use	↓	↓
Physical alteration of coastline	=	=

PCA:

Intensity: low moderate high

Trend: ↑ improving = unchanged ↓ worsening

Camping
Kigul Island
Photo: US FWS

Regional Setting

West of the Gulf of Alaska, the Aleutian Islands — the world's longest archipelago — extend westward towards Russia. This region is characterized by a narrow shelf, little freshwater input and no seasonal ice cover. The shelf slopes steeply offshore to the adjacent Aleutian Trench. The Aleutian Trench runs for 3,700 kilometers (2,300 miles) from Kodiak Island to the end of the Aleutian Chain, and has a maximum depth of 7,680 meters (25,194 feet). The Aleutian Trench extends in an arc south of the Aleutian Islands, where the Pacific plate slides under the North American plate. This subduction zone is along the Ring of Fire, the string of volcanoes and frequent-earthquake zones around the Pacific Ocean.

The Aleutian Archipelago contains numerous high-velocity straits and passes that connect the temperate north Pacific to the subpolar Bering Sea. The Alaskan Stream flows westward out of the Gulf of Alaska along the southern edge of the Aleutian Islands. As this flow continues along the Aleutian Islands, most of the shallower water (above 2,000 meters or 6,500 feet) enters the Bering Sea through Near Strait (170°E), although the Alaskan Stream moving through the passes also strongly influences water properties and circulation in the eastern Bering Sea (Stabeno and Reed 1994). The mean circulation through the Aleutian passes, the eastern Bering Sea and the Bering Strait is northward. Thus, little oceanic water is exchanged from the Arctic to the lower-latitude Pacific Ocean. Nutrient-rich water is introduced to shallow zones, where it can be used by phytoplankton, via strong mixing within the Aleutian passes. The Aleutian Archipelago may be considered a transition zone between the polar Bering and Arctic seas and the temperate waters of the mid-latitude northern Pacific Ocean.

Biological Setting

Rocky shores throughout the Aleutians contain abundant kelp forests (*Nereocystis luetkeana*), and major adult concentrations of sea otters (*Enhydra lutris*) can be found in the Aleutian chain, although populations have been in steep decline in recent years (Estes *et al.* 1998, Doroff *et al.* 2003). Exploration of seamounts in the Gulf of Alaska and Aleutian Islands have revealed rich faunas of deep water hydrocorals and gorgonian corals, especially *Paragorgia arborea* and *Primnoa resedaeformis*, creating unique deepwater ecosystems. Red-tree coral (*Primnoa* spp.) provides structural habitat for rockfishes (*Sebastes* spp.), sablefish (*Anoplopoma fimbria*), Atka mackerel (*Pleurogrammus monopterygius*) and arrowtooth flounder (*Atheresthes stomias*) (Krieger and Wing 2002). Colorful and beautiful gorgonians extend to depths of 730 meters (2,400 feet) and appear in aggregations like groves of trees (Witherell and Coon 2001). Some of these corals rise more than 4.5 meters (15 feet) above the sea floor. Large colonies of red-tree coral may be 500 years old (Andrews *et al.* 2002). There are at least 44 known species of deep-sea corals in Alaska, and species diversity may well rival tropical coral reefs (Heifetz 2002). The unique combination of rich nutrients and underwater volcanoes has created diverse and abundant coral habitat.

Leatherback sea turtles (*Dermochelys coriacea*) are occasionally sighted as far north and west as the Aleutian Islands. Nearly 40 million seabirds, representing 30 species, breed among these islands (Banks *et al.* 2000). Near the center of the Aleutian Archipelago there are several locations crucial for birds, including a key feeding habitat (Atka Pass), a large fulmar (*Fulmarus glacialis*) colony (Chagulak Island), and a notable feeding habitat for whiskered auklets (*Aethia pygmaea*; Sitkin Sound and Islands of Four Mountains). Additionally, Canada geese (*Branta canadensis*) breed in the region and overwinter in Mexican wetlands, and both the Laysan albatross (*Phoebastria immutabilis*) and pigeon guillemot (*Cepphus columba*) cross into Canadian and lower US waters to feed.

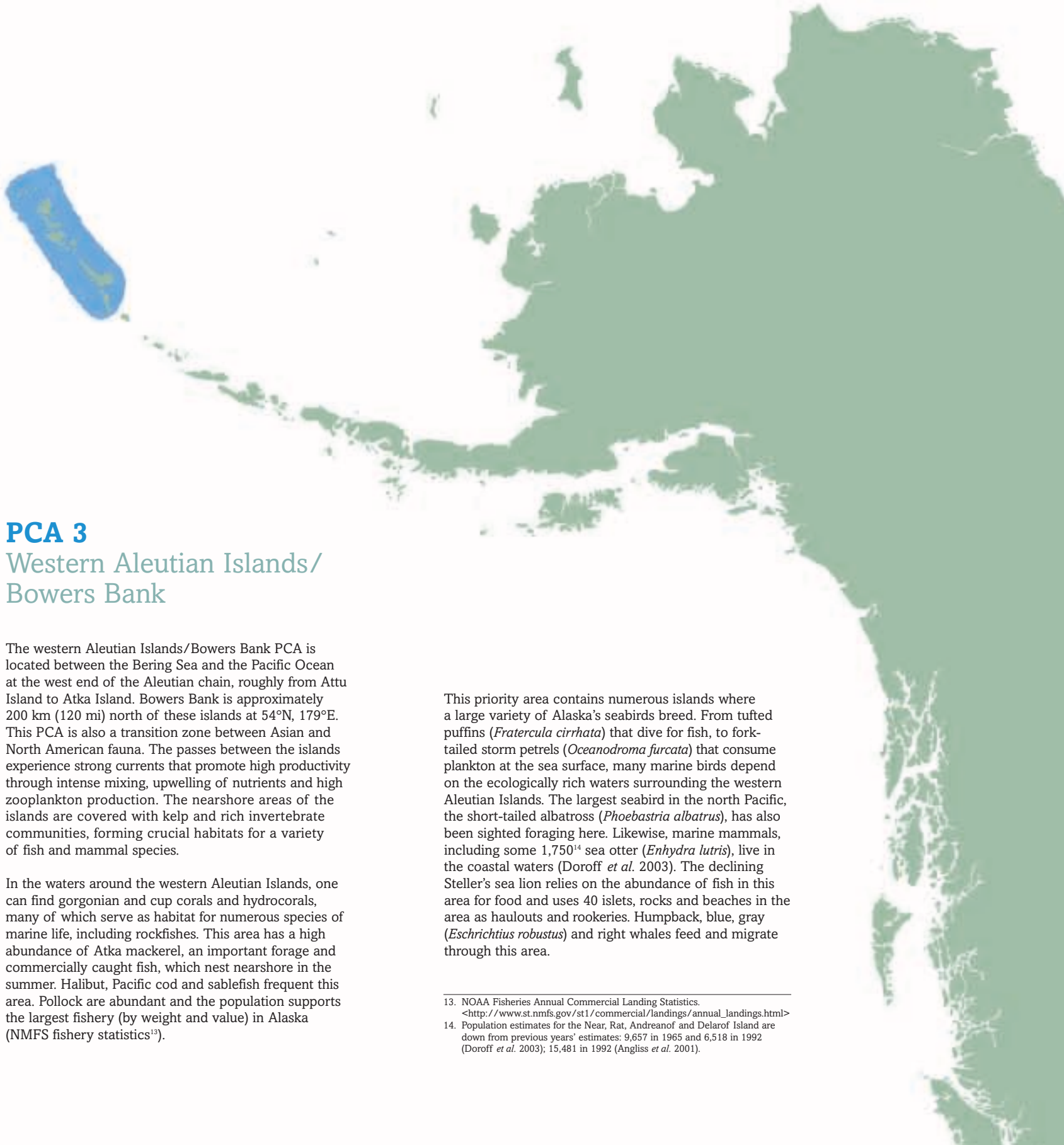
North Pacific right whales (*Eubalaena glacialis*) concentrate in the Aleutian Islands and major adult feeding concentrations of humpback whales (*Megaptera novaengliae*) occur from Kodiak Island to Unimak Pass. Blue whales (*Balaenoptera musculus*) feed near the Aleutian Islands and Bering Sea before heading south to southern California and Mexico to breed and calve. In addition, offshore killer whales (*Orcinus orca*) move between Alaskan, Canadian and lower US waters. Northern elephant seals (*Mirounga angustirostris*) feed in the region before returning south to the coasts of California, Pacific Mexico and Isla Guadalupe to breed and molt. In the Aleutians, there are 10,000 Steller's sea lions (*Eumetopias jubatus*). They have major rookery areas in the Aleutian Islands, but their numbers have declined by 75 percent since the 1970s (Angliss and Lodge 2002).

Fisheries in the Aleutians include a large number of species, including walleye pollock (*Theragra chalcogramma*), Atka mackerel, rockfishes (*Sebastes* spp.), sablefish (*Anoplopoma fimbria*), Pacific cod (*Gadus macrocephalus*), arrowtooth flounder (*Atheresthes stomias*), Pacific halibut (*Hippoglossus stenolepis*), Greenland turbot (*Reinhardtius hippoglossoides*) and others.

Human Activities

The Aleutian Archipelago consists mostly of uninhabited islands. However, many kinds of human activities have affected the ecoregion. Throughout the region, fishing is the predominant human influence, although shipping, tourism and marine recreation are all increasing. The trawl fishery for pollock and Atka mackerel is the main threat to the biodiversity. Most dramatic is the decline of most fish-eating seabirds, probably as a result of commercial fishing, which has caused a drastic drop in available food. Bottom trawling and longlining are threats to the deep-sea coral beds found throughout the Aleutians. Restrictions on trawling around Steller's sea lion colonies are in place. Overfishing of great whales is likely to have influenced the trophic dynamics of the ecosystem (Springer *et al.* 2003). Several alien species, including rats and foxes, threaten colonies of seabirds. Pollution is severe in certain areas, mostly from active and inactive military bases. Nuclear testing on Amchitka Island in 1971 resulted in radioactive isotopes entering the ecosystem. Since 1989, Dutch Harbor/Unalaska has averaged in excess of 226,800 tonnes (500 million pounds) of annual commercial fish landings, and is consistently the port with the largest annual landings in the United States (National Marine Fisheries Service (NMFS) fishery statistics[12]).

12. NOAA Fisheries Annual Commercial Landing Statistics. <http://www.st.nmfs.gov/st1/commercial/landings/annual_landings.html>



PCA 3
Western Aleutian Islands/ Bowers Bank

The western Aleutian Islands/Bowers Bank PCA is located between the Bering Sea and the Pacific Ocean at the west end of the Aleutian chain, roughly from Attu Island to Atka Island. Bowers Bank is approximately 200 km (120 mi) north of these islands at 54°N, 179°E. This PCA is also a transition zone between Asian and North American fauna. The passes between the islands experience strong currents that promote high productivity through intense mixing, upwelling of nutrients and high zooplankton production. The nearshore areas of the islands are covered with kelp and rich invertebrate communities, forming crucial habitats for a variety of fish and mammal species.

In the waters around the western Aleutian Islands, one can find gorgonian and cup corals and hydrocorals, many of which serve as habitat for numerous species of marine life, including rockfishes. This area has a high abundance of Atka mackerel, an important forage and commercially caught fish, which nest nearshore in the summer. Halibut, Pacific cod and sablefish frequent this area. Pollock are abundant and the population supports the largest fishery (by weight and value) in Alaska (NMFS fishery statistics[13]).

This priority area contains numerous islands where a large variety of Alaska's seabirds breed. From tufted puffins (*Fratercula cirrhata*) that dive for fish, to fork-tailed storm petrels (*Oceanodroma furcata*) that consume plankton at the sea surface, many marine birds depend on the ecologically rich waters surrounding the western Aleutian Islands. The largest seabird in the north Pacific, the short-tailed albatross (*Phoebastria albatrus*), has also been sighted foraging here. Likewise, marine mammals, including some 1,750[14] sea otter (*Enhydra lutris*), live in the coastal waters (Doroff *et al.* 2003). The declining Steller's sea lion relies on the abundance of fish in this area for food and uses 40 islets, rocks and beaches in the area as haulouts and rookeries. Humpback, blue, gray (*Eschrichtius robustus*) and right whales feed and migrate through this area.

13. NOAA Fisheries Annual Commercial Landing Statistics. <http://www.st.nmfs.gov/st1/commercial/landings/annual_landings.html>
14. Population estimates for the Near, Rat, Andreanof and Delarof Island are down from previous years' estimates: 9,657 in 1965 and 6,518 in 1992 (Doroff *et al.* 2003); 15,481 in 1992 (Angliss *et al.* 2001).

Federal and International Designations

- Alaska Maritime National Wildlife Refuge, US FWS
- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions
- Aleutian Islands Biosphere Reserve, United Nations Educational, Scientific and Cultural Organization (UNESCO)[15]

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, humpback whale, blue whale, northern right whale, gray whale
- seabirds: short-tailed albatross

Continental Uniqueness:

- high diversity of deep-sea corals and sponges
- diverse island archipelago

Important Ecological Linkages:

- 40 million seabirds breed among the Aleutian Islands; many transboundary
- Sitka Pass is a key seabird feeding area
- important Steller's sea lion habitat
- northern right whale concentrations following migration from Mexican and lower US waters

Physical/Oceanographic Uniqueness:

- world's longest island archipelago
- islands create unique oceanographic features
- transition zone between Asian and North American fauna
- transition zone between the polar seas of the Bering and Arctic, and the temperate waters of the mid-latitude north Pacific Ocean
- adjacent deep trench runs for 3,7000 kilometers (2,300 miles) at times reaching depths of 7,680 meters (25,194 feet)

15. <http://www.unesco.org/mab/> Man and Biosphere Reserve sites are listed for individual PCAs.

Colorful deep-sea coral
near Aleutian Islands
Photo: Andrew Lindner, NOAA Fisheries

PCA 4
Unimak Pass/ Aleutian Islands

The chain of Aleutian Islands is a westward extension of the Alaska Peninsula. The passes between the islands in the Aleutian chain connect the Bering Sea to the Pacific Ocean and are crucial areas for species migration. A main branch of the coastal current along the Gulf of Alaska turns north through Unimak and Samalga passes into the Bering Sea. The Aleutian waters to the east of Samalga Pass have distinctively different physical and ecological features from those to the west of Samalga Pass, implying that the oceanographic mechanisms in this region of narrow passage have a significant effect on the assemblage of species in the vicinity (Ladd *et al.* in press).

The highly productive benthic and planktonic communities are critical to baleen whales and migratory birds. Gorgonian, hydro, soft and cup corals are distributed on the seafloor all along the island chain. Endemic to the northern Pacific Ocean, Atka mackerel thrive in this area and nest nearshore. Pollock spawn here as well. This priority area is home to Pacific Ocean perch (*Sebastes alutus*), rockfishes, halibut and Pacific cod. Leatherback sea turtles are also sighted in the region.

These myriad islands are where the majority of Alaska's tufted puffins (*Fratercula cirrhata*) build their nests. Kittiwakes (*Rissa* spp.), storm petrels (*Oceanodroma* spp.), cormorants (*Phalacrocorax* spp.) and murres (*Uria* spp.) are often seen hovering over the waters around the Aleutian Islands. The endangered short-tailed albatross has also been sighted along the island chain. This area is an important migration corridor for shearwaters, alcids (puffins) and cormorants, and a major wintering area for auklets.

Some six hundred sea otters continue to roam the area's kelp forests, but the population across the Aleutians is declining (Doroff *et al.* 2003[16]). Steller's sea lions reside on the islands and forage in coastal waters. They have approximately 20 identified haulouts and 10 rookeries in the PCA, around which fishing restrictions are implemented. This is an important migratory pass for cetaceans, especially gray, fin (*Balaenoptera physalus*) and humpback whales.

16. For Fox Islands alone, previous years' estimates (1992) include 1,458 by Doroff *et al.* 2003 and 3,451 by Angliss *et al.* 2001.

Federal and International Designations

Unimak Pass/Aleutian Islands:

- Alaska Maritime National Wildlife Refuge, US FWS
- Izembek National Wildlife Refuge, US FWS
- Alaska Peninsula National Wildlife Refuge, US FWS
- Aniakchak National Monument and Preserve, National Park Service
- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions
- Aleutian Islands Biosphere Reserve, UNESCO
- Izembek Wetland of International Importance, Ramsar Convention

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, humpback whale, gray whale
- seabirds: short-tailed albatross
- sea turtles: leatherback

Continental Uniqueness:

- abundant seamount and deep sea coral and sponge communities

Ecological Linkages:

- 20 identified haulouts and 10 rookeries for Steller's sea lions
- important migratory corridors for shearwaters, alcids and puffins, as well as for gray, fin and humpback whales
- major humpback whale concentration following migration from Mexican and Californian waters
- northern right whale concentration area
- 40 million seabirds breed among the Aleutian Islands

Physical/Oceanographic Uniqueness:

- part of the world's longest island archipelago
- transition zone between the polar seas of the Bering and Arctic and the temperate waters of the mid-latitude north Pacific Ocean
- adjacent deep trench runs for 3,700 kilometers (2,300 miles) at times reaching depths of 7,680 meters (25,194 feet) along the length of the island chain
- Samalga Pass represents a divide in oceanographic features, resulting in different ecological features and species distributions on either side
- islands create unique salinity features

Steller's (or northern) sea lion (*Eumetopias jubatus*)
Alaska
Photo: Bob Wilson

Alaskan/Fjordland Pacific Ecoregion

Priority Conservation Areas

5. Western Kodiak Island/Shelikof Strait

6. Lower Cook Inlet/Eastern Kodiak Island

7. Prince William Sound/Copper River Delta

8. Patton Seamounts

9. Glacier Bay/Sitka Sound/Frederick Sound

10. Dixon Entrance/Langara Island/Forrester Island

11. Northern Queen Charlotte Sound/Hecate Strait/Gwaii Haanas

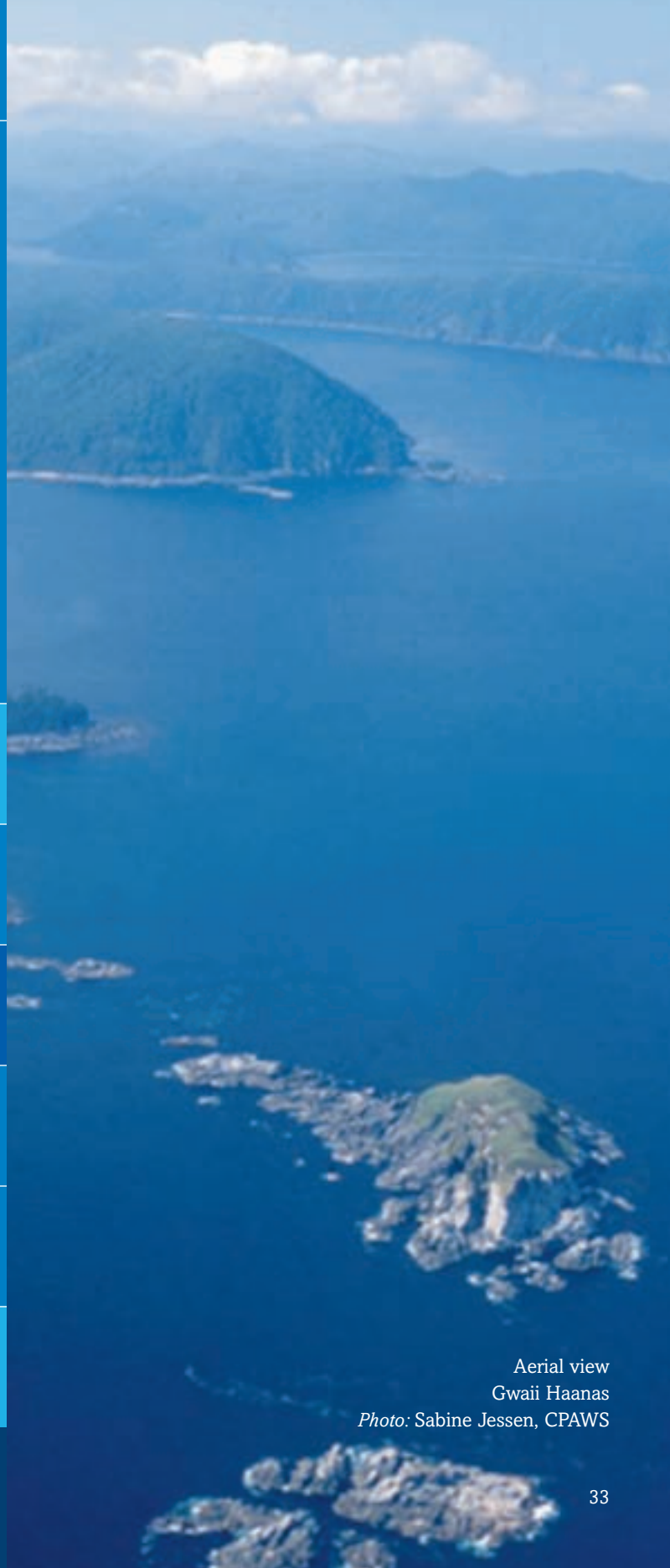
12. Scott Islands/Queen Charlotte Strait

PCA:

Threats:	Western Kodiak Island/Shelikof Strait	Lower Cook Inlet/Eastern Kodiak Island	Prince William Sound/Copper River Delta	Patton Seamounts	Glacier Bay/Sitka Sound/Frederick Sound	Dixon Entrance/Langara Island/Forrester Island	Northern Queen Charlotte Sound/Hecate Strait/Gwaii Haanas	Scott Islands/Queen Charlotte Strait
Extraction of non-renewable resources	↓	↓	↓	=	=	↓	↓	↓
Exploitation of renewable resources	↓	↓	↓	↓	=	↑	=	=
Coastal land use change	↓	↓	↓	=	=	=	↓	↓
Pollution at coast/ at sea	=	=	=	=	=	↓	↓	↓
Damaging recreational use	↓	↓	↓	=	↓	↓	↓	↓
Physical alteration of coastline	=	=	=	=	=	=	↓	=

Intensity: low moderate high

Trend: ↑ improving = unchanged ↓ worsening



Aerial view
Gwaii Haanas
Photo: Sabine Jessen, CPAWS

Regional Setting

The Alaskan/Fjordland Pacific Ecoregion encompasses all of the fjord-dominated coast of British Columbia (Canada) and the southeast Alaska Panhandle (United States), and runs out to sea over a narrow continental shelf. The region straddles the east and west coasts of Vancouver Island, starting at Cape Cook on the west side and the bottom of Johnstone Strait on the east side. It continues north through the Gulf of Alaska and extends into the Pacific south of the Aleutian Archipelago. Its numerous islands, deep fjords and sheltered straits, as well as the great amount of freshwater runoff from its numerous rivers, distinguish the southern portion of the region. The shelf of the Fjordland varies, but is generally narrow throughout — it extends about 20 kilometers (12 miles) from shore at the north end of Vancouver Island (Canada), is almost imperceptible at the southern end of the Queen Charlotte Islands (Canada), and broadens again in the Gulf of Alaska, where it is about 160 kilometers (100 miles) wide. The Gulf also includes a large proportion of the world's described seamounts.[17]

The major oceanographic influence in the eastern Gulf of Alaska is the counterclockwise Alaska Current, which is formed when the westerly North Pacific Current bifurcates at Vancouver Island to form the northerly Alaska Current and the southerly California Current. As the Alaska Current turns southwestward at the head of the Gulf of Alaska, it becomes the Alaskan Stream, a narrow, swift boundary current, and continues to the west.

17. K. Stocks. 2003. Map of sampled seamounts. SeamountsOnline: an online information system for seamount biology. Worldwide Web electronic publication <http://seamounts.sdsc.edu>.

Biological Setting

The Alaskan/Fjordland Pacific Ecoregion is one of the world's most productive marine ecosystems. Upwelling in the center of the Alaska gyre pushes nutrients, phytoplankton and zooplankton onto the continental shelf. Through the continental portion of the region, freshwater discharges from the Fraser (Canada), Skeena (Canada), Nass (Canada), Stikine (Canada/ United States), Susitna (United States) and other rivers carry vast amounts of nutrients to the ocean, stimulating the growth of phytoplankton, algae and other marine plant life. Along the water's edge, coastal salt marshes and mudflats contain large beds of eelgrass (*Zostera* spp.), important spawning sites for Pacific herring (*Clupea pallasii*) schools and other forage fish. The region is home to about 3,800 species of invertebrates, representing 3.5 percent of the known marine invertebrates in the world (Mercier and Mondor 1995). Of special interest are the glass-sponge reefs in Hecate Strait (Canada), a "living fossil" from the Age of the Dinosaurs.

In the subtidal zones lie vast forests of giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis luetkeana*). Recent exploration of seamounts in the Gulf of Alaska[18] has revealed rich faunas of deep-sea corals (especially gorgonian corals). These large invertebrate populations provide rich food sources for hundreds of species of fish living in the region. The Pacific herring is the most abundant, and there are large numbers of Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), Pacific halibut (*Hippoglossus stenolepis*), flounder (*Pleuronectiformes* spp.), Pacific hake (*Merluccius productus*), steelhead (*O. mykiss*) dolly varden (*Salvelinus malma*) and five species of salmon — coho (*Oncorhyncus kisutch*), chinook (*O. tshawytscha*), chum (*O. keta*), pink (*O. gorbuscha*), sockeye (*O. nerka*). Shellfishes such as clam, crab, scallop, shrimp, prawn and squid (*Loligo* spp.) are common. Over the years, salmon and herring stocks have been overfished and, though herring stocks are rebounding in some places, the health of salmon stocks remains precarious (Wiken *et al.* 1996, Pacific Fisheries Resource Conservation Council 2003).

18. NOAA Office of Exploration. <http://oceanexplorer.noaa.gov/explorations/02alaska/welcome.html>

Sea turtles are sighted in this region, with the leatherback turtle (*Dermochelys coriacea*) occurring as far north as Prince William Sound, while loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas agassizii*) strandings have occurred as far north as Shuyak Island and Prince William Sound (NMFS and US FWS 1998a, 1998b; Bane 1992).

The Alaskan/Fjordland Pacific Ecoregion is significant for having a large proportion of the world's population of Cassin's auklet (*Ptychoramphus aleuticus*), as well as the largest Cassin's auklet colony in the world on Triangle Island, in the Scott Islands off British Columbia, Canada (Bertram *et al.* 2000). Large populations of ancient murrelet (*Synthliboramphus antiquus*) inhabit the region. Both species disperse southward in the winter to Washington, Oregon, California and as far south as Baja California. The region also provides feeding and resting areas for large numbers of migrating and wintering ducks, geese (*Anser* and *Branta* spp.), swans, loons (*Gavia* spp.) and shorebirds, which come from the North American inland and Mexican coastal regions.

Marine mammals in this region include sea otters (*Enhydra lutris*), seals, sea lions, whales and dolphins. Although the sea otter's range is vast, the greater part of the world's population can be found in Alaskan waters. Major adult concentrations of sea otter can be found in the southeast Alaska Panhandle, Prince William Sound, and Kodiak Island. Once abundant in Canada, sea otters were locally extirpated, although a reintroduced colony is growing along the Pacific coast of Vancouver Island (largely within the Columbian Pacific Ecoregion), and there is a single sea otter colony in the Goose Island Group, along the central coast of British Columbia. The northern fur seal (*Callorhinus ursinus*) visits the offshore waters of this area from its large breeding grounds in the Bering Sea. Harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*) are common. The California sea lion migrates to this region from its breeding grounds in southern California and northern Baja California, Mexico. Thirty thousand Steller's sea lions (*Eumetopias jubatus*) breed in the Gulf of Alaska, along Alexander Archipelago, and in British Columbia, but the population east of Prince William Sound is listed as "threatened" under the US Endangered Species Act (since 1990). The species is also listed as "depleted" under the US Marine Mammal Protection Act (MMPA), protected from intentional killing in Canada by the Fisheries Act, and listed as "endangered" on the IUCN Red List.

Cetaceans common to the region include the gray whale (*Eschrichtius robustus*), minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*) and killer whale (*Orcinus orca*), harbor (*Phocoena phocoena*) and Dall's (*Phocoenoides dalli*) porpoises, and Pacific white-sided dolphin (*Lagenorhynchus obliquidens*). Pacific northern right whales (*Eubalaena glacialis*) are occasionally encountered off Kodiak Island (United States) and the Alaska Penninsula (United States). Major adult feeding concentrations of humpback whales occur from Kodiak Island (United States) to Unimak Pass (United States), in Prince William Sound (United States) and the Alaska Panhandle (United States), following winters spent breeding along Mexico and Costa Rica. The Cook Inlet stock of beluga whale (*Delphinapterus leucas*) declined by nearly 50 percent between 1994 and 1998, and has been listed as "depleted" under the US MMPA (Angliss and Lodge 2002).

Human Activities

The region is adjacent to coastal urban areas of southeast British Columbia, with one of the fastest growing human populations in North America, but also encompasses very sparsely populated areas of Alaska and northern British Columbia. Throughout the region, fishing, forestry, shipping, tourism, aquaculture and marine recreation are the main human activities. But with these lucrative and popular activities, impacts have also come, including ship traffic, deforestation and urban run-off, destruction of shoreline and bottom habitat, introduction of alien species, overfishing, and industrial pollution — the main sources of ecological stress to the region. Fishing rates are very high, raising concerns of overexploitation and collateral impacts from fishing— habitat damage, bycatch and effects on organisms that also feed on targeted species. Development in major estuaries and deltas has altered and reduced critical habitats. In this region the consequences of the aquaculture industry are hotly debated, due to its negative effects on the marine ecosystem through pollution, escaped individuals, disease introduction, and the killing of seals and sea lions (Volpe *et al*. 2000).

PCA 5
Western Kodiak Island/ Shelikof Strait

Shelikof Strait opens to the Gulf of Alaska in the southwest and connects with Cook Inlet to the northeast. It borders a rugged coastline and glacial fjords off the Alaskan Peninsula and Kodiak Island. A seafloor trough reaching 300 meters in depth extends to the southwest from the mouth of Shelikof Strait. The relatively protected waters wash the rocky shores of countless inlets and headlands. A major spawning area for walleye pollock, the largest of Alaska's fisheries, is in the strait. Herring spawning also occurs here. This productive marine area also supports halibut, Pacific cod, rockfishes (*Sebastes* spp.) and sablefish (*Anoplopoma fimbria*).

Loggerhead turtles have stranded as far north as western Kodiak Island and short-tailed albatross (*Phoebastria albatrus*) are sighted here. Nearly extirpated a century ago due to overhunting for their fur, sea otters in the thousands[19] now roam these nearshore waters. Steller's sea lions are common and haul out on both sides of the strait. Humpback whales come here to feed, migrating gray whales pass by, and right, blue (*Balaenoptera musculus*), fin (*B. physalus*) and sperm whales (*Physeter macrocephalus*) all occur in this area. Many of these whales feed in this area following breeding and calving in southern waters, such as those along the coast of Baja California, Mexico.

19. The Kodiac Island population was estimated at 6100 in 1994 (Anglis *et al.* 2001).

Federal and International Designations

- Alaska Maritime National Wildlife Refuge, US FWS
- Becharof National Wildlife Refuge, US FWS
- Kodiak National Wildlife Refuge, US FWS
- Katmai National Park and Preserve, National Park Service
- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions
- Aleutian Islands Biosphere Reserve, UNESCO

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, blue whale, humpback whale, northern right whale, gray whale
- seabirds: short-tailed albatross

Continental Uniqueness:

- major spawning area for walleye pollock

Ecological Linkages:

- area known for northern right and humpback whales following migration from Mexican and lower US waters

Physical/Oceanographic Uniqueness:

- 300-meter-deep trough extends from mouth of Shelikof Strait

Salmon seiner leaves harbor
Kodiak, Alaska
Photo: Marion Owen

PCA 6
Lower Cook Inlet/ Eastern Kodiak Island

This priority area is located at the north end of the central Gulf of Alaska. This island-strewn area is bordered by the Kenai Peninsula and Kodiak Island. The rugged shorelines follow the many inlets and headlands carved by glaciers. Pollock and herring spawn in this area. Atka mackerel (*Pleurogrammus monopterygius*) are found off the eastern shore of Kodiak Island. Pacific cod, halibut and other flatfishes are present.

Offshore islands in this priority area are home to horned puffin (*Fratercula corniculata*), common murre (*Uria aalge*) and a multitude of other seabirds. The highly endangered short-tailed albatross, of which there are only 1,800 worldwide (Hiroshi Hasegawa personal communication), forage in these waters. Lower Cook Inlet and the sea around Eastern Kodiak Island are home to sea otter[20] and Steller's sea lion. This area is part of the migratory route of humpback, gray and northern right whales. A stock of beluga whales, numbering between 300 and 500, lives in Cook Inlet, possibly year-round (Angliss and Lodge 2002). This stock has been declared "depleted" under the US MMPA.

This priority area includes one of the nation's largest fishing ports. In Kodiak, more than 113,000 tonnes (250 million pounds) of fish, worth US$63.3 million were landed in 2002, according to the NMFS.[21]

20. The population in Cook Inlet/Kenai Fjord alone was estimated to be 2,673 in 2002 (US FWS 2002a).
21. Total commercial fishery landings at an individual US port for all years after 1980 <http://www.st.nmfs.gov/st1/commercial/landings/lport_hist.html>.

Federal and International Designations

- Alaska Maritime National Wildlife Refuge, US FWS
- Kodiak National Wildlife Refuge, US FWS
- Katmai National Park and Preserve, National Park Service
- Kachemak Bay National Estuarine Research Reserve, NOAA
- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, blue whale, humpback whale, northern right whale, gray whale
- seabirds: short-tailed albatross

Continental Uniqueness:

- stock of beluga whales congregates here

Ecological Linkages:

- major concentrations humpback whales that migrate from Mexico and lower US waters
- northern right whales
- high concentration of nesting birds

Sockeye salmon (*Oncorhynchus nerka*) heading for spawning stream
Photo: US FWS

PCA 7
Prince William Sound/ Copper River Delta

On the northern edge of the Gulf of Alaska, Prince William Sound and the Copper River Delta feature numerous bays and inlets, fjord estuaries, rocky shores, high tidal ranges and coastal currents, with the large Alaskan gyre seasonally influencing the sound. The plume of the Copper River forms an eddy that transports nutrients through the area.

Herring spawn in nearshore seagrass beds in April and are a major food source for the wide variety of predatory fishes, birds and mammals that inhabit the sound. The herring population is extremely low compared to two decades ago (Holleman 2003). Pollock, another forage fish species, is also found here. Salmon, halibut, sablefish and several flatfishes are some of the other important components of this marine ecosystem. Leatherback turtles occasionally inhabit the area for feeding after traveling from nesting grounds in Mexico and Asia (NMFS and US FWS 1998a). A cold-stunned green sea turtle has also been recovered in Prince William Sound (Bane 1992).

Various seabirds use this area for feeding and nesting as well. Black-legged kittiwakes (*Rissa tridactyla*) build some 16,000 nests here (Dragoo *et al.* 2001), and there are also breeding sites for marbled murrelets (*Brachyramphus marmoratus*) and Kittlitz's murrelets (*B. brevirostris*), both in decline (Holleman 2003). This PCA encompasses Steller's sea lion haulouts, and sea otter forage in the kelp beds.[22] A resident killer whale population of 360 and a smaller group of transients roam the sound (Angliss and Lodge 2002). Gray, humpback and northern right whales visit these rich waters.

Fishing activities occur on a large scale in the sound and in the adjacent Gulf of Alaska. The port of Cordova landed nearly 27,215 tonnes (60 million pounds) of fish in 2002.[23]

22. In 1999, Prince William Sound was estimated to be home to 13,234 sea otter (US FWS 2002a).
23. Total commercial fishery landings at an individual US port for all years after 1980. <http://www.st.nmfs.gov/st1/commercial/landings/lport_hist.html>

Federal and International Designations

- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, humpback whale, gray whale, northern right whale
- sea turtles: leatherback

Continental Uniqueness:

- approximately 13,000 sea otters live in Prince William Sound

Ecological Linkages:

- major waterfowl staging area
- black-legged kittiwakes, 16,000 nests
- major concentrations of humpback whales following migration from Mexican and Californian waters

Physical/Oceanographic Uniqueness:

- major eddy originates at Copper River Delta

Sea otter (*Enhydra lutris*) mother and pup
Prince William Sound
Photo: Randall Davis
US FWS Permit MA-043219

PCA 8
Patton Seamounts

The Patton Seamounts, some 300 kilometers (185 miles) south of Kodiak Island, are a suite of underwater mountains that rise to approximately 200 meters (660 feet) beneath the sea surface in the Gulf of Alaska. Located on the edge of the US EEZ, the seamounts are composed of volcanic rock and have virtually no sediment. The current flowing through the Gulf of Alaska flows past the seamounts and forms a circular gyre around them, creating a stagnant column of water above the seamounts. This phenomenon serves to retain the lavae of marine species that reside on the seamounts. Because seamounts are isolated in the ocean, sometimes far from one another, species living on seamounts are mostly endemic and face a higher risk of extinction owing to their restricted range (Rogers 1994).

The complex habitat of the Patton Seamounts sustains a multitude of marine organisms, including a large number of filter feeding organisms such as sponges and deep-sea corals. Large numbers of deep-sea crabs, sablefish and rockfishes are also associated with this topographically and ecologically unique place. Humpback, blue, gray and northern right whales feed here on their migratory journeys.

Trawl and longline fisheries are by far the main threat to this area because of their ability to damage this rare and fragile habitat.

Federal and International Designations

- no designated areas

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: blue whale, humpback whale, northern right whale, gray whale

Continental Uniqueness:

- one of the only seamount complexes within North American EEZs
- high seamount endemism due to isolation
- large complex of deep sea corals and sponges

Physical/Oceanographic Uniqueness:

- current from Gulf of Alaska forms Taylor columns which retain larvae around seamounts

Short-tailed albatross (*Phoebastria albatrus*)
Photo: Hiroshi Hasegawa, Toho University

PCA 9
Glacier Bay/Sitka Sound/ Frederick Sound

The coastal waters of southeast Alaska have numerous fjords, islands, inland straits and rocky shores. There exist many estuaries with strong tidal mixing. The Sitka Eddy is generated in this area, traveling to the west across the continental shelf, possibly contributing larvae to Gulf of Alaska seamounts. The coastal current connects the waters of these embayments with Kodiak Island and the Aleutian Islands. This area is a likely source of larvae for other marine regions in Alaska.

Gorgonian corals are abundant west of Sitka Sound in the Gulf of Alaska (Etnoyer and Morgan 2003). Forage fish, such as herring and eulachon (*Thaleichthys pacificus*), are abundant in the coastal and inland waters of southeast Alaska. All species of salmon are found here. Marine birds, including marbled murrelet, fork-tailed storm petrel (*Oceanodroma furcata*) and pelagic cormorant (*Phalacrocorax pelagicus*), depend on the waters and upland areas for feeding and nesting. Steller's sea lions and some 12,000 sea otters inhabit the waters of southeast Alaska (US FWS 2002b). Receiving protected status in all three nations, humpback whales feed in Sitka Sound every winter. Blue, fin, gray and killer whales also use this area regularly.

Commercially important fishes include halibut, Pacific cod, rockfishes, sablefish and king crab (*Paralithodes* spp.). The extraction of living marine resources is a major threat to Glacier Bay and the surrounding area. Sitka, in Sitka Sound, is one of the United States' largest fishing ports, Sitka, with an annual landing of nearly 31,750 tonnes (70 million pounds) of fish.[24] Deep in Frederick Sound, Petersburg is another major fishing port. Pollution and damaging recreational use are also risks, especially from a large influx of cruise ships in recent years.

24. Total commercial fishery landings at an individual US port for all years after 1980. <http://www.st.nmfs.gov/st1/commercial/landings/lport_hist.html>

Federal and International Designations

- Glacier Bay National Park and Preserve, National Park Service
- Glacier Bay and Admiralty Island Biosphere Reserve, UNESCO
- Glacier Bay National Park, World Heritage Site, UNESCO

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, humpback whale, blue whale, gray whale

Continental Uniqueness:

- some 12,000 sea otters inhabit the area
- one of the healthiest land-sea interfaces in the B2B region
- important breeding area for Steller's sea lions

Ecological Linkages/Uniqueness:

- one of the largest sources of larvae for the Gulf of Alaska
- humpback whale feeding concentrations; migrate from Mexico and California

Physical/Oceanographic Uniqueness:

- origin of the Sitka Eddy

Glacier Bay
Photo: James Bodkin, USGS

PCA 10
Dixon Entrance/Langara Island/Forrester Island

Dixon Entrance is a transboundary water body between southeast Alaska and British Columbia's Queen Charlotte Islands (QCI), connecting to Hecate Strait to the south. Situated on the continental shelf, it is a largely shallow area, with few places deeper than 300 meters (980 feet). Forrester and Langara Islands are located at Dixon Entrance's opening to the Pacific Ocean on the US and Canadian sides, respectively. The east and south sides of Dixon Entrance receive small amounts of freshwater input from mainland British Columbia's fjord estuaries and from QCI rivers. Tidal mixing is the dominant oceanographic influence. The Haida Eddy originates off the northwest coast of QCI, transporting nutrients offshore toward the southwest. Rose Spit Eddy circulates in eastern Dixon Entrance.

Kelp and eelgrass line the coastal seafloor, providing suitable habitat for sea otter and spawning sites for herring. A concentration of red-tree corals (*Primnoa* spp.) is located at the west end of Dixon Entrance on Learmonth Bank. Many commercially important invertebrate and fish species are present here, including sablefish, Pacific Ocean perch (*Sebastes alutus*), rougheye rockfish (*S. aleutianus*), lingcod (*Ophiodon elongatus*), Dungeness crab (*Cancer magister*) and geoduck clam (*Panopea abrupta*).

Many marine birds rely on, and are part of, this biologically diverse ecosystem. Cormorants (*Phalacrocorax* spp.), gulls (*Larus* spp.) and small alcids are a common sight. Black-legged kittiwakes catch fish at the sea surface while common murres and rhinoceros auklets (*Cerorhinca monocerata*) swim underwater in search of prey. More than 10,000 pairs of ancient murrelets breed on Langara Island along with cormorants. There are also minor nesting sites for Cassin's auklet, black oystercatcher (*Haematopus bachmani*) and pigeon guillemot (*Cepphus columba*) near Langara Island (Harfenist *et al.* 2002). The marine waters around Langara Island are also important for marbled murrelet, considered vulnerable by IUCN and listed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).[25] A wide variety of shorebirds reside and nest on the islands as well.

Both the transient and resident stocks of threatened killer whales are spotted year round. Humpback whales, also listed as threatened by COSEWIC, migrate through the coastal waters southward in the fall and northward in the spring from breeding grounds in Mexico and Costa Rica. This area is also part of the migratory route of the fin whale, which receives a "special concern" status from COSEWIC in Canada and is considered "depleted" in the US under the MMPA.

25. COSEWIC <http://www.cosewic.gc.ca/index.htm>

Federal and International Designations

- NOAA Fisheries-designated Steller's sea lion critical habitats with fishing restrictions around Forrester Island

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, blue whale, humpback whale, northern right whale, gray whale

Continental Uniqueness:

- highest marine species diversity along the Pacific Coast of North America

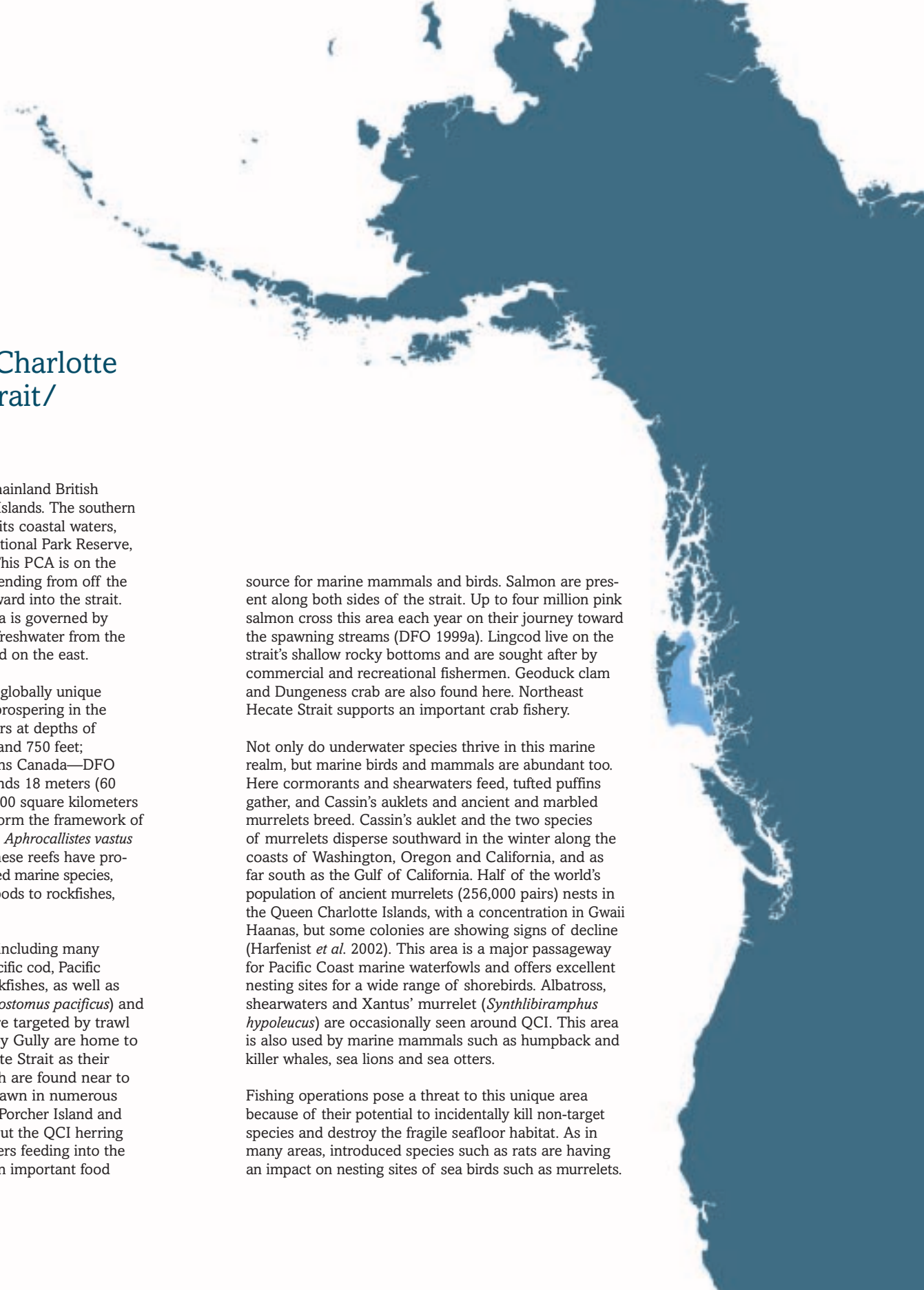
Ecological Linkages:

- important seabird area in British Columbia
- important to transboundary species

Physical/Oceanographic Uniqueness:

- origin of the Haida and Rose Spit Eddies

Bullwhip kelp
(*Nereocystis leutkeana*)
Queen Charlotte Island
Photo: Roeland Baans



PCA 11
Northern Queen Charlotte Sound/Hecate Strait/ Gwaii Haanas

Hecate Strait is situated between mainland British Columbia and the Queen Charlotte Islands. The southern half of the island group, excluding its coastal waters, forms part of the Gwaii Haanas National Park Reserve, north of Queen Charlotte Sound. This PCA is on the continental shelf, with a trough extending from off the southern tip of QCI roughly northward into the strait. The movement of water in this area is governed by coastal currents, tides, winds, and freshwater from the island on the west and the mainland on the east.

Along iceberg-scoured troughs are globally unique glass-sponge (hexactinellid) reefs, prospering in the low-sedimentation, high-silica waters at depths of between 165 and 230 meters (550 and 750 feet; Department of Fisheries and Oceans Canada—DFO 2000). The sponge reefs form mounds 18 meters (60 feet) tall in complexes as large as 300 square kilometers (115 square miles). Three species form the framework of the sponge reefs, *Chonelasma calyx, Aphrocallistes vastus* and *Farrea occa*. For 9,000 years, these reefs have provided shelter for a suite of associated marine species, ranging from bryozoans and gastropods to rockfishes, crabs and shrimp.

Hecate Strait is rich in marine life, including many commercially important species. Pacific cod, Pacific Ocean perch, and many other rockfishes, as well as halibut, flounder, and Dover (*Microstomus pacificus*) and English soles (*Parophrys vetulus*) are targeted by trawl fisheries. Troughs such as Moresby Gully are home to the rockfishes. Sablefish use Hecate Strait as their nursery area and juvenile sablefish are found near to shore and on the shelf. Herring spawn in numerous small inlets of the strait, including Porcher Island and Big Bay (northeast Hecate Strait), but the QCI herring stock is in decline. Many of the rivers feeding into the strait are where eulachon spawn, an important food source for marine mammals and birds. Salmon are present along both sides of the strait. Up to four million pink salmon cross this area each year on their journey toward the spawning streams (DFO 1999a). Lingcod live on the strait's shallow rocky bottoms and are sought after by commercial and recreational fishermen. Geoduck clam and Dungeness crab are also found here. Northeast Hecate Strait supports an important crab fishery.

Not only do underwater species thrive in this marine realm, but marine birds and mammals are abundant too. Here cormorants and shearwaters feed, tufted puffins gather, and Cassin's auklets and ancient and marbled murrelets breed. Cassin's auklet and the two species of murrelets disperse southward in the winter along the coasts of Washington, Oregon and California, and as far south as the Gulf of California. Half of the world's population of ancient murrelets (256,000 pairs) nests in the Queen Charlotte Islands, with a concentration in Gwaii Haanas, but some colonies are showing signs of decline (Harfenist *et al.* 2002). This area is a major passageway for Pacific Coast marine waterfowls and offers excellent nesting sites for a wide range of shorebirds. Albatross, shearwaters and Xantus' murrelet (*Synthlibiramphus hypoleucus*) are occasionally seen around QCI. This area is also used by marine mammals such as humpback and killer whales, sea lions and sea otters.

Fishing operations pose a threat to this unique area because of their potential to incidentally kill non-target species and destroy the fragile seafloor habitat. As in many areas, introduced species such as rats are having an impact on nesting sites of sea birds such as murrelets.

Federal and International Designations

- Gwaii Haanas National Park Reserve, Parks Canada

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, blue whale, humpback whale

Continental Uniqueness:

- globally unique glass-sponge (hexactinellid) reefs
- half of the world's ancient murrelet (256,000 pairs) nest in QCI, most of them in this PCA

Ecological Linkages:

- a major passageway for Pacific Coast marine migratory waterfowl
- important seabird area in British Columbia

Kayaking off the coast
Queen Charlotte Island
Photo: Sabine Jessen, CPAWS

PCA 12
Scott Islands/ Queen Charlotte Strait

The Scott Islands are at the south edge of Queen Charlotte Sound, 15 to 40 kilometers (9 to 25 miles) northwest of Vancouver Island. Approximately 100 kilometers (60 miles) long and 25 kilometers (15 miles) wide, Queen Charlotte Strait is a southward extension of Queen Charlotte Sound between mainland British Columbia and northern Vancouver Island. This semi-protected water body is no more than 200 meters (660 feet) deep. Island-strewn, it is bordered by rugged coastlines with countless glacier-sculpted inlets.

Underwater, Queen Charlotte Strait's eelgrass and kelp forests serve as nursery and foraging habitats for myriad marine animals. Hydrocorals and gorgonian corals are found in Queen Charlotte Strait and rockfishes abound. Thirty-four species of rockfish are found in British Columbian waters: quillback (*Sebastes maliger*), tiger (*S. nigrocinctus*), yellowtail (*S. flavidus*), yelloweye (*S. ruberrimus*) and widow rockfish (*S. entomelas*) are a few that seek refuge on high-relief rocky seafloors. Yellowmouth, rougheye, silvergray (*S. brevispinis*) and canary rockfish (*S. pinniger*) are targeted by trawl and hook-and-line fisheries. Bottom-dwelling lingcod are also sought after by recreational and commercial fishermen, and sablefish support a trap fishery. Eulachon spawn in the surrounding inlets and rivers. There are also many invertebrates, such as geoduck clams and an assortment of shrimps and crabs. Salmon are present in nearly all the streams and bays in the area, so the strait is an important part of their migratory pathway.

This area is critical for seabirds. More than 400,000 pairs of Cassin's auklets nest on Triangle Island in the Scott Islands, comprising the world's largest colony (Bertram *et al.* 2000), while others nest around the Queen Charlotte Strait. Triangle Island is also home to some 40,000 pairs of rhinoceros auklets and 26,000 pairs of tufted puffins (Bertram *et al*. 2001). Other nesting seabird species in this PCA include common murre, thick-billed murre (*Uria lomvia*), pelagic cormorant, glaucous-winged gull (*Larus glaucescens*) and various species of storm petrels (*Oceanodroma* spp.). The threatened marbled murrelet occurs in the protected waters, feeding on forage fish. Steller's sea lions and harbor seals are regularly sighted. Sea otters, once locally extirpated, are still rare visitors to this area, despite their reintroduction on Vancouver Island. Blue, humpback, killer (both transient and resident), gray and minke whales also frequent these waters.

Federal and International Designations

- Scott Islands are a candidate for British Columbia's first National Marine Wildlife Area, Environment Canada

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, blue whale, humpback whale, northern right whale, gray whale

Continental Uniqueness:

- world's largest colony of Cassin's auklet (more than 400,000 pairs) is in the Scott Islands

Ecological Linkages:

- area is critical for seabirds, including transboundary species
- major salmon migratory corridor north to Alaska

Tufted puffin (*Fratercula cirrhata*) pair on rocks
Alaska
Photo: US FWS

Columbian Pacific Ecoregion

Priority Conservation Areas

13. Southern Strait of Georgia/San Juan Islands

14: Barkley Sound/Pacific Coastal Washington

15: Central Oregon/Cape Mendocino

PCA:

Threats:	Southern Strait of Georgia/San Juan Islands (Canada)	Southern Strait of Georgia/San Juan Islands (United States)	Barkley Sound/Pacific Coastal Washington (Canada)	Barkley Sound/Pacific Coastal Washington (United States)	Central Oregon/Cape Mendocino
Extraction of non-renewable resources	=	=	↓	=	↓
Exploitation of renewable resources	↓	↑	=	=	=
Coastal land use change	↓	↓	=	↓	↓
Pollution at coast/ at sea	↓	↓	↓	↓	↓
Damaging recreational use	↓	↓	↓	↓	↓
Physical alteration of coastline	↓	↓	=	↓	=

Intensity: low moderate high

Trend: ↑ improving = unchanged ↓ worsening

Coastal lighthouse
Porlier Pass
Photo: Sabine Jessen, CPAWS

Regional Setting

The Columbian Pacific Ecoregion stretches along the Pacific Coast from Cape Cook on Vancouver Island (Canada) to Cape Mendocino (United States) in the south. This region includes the inland waters of the Strait of Juan de Fuca (Canada/United States), Strait of Georgia (Canada) and Puget Sound (United States).

Georgia Strait and Puget Sound together form an inland sea. To the west, the Strait of Juan de Fuca connects this inland sea with the Pacific Ocean. Puget Sound and the Strait of Georgia are the result of glacier scour over the past 20,000 years. The region is a complex system of interconnected channels and bays, with tidal seawater entering from the west, and freshwater entering from streams and rivers of the surrounding uplands. The Fraser River drains into the Strait of Georgia, carrying vast amounts of nutrients and freshwater to the northeast Pacific Ocean through the Strait of Juan de Fuca. These nutrients stimulate growth of phytoplankton, algae and other marine plant life. Puget Sound is distinguished by extensive tidal mud flats.

The northeast Pacific is characterized by a moderately narrow continental shelf and a steep continental slope. The seafloor of the Juan de Fuca plate, north of the Mendocino escarpment, is shallower than the seafloor of the Pacific plate to the south. Offshore seafloor features include Heceta Bank, which rises to within 75 meters (250 feet) of the ocean surface. Its mass and depth force the California Current to flow over or around it, introducing eddies and other instabilities that affect areas downstream along the Oregon coast. Underwater canyons at the edge of the continental shelf, such as the Astoria Canyon and Rogue River Canyon, have unique habitats and set up their own upwelling conditions that concentrate nutrients into an area of topographic relief, driving a high level of biomass productivity.

The coast includes extensive tracts of forest, dunes, estuarine areas and rocky shorelines with spectacular coastal headlands and tidal pools. The region has higher runoff than the regions to the south, especially from the Columbia River, which drains a watershed of approximately 671,000 square kilometers (259,075 square miles). The river's plume creates a surface lens of lower-salinity water spreading west and south in the California Current as far south as Cape Mendocino. The California Current is the dominant current system affecting the coastal region. Upwelling occurs seasonally from February through September off major capes, and near the southern end of Vancouver Island.

Biological Setting

The Columbian Pacific region has a temperate fauna and flora, lacking many of the subtropical species that intrude into its southern neighbor, the Montereyan Pacific Transition Ecoregion. The Strait of Juan de Fuca represents a major faunal discontinuity. The seasonal upwelling contributes to moderately high productivity. Puget Sound is the largest and most important estuary of the region, forming a unique coastal environment. Boundary Bay (Canada) is a significant stopover for migrating birds. Willapa Bay (United States) is the second largest of the estuaries, covering roughly 240 square kilometers (90 square miles) at high tide and yielding the largest commercial harvest of oysters in the United States. A variety of important species, including Dungeness crab (*Cancer magister*), harbor seal (*Phoca vitulina*), salmon (*Oncorhyncus* spp.), Pacific herring (*Clupea pallasii*) and perch, are found in estuaries characterized by low temperatures and low salinities in northern California, Oregon, Washington and British Columbia. About 109 million adult geoduck clams (*Panopea abrupta*) are packed into Puget Sound's sediments (Washington State Department of Ecology[26]), the highest density of geoducks in the contiguous United States.

Forage fish, including surf smelt (*Hypomesus pretiosus*) and sand lance (*Ammodytes hexapterus*), are ecologically important throughout the region. Sand lance school in many bays and inlets and are important food for young salmon — constituting up to 60 percent of the diet of juvenile chinook salmon (*O. tshawytscha*). Minke whale (*Balaenoptera acutorostrata*), other marine mammals and many species of seabirds also prey on sand lance and surf smelt. Salmon, Dover sole (*Microstomus pacificus*) and rockfish (*Sebastes* spp.) are a few of the dominant commercial species inside the Puget Sound/Strait of Georgia region.

Leatherback turtles (*Dermochelys coriacea*) feed in this region, following nesting and breeding in the more southern latitudes of Mexico and Asia, and loggerhead turtle (*Caretta caretta*) also occur in the region. The numerous rocks and islands along the nearshore zone provide valuable habitat for many nesting seabirds, such as the common murre (*Uria aalge*), pigeon guillemot (*Cepphus columba*) and murrelets. This region has one of the highest densities of pelagic seabirds along the continental US coastline (Ford and Bonnell 1996). Seabirds found here include black-footed (*Phoebastria nigripes*) and Laysan (*P. immutabilis*) albatrosses, northern fulmar (*Fulmarus glacialis*), pink-footed (*Puffinus creatopus*), sooty (*P. griseus*) and short-tailed (*P. tenuirostris*) shearwaters, Leach's (*Oceanodroma leucorhoa*) and fork-tailed (*O. furcata*) storm petrels, phalaropes (*Phalaropus* spp.), jaegers (*Stercorarius* spp.), black-legged kittiwakes (*Rissa tridactyla*), and auklets. The high-productivity waters are key feeding habitats for globally vulnerable seabirds such as the short-tailed albatross (*Phoebastria albatrus*) and Xantus' murrelet (*Synthliboramphus hypoleucus*). Brown pelicans (*Pelecanus occidentalis*) and Heermann's gulls (*Larus heermanni*) migrate north to the region from breeding grounds in and around the Gulf of California.

26. Washington State Department of Ecology: geoduck clam. <http://www.ecy.wa.gov/programs/sea/pugetsound/species/geoduck.html>

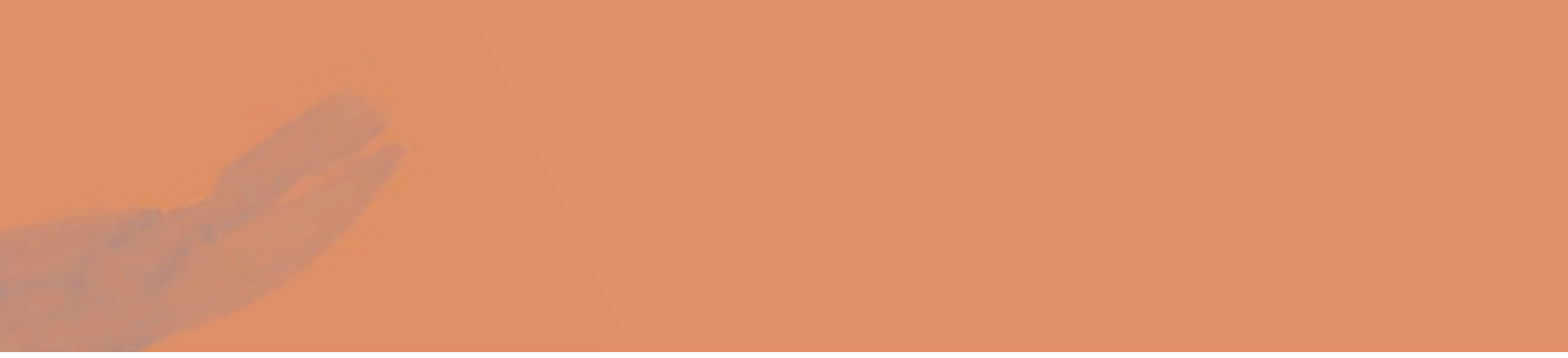
Human Activities

Submerged rocky reefs are also scattered along the coast. These areas and their associated kelp forests are critical habitat for a wide variety of marine species. Bull kelp (*Nereocystis luetkeana*) is the most abundant surface canopy kelp in this region in waters less than 25 meters (80 feet) deep. Within the kelp forests, sea otter (*Enhydra lutris*) play a critical role in maintaining balances within the food web and, for this reason, are often held up as an example of a marine keystone species.

Pinnipeds, including California sea lions (*Zalophus californianus*) and Steller's sea lions (*Eumetopias jubatus*), frequent these waters. Major adult concentrations of killer whale (*Orcinus orca*) begin north of the Columbia River. The region is also host to gray (*Eschrichtius robustus*), blue (*Balaenoptera musculus*), minke and humpback (*Megaptera novaeangliae*) whales that feed in the region following migration from southern feeding and calving grounds in southern California, Baja California, Mexico, and further south. Harbor porpoise (*Phocoena phocoena*) and Dall's porpoise (*Phocoenoides dalli*) are common throughout the region.

Throughout the region, fishing, shipping, tourism and marine recreation are the main human activities contributing to the area's high standard of living. These lucrative and popular activities, along with pollution from ship traffic, urban run-off, destruction of shoreline habitat, and industrial pollution combine, however, to create the main sources of ecological stress for the region. Development in major estuaries and deltas has altered and reduced critical habitats, while overfishing has seriously affected a variety of fish and shellfish populations, and other organisms that depend on them.

There is ongoing concern over the development of aquaculture in this region. Shellfish aquaculture can foul beaches and deprive seabirds of habitat and food, although hanging shellfish aquaculture is more benign. Salmon farming, with its many associated ecological risks, occur, throughout the region and and is most extensive on the south central coast of British Columbia (Broughton Archipelago and near Campbell River, where Johnstone Strait meets the Strait of Georgia) and, to a lesser extent, on the west coast of Vancouver Island and in Puget Sound. Harmful algal blooms have shut down many of the salmon farms that used to operate in the mid-Strait of Georgia. High water temperatures combined with nutrient loading and poor circulation are thought to be responsible. In this region, concerns over disease transmission to wild salmon populations, competition between escaped farm fish and endemic species, and pollution from fish farm effluent have led to an intensified debate over the ecological risks of farm fish, as clearly there are negative effects on the marine ecosystem (Naylor *et al.* 2003).



The Puget Sound region is home to nearly 3.9 million people — double the population in the mid-1960s. Over the last 100 years, 73 percent of tidal wetlands and perhaps as much as 33 percent of eelgrass beds have been lost to dredging, filling and diking in Puget Sound. More than 50 percent of the estuarine wetland habitat in Puget Sound has been dredged or filled since 1850 (White 1997). Approximately one-third of Puget Sound's shoreline has been altered by human development of port facilities, piers, bulkheads and other shoreline armoring structures. Many of the other larger estuaries of the region have also been altered through dredging, filling or diking. Many smaller estuaries, however, remain in a natural state and provide important biological services. With the exception of Puget Sound, much of the rest of the Pacific Coast in this region is relatively sparsely populated.

Fisheries have traditionally been a mainstay of the region's economy. Pacific salmon and a number of marine fish species in Puget Sound and along the Pacific Coast have shown significant population decreases (Musick *et al.* 2000, Pacific Fisheries Resource Conservation Council 2003). The dramatic decrease in traditional salmon catches and the overfishing of other groundfish species has resulted in a shift toward nearshore reef fisheries. Commercial catches of most rockfishes are also declining and large-scale fishing closures were implemented in 2002 by the US Pacific Fishery Management Council. The live-fish fishery and the sport rockfish fishery focus effort in this rocky reef habitat, and the impacts of these fisheries have not been fully assessed. Populations of Pacific herring and other fishery species have also greatly decreased since 1975. This decrease is thought to be due to changing predation by harbor seals and Pacific hake, alteration of critical nearshore habitat, especially in eelgrass beds, and possibly changing water conditions such as varying temperatures.

The Columbia River generates electric power for residents and businesses, provides irrigation for crops, and harbors deep-water ships that come and go across the Pacific. Millions of people depend on the river for employment in water-related industries, for commerce, and for transportation. The river is under mounting pressure from competing uses, including stormwater runoff, industrial discharges, fishing, development, irrigation, power generation, forestry, mining, transportation and water removal, all which have affected the estuaries, anadromous fishes and the nearby marine ecosystem.

PCA 13
Southern Strait of Georgia/San Juan Islands

The waters surrounding the Canadian Gulf Islands and the US San Juan Islands are locally and traditionally referred to as the Salish Sea. Despite the demarcation of national territories, British Columbia's southern Strait of Georgia and Washington State's northern Puget Sound are an inseparable ecosystem, critical to a variety of marine life. This marine realm is shallow with a high-relief, rocky bottom around the islands. It also has tidal flats and a large river delta on the mainland coast at the mouth of the Fraser River, which is a major freshwater and nutrient source for the region. This inland sea features very strong currents and intense mixing, transporting nutrients and dispersing larvae.

Eelgrass (*Zostera* spp.) and kelp beds offer spawning and foraging habitats for fish, birds and mammals. Sponges and hydrocorals can be found at various locations on the seafloor. The rocky reef habitat in this area is inhabited by an array of rockfish species, including bocaccio (*Sebastes paucispinis*), yellowtail (*S. flavidus*), copper (*S. caurinus*) and Puget Sound rockfish (*S. emphaeus*). Bottom-dwelling lingcod (*Ophiodon elongates*), wolf eel (*Anarrhichthys ocellatus*), cabezon (*Scorpaenichthys marmoratus*) and kelp greenling (*Hexagrammos decagrammus*) also frequent this area. In recent years, there has been great concern over declining groundfish stocks in this area (*Federal Register* 1999, Musick *et al.* 2000). Salmon migrate through here and their presence supports a large number of salmon-eating mammals. The Fraser River/Georgia Basin region produces 10 million sockeye salmon (*Oncorhyncus nerka*) annually (DFO 1999b).

There are breeding colonies of several marine bird species in this area. Marbled (*Brachyramphus marmoratus*) and ancient (*Synthliborampus antiquus*) murrelets flock to feast on the forage fish this area provides, following winter breeding in Mexico and southern California. Cormorants (*Phalacrocorax* spp.), puffins (*Fratercula* spp.), many shorebirds and marine waterfowl nest and feed here as well. Black brant geese (*Branta bernicla*) in British Columbia are part of a larger Pacific population composed of several smaller stocks wintering along the Pacific coastline from Alaska to Mexico after breeding in the Arctic (Sedinger *et al.* 1994). During the last two to three decades, the Pacific Flyway population has generally fluctuated between 120,000–150,000 birds.

Resident killer whales are joined by sea otters (although rare), seals and sea lions as mammals that rely on this rich ecosystem. Gray whales come here to feed as well, following mating and calving in Baja California, Mexico. The population of harbor seal has grown since the 1970s in response to increased protection under the Marine Mammal Protection Act of 1972 and other conservation actions.

Though not a major fishing ground, this priority area experiences high anthropogenic impacts because of the dense human populations along the coast and the expanding marine tourism industry.

Federal and International Designations

- San Juan Islands National Wildlife Refuge (United States), US FWS
- Gabriola Passage (in Georgia Strait) and Race Rocks (off Vancouver Island) are being reviewed by Fisheries and Oceans Canada
- Gulf Islands National Park Reserve (Canada), Parks Canada
- Orca Pass International Stewardship Area
- Mount Arrowsmith Biosphere Reserve (Canada), UNESCO
- Alaksen National Wildlife Area, Canadian Wildlife Service and Alaksen Wetland of International Importance (Canada), Ramsar Convention

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter (rare), killer whale, gray whale

Ecological Linkages/Uniqueness:

- ecologically unique area because of inland sea
- produces 10 million sockeye salmon annually
- high concentrations of resident killer whales
- transboundary area of interest and importance to marine mammals and seabirds
- important seabird migration stopover
- largest production of clams in the United States

Physical/Oceanographic Uniqueness:

- only true inland sea along west coast of North America
- extensive tidal mud flats

Harbor seal (*Phoca vitulina*)
Photo: Phillip Colla, OceanLight.com

PCA 14
Barkley Sound/ Pacific Coastal Washington

This transboundary PCA is in the open ocean on the west side of southern Vancouver Island and Washington's outer coast. The rocky shoreline, interspersed with tidal flats, receives high-energy waves constantly. The continental shelf here is about 40 kilometers (25 miles) wide, except at the mouth of the Strait of Juan de Fuca where a submarine canyon extends to the southwest. Barkley Sound is just north of the opening of the Strait on Vancouver Island's west coast. This wide embayment encompasses numerous islets and is connected to a long and narrow inlet that extends far inland. The nutrient-rich plume from the Fraser River goes through this priority area, and the eddy that originates at the mouth of the Strait carries the nutrients offshore across the shelf.

Glass sponges and black and gorgonian corals are found along the continental slope off the Washington coast. To the west of this priority area, 250 kilometers (155 miles) offshore, are the Endeavor hydrothermal vents, where a suite of endemic species thrive that are not found elsewhere in the world.

The Barkley Sound/Pacific Coastal Washington area is home to an assortment of fishes. Important fishes include salmon, herring, hake (*Merluccius productus*) and other species, such as eulachon (*Thaleichthys pacificus*), mackerel and sardine (*Sardinops sagax*), are important components of the ecosystem (DFO 2003). Flatfishes such as Pacific halibut (*Hippoglossus stenolepis*) and Dover sole, as well as yellowtail, copper, quillback (*Sebastes maliger*) and various other rockfishes which enjoy high-relief habitat are found here. Commercial fisheries also target salmon, Pacific Ocean perch (*Sebastes alutus*) and rougheye rockfish (*S. aleutianus*). In addition to the 400,000 sockeye that come from the various streams feeding into Barkley Sound (DFO 1999c), other salmon from the Georgia Strait traverse this PCA as well.

Occasionally, feeding leatherback sea turtles and, more rarely, loggerhead turtles are sighted in the Strait of Juan de Fuca and around Grays Harbor, Washington. The productive waters sustain a variety of birds and mammals. Large concentrations of seabirds forage in the area, with their numbers peaking in the spring and fall. Common murre, rhinoceros auklet and tufted puffin are some of the seabirds that nest here. Gray and humpback whales regularly travel through on their way north to feeding grounds in Alaska. The Strait of Juan de Fuca is a key habitat for killer whales. Steller's and California sea lions and Pacific harbor seals haul out on beaches. The Olympic Peninsula coastline between Neah Bay and Destruction Island is a key habitat for a growing population of sea otter, reintroduced in 1970 following their local extirpation by fur hunters.[27]

27. US Department of the Interior, National Biological Service: Our living resources — translocated sea otter populations off the Oregon and Washington coasts <http://biology.usgs.gov/s+t/SNT/noframe/pn175.htm>.

Federal and International Designations

- Pacific Rim National Park (Vancouver Island, Canada), Parks Canada
- Clayoquot Sound Biosphere Reserve (Canada), UNESCO
- Olympic Coast National Park (United States), National Park Service
- Flattery Rocks National Wildlife Refuge (United States), US FWS
- Quillayute Needles National Wildlife Refuge (United States), US FWS
- Copalis National Wildlife Refuge (United States), US FWS
- Olympic Coast National Marine Sanctuary (United States), NOAA
- Olympic Biosphere Reserve (United States), UNESCO

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, blue whale, gray whale, killer whale, humpback whale

Key Ecological Linkages:

- high salmon productivity
- the area is a key habitat for killer whales, as well as important feeding grounds for gray and humpback whales heading north to Alaska
- Neah Bay to Destruction Island is key habitat for sea otter
- large concentrations of foraging seabirds found in the spring and fall

Physical/Oceanographic Uniqueness:

- Juan de Fuca Eddy originates here and carries nutrients from the Frasier River plume offshore across the shelf
- Swiftsure/La Perouse offshore banks are extremely productive fishing grounds and foraging areas for birds and mammals

Seastack
Olympic Penninsula coast
Photo: Elliott Norse

PCA 15
Central Oregon/ Cape Mendocino

This coastal area from central Oregon to Cape Mendocino includes high-energy open coast, headlands, submarine canyons (Astoria and Rogue Rivers), the offshore Heceta Bank, rocky intertidal regions, and reefs, coastal lagoons and estuaries. These rocky shores are artifacts of thousands of years of dynamic geologic processes. The Pacific Ocean has worked against the rocks of the land, exploiting variations of hardness and orientation in the rocks, seeking out the zones of weakness caused by fractures and faults, and eroding deeper into the coastal mountains. This has resulted in hundreds of offshore rocks, haystacks and reefs, including Simpson's Reef at Cape Arago, a haulout for thousands of pinnipeds. These rocky areas are the tips of extensive underwater rocky landscapes covering thousands of acres. The southern edge of this PCA includes the tectonic plate, ridges, methane and cold seeps, transition zone, and hydrate ridges found along the Mendocino Fracture (where the Pacific Plate and Juan de Fuca plate collide). Recently, a deep-sea "reproductive hot spot" for fish and cephalopods was described in this area (Drazen *et al.* 2003).

The oceanography of the area is dictated by intense seasonal upwelling and the southward-flowing California current. Strong offshore-flowing currents at coastal headlands during windy periods and returning onshore flows during breaks in upwelling winds drive a coastal system of high biomass productivity. During the winter, there is significant wave exposure on the coast. Shallow banks also have a significant influence on productivity and upwelling. Offshore seafloors contain a variety of deep sea corals (Etnoyer and Morgan 2003).

In addition to the abundant pinniped populations, this area is characterized by high seabird species diversity, including alcids (puffins, murres, guillemots), tubenoses (black-footed albatross, shearwaters, petrels) and cormorants, as well as migratory waterfowl. Marine mammals include gray whale, blue whale and fin whale on their way to the productive feeding grounds of the Arctic and Alaskan waters. This area was in the historic range of sea otter, and sea turtles are occasionally observed during warm-water periods. The extensive kelp beds support a diverse assemblage of rockfishes and invertebrates, including sea urchins, abalone and rock crabs. Salmon, Dungeness crabs, pink shrimp, albacore, yellowfin tuna, rockfishes (snapper), sablefish, soles, flounders and Pacific whiting are all important commercial fishery species in this area.

Federal and International Designations

- South Slough National Estuarine Research Reserve (Coos Bay), NOAA
- Redwood National Park, US National Park Service

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter (historic), killer whale, blue whale, humpback whale, gray whale
- seabirds: short-tailed albatross, pink-footed shearwater, Xantus' murrelet
- sea turtles: leatherback, loggerhead

Ecological Linkages/Uniqueness:

- high species representation
- high diversity of seabirds, including many migratory and transboundary species

Physical/Oceanographic Uniqueness:

- unique coastal geology area, including sharp rocky coastlines
- tectonic plates, ridges, methane and cold seeps, and hydrate ridges found along the Mendocino Fracture
- offshore Heceta Bank is an extremely productive fishing ground
- high upwelling/productivity

Pink-footed shearwater (*Puffinus creatopus*)
Photo: Glen Tepke

Montereyan Pacific Transition Ecoregion

Priority Conservation Areas

16. Central California

17. Upper Bight of the Californias/Channel Islands/San Nicolas Island

Threats:	PCA: Central California	PCA: Upper Bight of the Californias/Channel Islands/ San Nicolas Island
Extraction of non-renewable resources	=	=
Exploitation of renewable resources	↓	↓
Coastal land use change	↓	↓
Pollution at coast/ at sea	=	=
Damaging recreational use	↓	↓
Physical alteration of coastline	↓	↓

Intensity: low moderate high

Trend: ↑ improving = unchanged ↓ worsening

Giant kelp forest
(*Macrocystis pyrifera*)
San Clemente Island, California (E. Pacific)
Photo: Phillip Colla, OceanLight.com

Regional Setting

The Montereyan Pacific Transitional Ecoregion stretches along the central California coast from Point Conception to Cape Mendocino (United States). This region consists of a very narrow continental shelf and steep continental slope, transected by a series of submarine canyons. Shelf habitats are predominantly composed of soft sediments, with extensive rocky coastal areas. Seafloor features include the central California shelf; central California slope and canyon system (Lucia, Monterey, Carmel, Pioneer and Bodega Canyons); central California abyssal plain and seamounts (Davidson, Guide and Pioneer); coastal estuaries, including Tomales Bay, San Francisco Bay, Elkhorn Slough, as well as many smaller lagoons. The California Current is the dominant current system affecting the region, although the Davidson Countercurrent reaches northwards in winter, accounting for this region's transitional nature. Upwelling occurs off major capes, particularly during the spring and summer.

Biological Setting

The region represents a transitional zone between the subtropical species representative of southern California (United States) and Baja California (Mexico), and the more northerly species. The major biogeographic affinities seem to be with the northern regions, but southern species often extend their ranges during El Niño Southern Oscillation events and warm phases of the Pacific Decadal Oscillation. The seasonal upwelling contributes to moderately high productivity.

This remarkably productive coastal environment is home to abundant marine life. Giant kelp (*Macrocystis pyrifera*) forms dense beds on rocky subtidal areas. Bull kelp (*Nereocystis luetkeana*), is the most abundant surface canopy kelp in California north of Santa Cruz, while giant kelp dominates to the south. Kelp forests are among the most productive marine habitats. Kelp provides substrate for numerous benthic and epibenthic invertebrates, as well as food and/or shelter for many fishes, seabirds and marine mammals. Within this region, the sea otter (*Enhydra lutris*) is resident between Point Conception and Monterey Bay. It is regarded as a keystone species because of its significant influence in maintaining kelp forest communities, primarily through its predation on sea urchins (*Strongylocentrotus* spp.) and other herbivores (Estes and Duggins 1995). Sea otters were protected from hunting in 1911, by international treaty. The only population to survive south of Alaska was along the rugged Big Sur coast of central California (Kenyon 1969).

Sea turtles are rare, although leatherbacks (*Dermochelys coriacea*) travel throughout the California Current feeding on a diversity of jellyfish which reside in the region. One of the world's largest concentrations of great white sharks (*Carcharodon carcharias*) occurs in this region.

Coastal wetlands associated with estuaries support millions of migrating waterfowl and shorebirds during spring and fall migrations, and over the winter months. These estuaries also serve as important spawning and nursery grounds for marine species, e.g., Pacific herring (*Clupea pallasii)* and salmon (*Oncorhynchus* spp.). The San Francisco Bay Delta estuary supports an extraordinarily diverse and productive ecosystem due to its highly dynamic and complex environmental

conditions. More than 50 percent of the birds migrating along the Pacific Flyway use the estuary's wetlands for wintering. Seasonally, the estuary's mudflats and saltflats support more than one million shorebirds. Hundreds of thousands of native and hatchery-bred salmon migrate through the delta's waters on their way to spawning grounds upriver.

Abundant seabirds, including common murre (*Uria aalge*), black-legged kittiwake (*Rissa tridactyla*), tufted puffin (*Fratercula cirrhata*) and pigeon guillemot (*Cepphus columba*), gather on the Farallon Islands near San Francisco and many smaller offshore rocks to breed. Other seabirds include a variety of petrels (*Pterodroma* spp.), albatrosses (*Phoebastria* spp.), shearwaters (*Puffinus* spp.), cormorants (*Phalacrocorax* spp.) and gulls (*Larus* spp.). Xantus' murrelet (*Synthliboramphus hypoleucus*), elegant tern (*Sterna elegans*), and Heermann's gull (*Larus heermanni*) are also found in the region as they travel from breeding areas in southern California and Mexico.

Pinnipeds are abundant in central California. Harbor seal (*Phoca vitulina*) and northern elephant seal (*Mirounga angustirostris*) populations are expanding. Northern elephant seal rookeries extend north to Cape Mendocino from Baja California, with a large rookery at Año Nuevo in this region. California sea lion (*Zalophus californianus*), Dall's and harbor porpoise (*Phocoenoides dalli, Phocoena phocoena*), and Pacific white-sided dolphins (*Lagenoryhnchus obliquidens*) are common in this region. Gray, blue and humpback whales (*Eschrichtius robustus, Balaenoptera musculus, Megaptera novaeangliae,* respectively) are regular visitors to this region as they travel from feeding grounds in the north Pacific to breeding grounds in Mexico. The Gulf of the Farallones is a key feeding habitat for blue and humpback whales, as is Monterey Bay for killer whales (*Orcinus orca*) and blue whales.

Human Activities

The Montereyan Pacific Transition Ecoregion includes scenic coastlines and the San Francisco urban area — the second largest urban population on the west coast of North America. The San Francisco Bay estuary is renowned for its natural beauty, international commerce, recreation and sports fishing. The area also supports many important economic activities, including commercial and sport fishing, shipping, industry, agriculture, recreation and tourism. However, more than 95 percent of the historic tidal marshes have been modified, with attendant losses in fish and wildlife habitat[28] (Nichols *et al.* 1986). The flow of freshwater into the estuary has been greatly reduced by water diversions, largely to support irrigated agriculture. Harbor and channel dredging, including both dredged and disposal sites, disturb communities and alter water flow patterns and salinity. Contaminants also enter the estuary through municipal and industrial sewage, as well as through urban and agricultural runoff. Exotic invasive species are a major threat to San Francisco Bay's biota.

Fisheries in the region are important, but some have suffered major declines. Numerous species, including rockfishes, (*Sebastes* spp.), herring, salmon, sablefish (*Anoplopoma fimbria*) and abalone (*Haliotis* spp.), have declined under pressure of commercial and recreational fishing. In February 2002, the US Secretary of Commerce declared nine groundfish stocks overfished: bocaccio (*Sebastes paucispinis*), canary rockfish (*S. pinniger*), cowcod (*S. levis*), darkblotched rockfish (*S. crameri*), widow rockfish (*S. entomelas*), yelloweye rockfish (*S. ruberrimus*), Pacific Ocean perch (*S. alutus*), lingcod (*Ophiodon elongatus*) and Pacific whiting (*Merluccius productus*). Salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) populations have been listed under the US Endangered Species Act.[29]

28. <http://sfbay.wr.usgs.gov/access/yearbook.html>
29. <http://www.nwr.noaa.gov/1salmon/salmesa/>

PCA 16
Central California

This PCA encompasses a large section of central California including most of the area inside three US National Marine Sanctuaries: Cordell Bank, Gulf of the Farallones and Monterey Bay. To the north lie Point Reyes and the Gulf of the Farallones, including the Farallon Islands. The outflow through the Golden Gate drains the majority of California's land area via the San Joaquin and Sacramento Rivers into the Gulf of the Farallones. To the south sits Monterey Bay, one the largest submarine canyons in the B2B region.

Two species of salmon are common to the Gulf of the Farallones, chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*). Pelagic fishes such as sardine (*Sardinops sagax*), anchovy and Pacific herring are also abundant. A variety of rockfishes inhabit the rocky shores of the region, while Dover sole (*Microstomus pacificus*) and sablefish are found over sand and mud bottoms. Pacific hake (*Merluccius productus*) migrate through in abundance, attracting marine mammals. In the fall months, this region is home to white sharks that prey on seals and sea lions. The abundance of fishes supports 12 species of breeding seabirds on the Farallon Islands, including common murre, Cassin's auklet (*Ptychoramphus aleuticus*), rhinoceros auklet (*Cerorhinca monocerata*), western gull (*Larus occidentalis*), Brant's (*Phalacrocorax penicillatus*) and pelagic (*P. pelagicus*) cormorants, storm petrel (*Oceanodroma* spp.), tufted puffin, and pigeon guillemot (Stallcup 1990). Thirty-five species of migratory seabirds have also been recorded from the area, including loons (*Gavia* spp.), grebes, shearwaters (*Puffinus* spp.), albatrosses and scoters (*Melanitta* spp.). Thirty-three species of marine mammals visit the Gulf of the Farallones: common species include gray whale, Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), harbor porpoise, Dall's porpoise, California sea lion, elephant seal, northern fur seal (*Callorhinus ursinus*) and harbor seal. Blue and humpback whales feed in the summer and fall, while other cetaceans include minke whale (*Balaenoptera acutorostrata*), beaked whale, dolphin, pilot whale (*Globicephala macrorhynchus*) and killer whale.

A spectacular diversity and abundance of fishes, seabirds and mammals inhabit the Monterey Bay area. Sea otter inhabit the coastal stretch from Point Año Nuevo to Purisima Point. The Monterey Submarine Canyon approaches close to the shore, allowing deep-water species of whales, dolphins and seabirds to occur near the coast. Shallow water species, such as the gray whale, are found very close to shore in the narrow shelf area. Seasonally, blue and humpback whales come to feed on dense swarms of euphausiids. Other species include killer whale, Pacific white-sided dolphin, Risso's dolphin (*Grampus griseus*), northern right whale dolphin (*Lissodelphis borealis*), common dolphin (*Delphinus delphis*) and Dall's porpoise. Less commonly seen are fin whale (*Balaenoptera physalus*), minke whale, beaked whale, and bottlenose dolphin (*Tursiops truncatus*).

Monterey Bay is one of only a few places where mid- and deeper-water habitats have been studied by scientists. A wide diversity of marine life, including comb-jellies (*Beroe* spp.), squids (*Loligo* spp.) and fishes, has been discovered in the mid-water depths of Monterey Canyon. Fish landings at Monterey and Moss Landing totaled approximately 43,000 tonnes (95 million pounds) in 2002.[30]

30. <http://www.st.nmfs.gov/st1/commercial/landings/lport_yeard.html>

Federal and International Designations

- Gulf of the Farallones National Marine Sanctuary, NOAA
- Cordell Bank National Marine Sanctuary, NOAA
- Monterey Bay National Marine Sanctuary, NOAA
- Golden Gate National Recreation Area, National Park Service
- Point Reyes National Seashore, National Park Service
- Elkhorn Slough National Estuarine Research Reserve, NOAA
- San Francisco Bay National Estuarine Research Reserve, NOAA
- SE Farallon Island National Wildlife Refuge, US FWS
- California Coast Ranges Biosphere Reserve, UNESCO
- Golden Gate Biosphere Reserve, UNESCO
- Bolinas Lagoon Wetland of International Importance, Ramsar Convention
- Tomales Bay Wetland of International Importance, Ramsar Convention

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, killer whale, blue whale, humpback whale, gray whale
- sea turtles: leatherback

Ecological Linkages/Uniqueness:

- 35 species of migratory seabirds recorded in the region, breeding seabird colonies on Farallon Islands
- San Francisco Bay is a major area for migratory birds in the Pacific Flyway
- 33 species of marine mammals common to the Gulf of Farallones and Monterey Bay
- high diversity of marine life found in mid- and deep-water habitats in Monterey Canyon
- abundance of kelp forests in the area
- seasonally large concentration of great white shark

Physical/Oceanographic Uniqueness:

- Monterey Bay is one of the largest submarine canyons in the B2B region
- productive coastal upwelling system

Great white shark
(*Carcharodon carcharias*)
Photo: Phillip Colla, OceanLight.com

PCA 17
Upper Bight of the Californias/Channel Islands/San Nicolas Island

This PCA stretches from just north of Point Conception, California (part of the Montereyan Pacific Transition Ecoregion), south into the Southern California Bight, including the Channel Islands (part of the Southern Californian Pacific Ecoregion). This PCA straddles the largest biogeographic transition zone in the California Current. Many temperate species have their southernmost occurrences in this area, while many subtropical species have their northernmost occurrences here.

This PCA contains a diversity of habitats, including kelp beds, sandy and rocky shores, offshore banks, coral studded pinnacles and steep submarine cliffs. The Channel Islands are home to diverse mammals and seabirds. More than 27 species of whales and dolphins also visit the Channel Islands (United States).[31]

More than 25 species of sharks inhabit the surrounding waters of the Channel Islands (Ebert 2003). The blue shark (*Prionace glauca*) is a common resident, as is the white shark. Kelp forests provide habitats for a great diversity of fishes, including Garibaldi (*Hypsypops rubicundus*), sheepshead (*Semicossyphus pulcher*), senorita (*Oxyjulius californica*), blacksmith (*Chromis punctipinnis*), torpedo rays (*Torpedo californica*) and moray eels (*Gymnothorax mordax*). Numerous species, including giant seabass (*Stereolepis gigas*), white seabass (*Atractoscion noblis*), yellowtail (*Seriola lalandi*), California halibut (*Paralichthys californianus*) and spiny lobster (*Panulirus interruptus*), have declined under the pressure of commercial and recreational fishing (Dayton *et al.* 1998). More than 60 species of rockfish (*Sebastes* spp.) inhabit this region (Love *et al.* 2002), including cowcod (*Sebastes levis*) and bocaccio (*S. paucispinis*), both currently overfished. Several abalone species have undergone severe declines (Rogers-Bennett *et al.* 2002), and the white abalone (*Haliotis sorensi*), is listed under the US Endangered Species Act.

The Northern Channel Islands and Santa Barbara Island are key breeding habitat for Xantus' murrelet and are the only nesting site for black storm petrels (*Oceanodroma melania*) in the United States. Anacapa Island is the only permanent nesting site for brown pelicans (*Pelecanus occidentalis*) in California. Northern fulmars (*Fulmarus glacialis*) breed in the Bering Sea region, but the Channel Islands are the southern extent of their non-breeding range.

The Channel Islands are also key habitats: specifically, San Nicolas Island for sea otter and the Guadalupe fur seal (*Arctocephalus townsendi*), and San Clemente Island for the Guadalupe fur seal. This area is also a major breeding and haulout region for California sea lions and northern fur seals (*Callorhinus ursinus*), following feeding farther north off British Columbia. Major California sea lion rookeries occur at San Miguel and Santa Barbara Islands. Other abundant pinnipeds include the northern elephant seal and Pacific harbor seal.

The common dolphin (*Delphinus delphis*) is the most abundant cetacean species off the southern California coast, and may be seen traveling in pods up to 1,000 individuals. The area is a hotspot of marine mammal diversity and abundance (Ford and Bonnell 1996). The San Pedro and Santa Barbara Channels are known as key feeding habitats for the humpback whales and serve as a migratory corridor. In addition, the Channel Islands are key feeding habitats for blue whale (Fiedler *et al.* 1998). Gray whales migrate through the region.

The land bordering this marine ecoregion is heavily populated. Los Angeles, Orange and San Diego counties have the first-, fifth- and sixth-largest populations in the United States, respectively, collectively totaling more than 15 million people.[32] Despite rapid increases in population, wastewater discharges of most pollutants have been decreased by 50 to 99 percent since the 1970s in Los Angeles, Orange and San Diego counties, resulting in improvements in benthic and kelp communities and reductions in contaminants in fish and marine mammals (Schiff *et al.* 2000).

31. <http://www.sanctuaries.nos.noaa.gov/oms/omschannel/omschannel.html>
32. <http://www.demographia.com/>

Federal and International Designations

- Channel Islands National Park, National Park Service
- Channel Islands National Marine Sanctuary, NOAA
- Channel Islands Biosphere Reserve, UNESCO

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: sea otter, Guadalupe fur seal, blue whale, humpback whale, gray whale
- seabirds: Xantus' murrelet
- sea turtles: leatherback

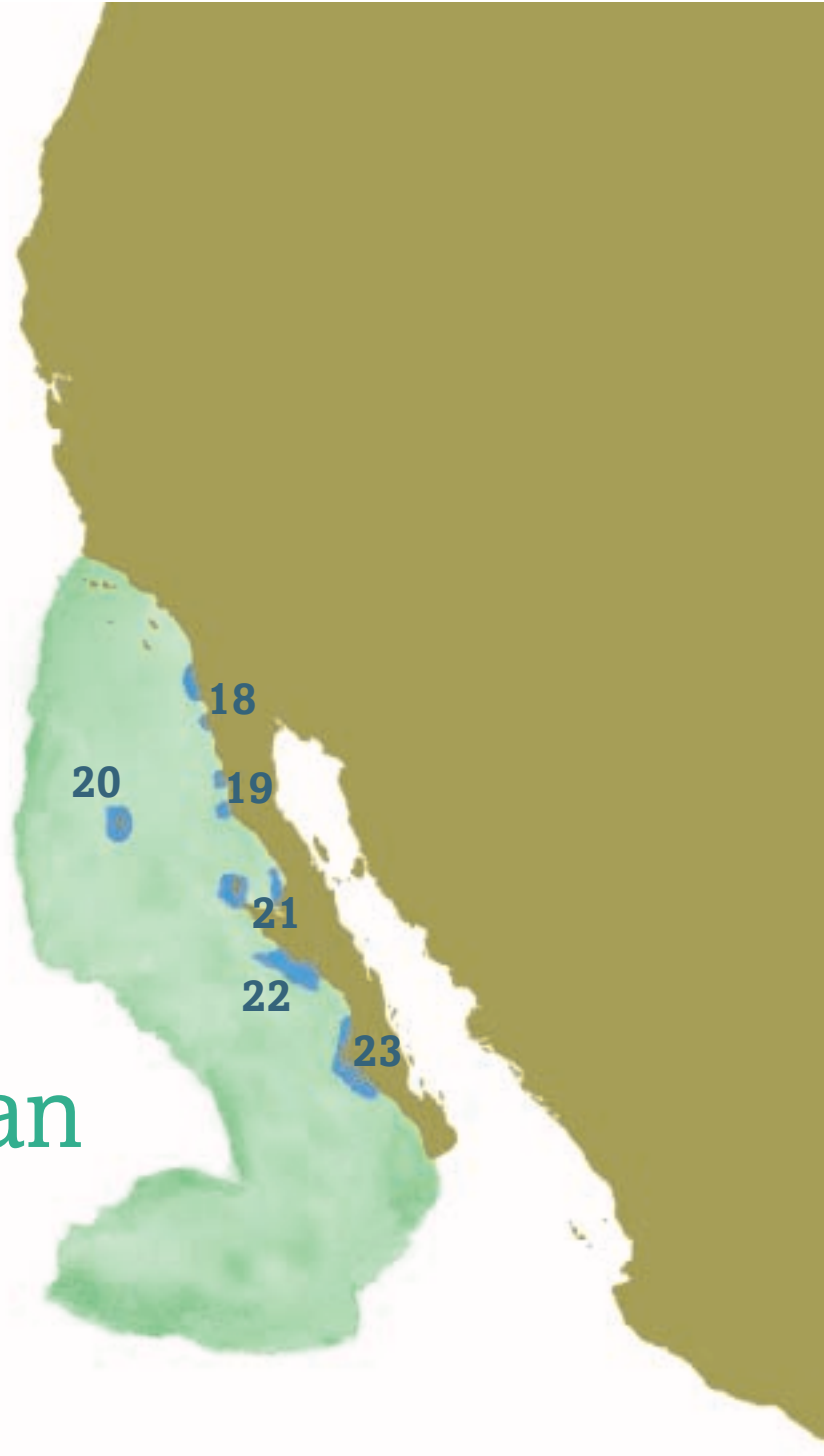
Ecological Linkages/Uniqueness:

- biogeographic transition zone between temperate and subtropical species
- important migratory corridor and feeding area for marine mammals, especially blue and humpback whales
- seabird and pinniped rookeries
- high abundance and diversity of marine mammals
- southernmost range of sea otters

Physical/Oceanographic Uniqueness:

- highly productive upwelling region at Point Conception
- three major currents meet in this region creating unique oceanographic and ecologic features
- island archipelago with endemism
- large coastal shelf
- many offshore banks and diverse habitats

Common dolphin (*Delphinus delphis*)
Photo: Phillip Colla, OceanLight.com



Southern Californian Pacific Ecoregion

Priority Conservation Areas

18. Lower Bight of the Californias/Islas Coronados

19. Bahía San Quintín/Bahía El Rosario

20. Isla Guadalupe

21. Vizcaíno/Isla Cedros

22. Laguna San Ignacio

23. Bahía Magdalena

PCA:

Threats:	Lower Bight of the Californias/Islas Coronados	Bahía San Quintín/Bahía El Rosario	Isla Guadalupe	Vizcaíno/Isla Cedros	Laguna San Ignacio	Bahía Magdalena
Extraction of non-renewable resources	=	↓	=	=	=	=
Exploitation of renewable resources	↓	↓	↑	↑	↑	↓
Coastal land use change	↓	↓	=	=	=	=
Pollution at coast/ at sea	↓	=	=	=	=	↓
Damaging recreational use	↓	↓	=	=	=	↓
Physical alteration of coastline	↓	↓	=	↓	=	=

Intensity: low moderate high

Trend: ↑ improving = unchanged ↓ worsening

Giant kelp forest (*Macrocystis pyrifera*) fronds grow upward from the reef below to reach the ocean surface and spread out to form a living canopy
San Clemente Island
Photo: Phillip Colla, OceanLight.com

Regional Setting

The Southern Californian Pacific Ecoregion stretches along the Pacific Coast south from Point Conception, California, in the United States, to the southern tip of Mexico's Baja California at Cabo San Lucas. The relatively wide shelf of the Lower Bight of the Californias is dotted with pinnacles, offshore banks and ledges. Moving toward Mexico, the shelf narrows and upwelling dominates the northern half of Baja California. Further south, the shelf widens slightly to 120 kilometers (70 miles) from Bahía Sebastian Vizcaíno to north of Bahía Magdalena. At the shelf break, the seafloor drops rapidly to 1,000-meter (3,280-feet) and 3,000-meter (9,840-feet) depths. Seaward of the shelf, but landward of the abyssal plain, is the Baja California Borderlands — a mountainous region found at depths between 800 meters (2,630 feet) and 1,000 meters (3,280 feet) — that includes islands, banks and deep basins. Oceanic islands (Isla Guadalupe, Mexico) and seamounts are also found in deeper waters off this region. The region contains many islands, including Los Coronados (Mexico) and Rocas Alijos (Mexico). Coastal zones are characterized by coastal lagoons, sea grass beds, rocky shores, sand beaches and extensive giant kelp forests.

The climate is arid to semi-arid and there is limited freshwater input to the coast. The region is dominated oceanographically by the north-to-south flowing California Current, although local upwelling, the California Countercurrent, and extension of the Equatorial Countercurrent also influence it. Seasonal upwelling south of prominent capes occurs near Cabo Colonett (Mexico), Punta Baja (Mexico), Cabo San Quintín (Mexico), Punta Eugenia (Mexico), Punta Abreojos (Mexico) and Cabo Falso (Mexico). Due to the curvature of the coast at Point Conception (United States), the California Current moves offshore, allowing the nearshore to be influenced by the warmer Southern California Countercurrent (which has a discontinuous northward flow beginning seasonally in August to October and strengthening in winter). A similar system develops seasonally at Bahía Sebastian Vizcaíno (Mexico).

Biological Setting

This region is characterized by mixing — of waters, floras and faunas — from north and south, leading to relatively high species diversity. The southern range terminus of many high-latitude fishes and invertebrates, as well as the northern range terminus of many equatorial species occurs around Point Conception (Eschmeyer *et al.* 1983). Productivity is moderately high due to the coastal upwelling systems, which bring nutrients to nearshore surface waters. El Niño Southern Oscillation conditions and Pacific Decadal Oscillations, which bring warm equatorial waters further north, lead to variations in the productivity and recruitment success of many species, and the community dynamics of the region.

This region includes the northernmost extension of mangrove habitats in the eastern Pacific (at 28°N to 29°N, close to Bahía Sebastian Vizcaíno, Mexico) and the southernmost extension of kelp forests (near Bahía Magdalena, Mexico).[33] Sandy beaches and dunes are covered by plant species such as *Abronia maritime* and sea rocket (*Cakile maritima*), an alien species that is replacing the native sea rocket (*Cakile edentula*[34]) (Moreno-Casasola *et al.* 1998, Espejel *et al.* 2001).

Kelp forests at depths of six to 30 meters (20–100 feet) are among the most productive marine habitats, providing food and shelter for numerous invertebrates, fishes, seabirds and marine mammals. Boccacio (*Sebastes paucispinis*)—a critically endangered rockfish (IUCN Red List), other rockfishes, and abalones are endangered throughout their range.

Loggerhead (*Caretta caretta*) and green (*Chelonia mydas agassizii*) sea turtles, both considered endangered by IUCN, use this area as key feeding habitat. It is possible that the loggerhead's arrival at these and other North American feeding grounds follows a cross-Pacific migration from as far away as Japan (Eckert 1993).

The region supports large seabird and marine mammal populations. The pink-footed shearwater (*Puffinus creatopus*), considered vulnerable by IUCN, short-tailed albatross (*Phoebastria albatrus*) and Xantus' murrelet (*Synthlibiramphus hypoleucus*) — highly migratory seabirds at risk of extinction — all use the productive waters in this region for feeding. The breeding colonies of the Xantus' murrelet are found between San Benito and Guadalupe Islands (Baja California Sur, Mexico) and the northern California Channel Islands (United States).

33. <http://www.cicese.mx/~proester/inv/contesp/introesp.htm>
34. <http://usgssrv1.usgs.nau.edu/swepic/factsheets/Cakile_maritima.pdf>

A major California sea lion (*Zalophus californianus*) rookery occurs in Bahía Sebastian Vizcaíno. Important northern elephant seal (*Mirounga anugustirostris*) rookeries occur at Islas San Benito and Guadalupe Island. The Guadalupe fur seal (*Arctocephalus townsendi*) — a transboundary species at risk and with a very limited range — is found in these waters between Isla Guadalupe off the California peninsula (Mexico) and San Nicolas Island off southern California (United States). The species' breeding and pupping occur on Isla Guadalupe as well as Isla Benito del Este, Mexico. Guadalupe fur seal, despite recent increases, are still considered vulnerable by IUCN and threatened under the US Endangered Species Act.

Laguna Guerrero Negro, Laguna San Ojo de Liebre, Laguna San Ignacio, Santo Domingo Channel, and Bahía Magdalena — all in Mexico — are thought to be the most important breeding and calving areas for the gray whale, a species with one of the longest migratory routes of all mammals — 22,000 kilometers (13,670 miles) yearly from the Bering Sea to Baja California. Blue whales are found year round along the west coast of the California peninsula and beyond the southwest Baja California shelf, although many travel as far north as the Gulf of Alaska to feed during the summer. The blue whale is considered endangered both under the US Endangered Species Act and by IUCN.

A regional planning study of the Mexican section of this PCA, coordinated by the National Institute of Ecology (*Instituto Nacional de Ecología* — INE), can be consulted at the web site of the Mexican Secretary of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales* — Semarnat).[35] This study presents a review of the biodiversity and socioeconomic issues in the coastal and marine region. Conservation priorities in Mexico for marine zones, coastal watersheds and terrestrial ecosystems have been previously examined by the government.[36]

35. <http://www.semarnat.gob.mx/>
36. <http://www.conabio.gob.mx/>

Human Activities

The Southern Californian Pacific Ecoregion includes highly urbanized coastal areas of southern California (United States) and Tijuana (Mexico), as well as sparsely populated coasts of Baja California Sur (Mexico). Despite rapid increases in population, wastewater discharges of most pollutants have been decreased by 50 to 99 percent since the 1970s, resulting in improvements in benthic and kelp communities, and reductions in contaminants in fish and marine mammals (Schiff *et al.* 2000).

The region is rich in a variety of fishery resources. Anchovies and sardines (*Sardinops sagax*) are key links in the local trophic system (Dickerson 1990, Bakun 1993). Other commercial fishes include Pacific mackerel (chub mackerel, *Scomber japonicus*), Pacific bonito (*Sarda chiliensis*), jack mackerel (*Trachurus symmetricus*), Pacific whiting (*Merluccius productus*) and more than 60 species of rockfish (*Sebastes* spp.) (MacCall 1986). Numerous species, including rockfishes, salmon (*Oncorhynchus* spp.), sablefish (*Anoplopoma fimbria*) and abalone (*Haliotis* spp.), have declined under pressure from commercial and recreational fishing. White abalone (*Haliotis sorenseni*) is listed under the US Endangered Species Act. Many pelagic species such as tuna, swordfish (*Xiphias gladius*) and marlin have also declined. The largest fishing port in California, by weight of catch landed, is Los Angeles, totaling 77,156 tonnes (170.1 million pounds) in 2002.[37]

Coastal zones in this region vary significantly in the degree of human alteration — from pristine to highly modified. Modifications include major centers of marine transportation, recreation and offshore oil. Major environmental issues that affect the region include oil and gas development, busy shipping lanes in nearby waters, non-point-source pollution, and commercial and recreational fishing. Over-exploitation of resources in this northern Mexican range is high in some cases, but not increasing. Power plants, ports and nautical projects, urban development, sewage, and wastewater threaten the coastline and these threats are increasing over time. While scientific information is readily available, local support is minimal and a lack of extensive legal protection also persists.

37. <http://www.st.nmfs.gov/st1/commercial/landings/lport_yeard.html>

PCA 18
Lower Bight of the Californias/Islas Coronados

This transboundary area is found just south of the Channel Islands and is situated just north of the coastal city of Ensenada (Mexico). The Lower Bight of the Californias incorporates coastal lagoons and submarine canyons, as well as the steep volcanic rock, which composes Islas Coronado and Islas Todos Santos.

This area is found inshore of the California Current and is a mixture of diverse oceanographic features. Estuarine circulation in the area results from the rivers in the region, such as the San Antonio and Tijuana rivers. Vertical mixing, significant upwelling and transboundary eddies lead to the elevated productivity of the area. These features aid in supporting many binationally significant fisheries, and the convergence of currents results in larval retention that produces locally high endemism.

The coastal strand is covered by native dune perennial species such as *Abronia maritima*, sometimes associated with wetland and coastal succulent scrub species. It is the southern limit of *Atriplex leucophyla*, a herbaceous Californian strand species (Moreno-Casasola *et al.* 1998, Espejel *et al.* 2001). Endangered wetland plant species occur such as *Cordylanthus maritimus* (Zedler 1982) and *Triglochin concinna*, which are on the Mexican endangered species list (Semarnat 2000). The Lower Bight contains kelp forests that support a diversity of marine life, including commercially valuable abalone and sea urchins. Aquaculture, such as that for bluefin tuna (*Thunnus thynnus*), is also an emerging industry in the region. Coastal pelagic fisheries, including sardine and chub mackerel, are vital to this area of Mexico. Several fisheries have suffered major declines, including large pelagic fishes such as swordfish, tuna and marlin. A resident population of green sea turtles also makes the bays — including San Diego Bay — and lagoons home, relying on algae and seagrasses for food.

The Islas Coronados are internationally significant for the breeding of many seabirds, including the ashy storm petrel (*Oceanodroma homochroa*), listed as near threatened by IUCN, brown pelican (*Pelecanus occidentalis*) and Brandt's cormorant (*Phalacrocorax penicillatus*), as well as the approximately 750 breeding pairs of Xantus' murrelets found on Islas Coronados (BirdLife International 2000), one of their key breeding habitats. A wintering population of Xantus' murrelets is known to reside along the southern California Bight as well. The area is part of the Pacific Flyway.

Migratory marine mammals, including gray whales, converge on the area in the winter for breeding and calving following summer feeding in the waters off Alaska (Reeves *et al.* 2002). The islands are especially important haulout regions for the California sea lion, Pacific harbor seal (*Phoca vitulina*) and northern elephant seal.

Federal and International Designations

- Tijuana River National Estuarine Research Reserve, NOAA (United States)
- None (Mexico)

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: blue whale
- seabirds: Xantus' murrelet
- sea turtles: green

Continental Uniqueness:

- larval retention caused by convergence of currents results in high endemism
- Islas Coronados are an internationally significant seabird breeding site, especially for Xantus' murrelets

Ecological Linkages:

- area is especially important haulout for seals and sea lions
- important area for breeding and calving of whales, especially gray whales who travel to breed here from Alaska
- many of the fisheries are of concern to both United States and Mexico

Ocean sunfish (*Mola mola*) schooling in the open ocean near San Diego
Photo: Phillip Colla, OceanLight.com

PCA 19
Bahía San Quintín/ Bahía El Rosario

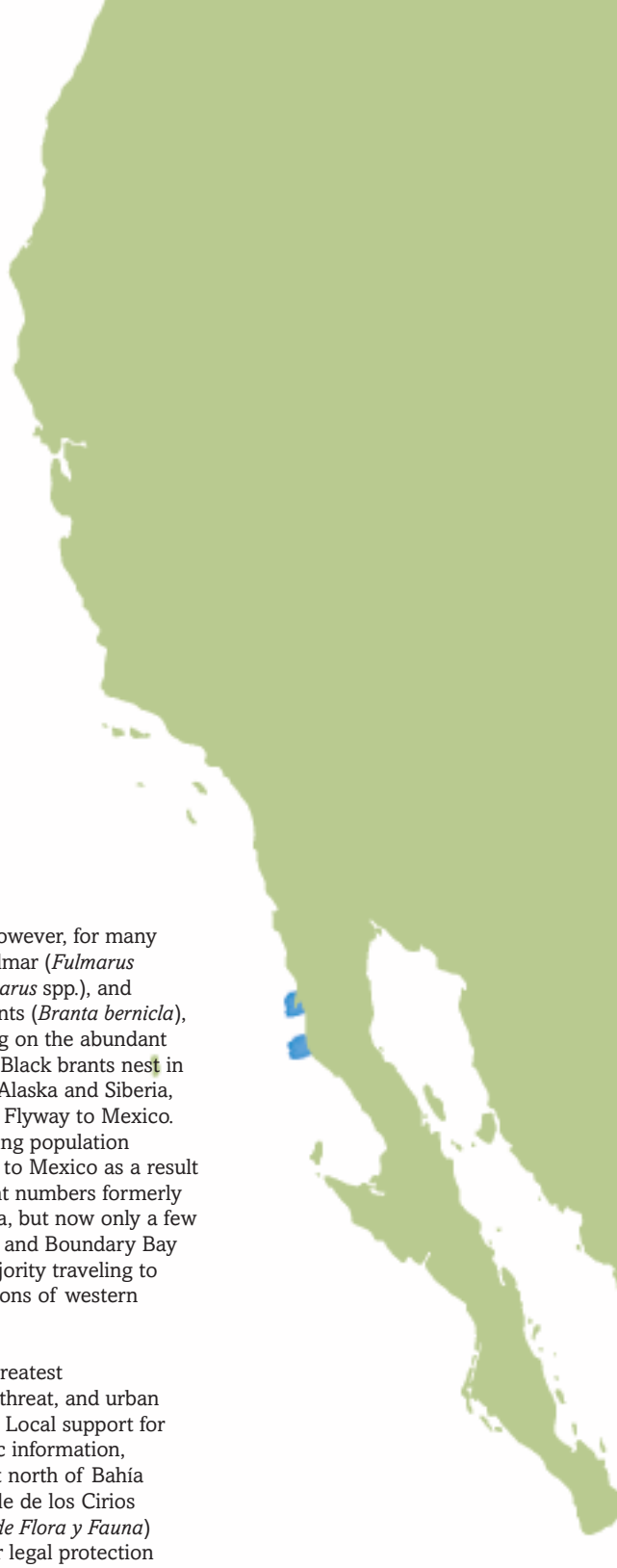
The bays of San Quintín, El Rosario and the surrounding area are a mixture of sand dunes, rocky points, beaches and wetlands and incorporate both coastal lagoons and shallow, open bays. Located between Cabo Colonett and Punta San Antonio, this area also includes the volcanic islands of San Jerónimo and San Martín. Most strand and dune plant communities are very well preserved but are threatened by off-road vehicles.[38]

The unique ecosystem of this area flourishes because of the intense upwelling at Cabo San Quintín and Punta Baja, the nutrient-rich runoff from the surrounding lands, and the eddies which circulate in the area. As a result, high productivity dominates the area and fisheries abound. Among them are dive-caught red (*Strongylocentrotus franciscanus*) and purple sea urchins (*S. purpuratus*), black abalone (*Haliotis cracherodii*) and sea cucumbers, and trap fisheries for spiny lobster (*Panulirus interruptus*). Kelp forests, which line the coasts, also help to support fisheries, as well as other marine life such as sea snails and splitnose rockfish (*Sebastes diploproa*). The Pismo clam (*Tivela stultorum*), which resides in this area, may be the species of greatest commercial importance to both the United States and Mexico as more than 1,500 tonnes (3,306,930 pounds) of clams are imported into the United States from the Baja California peninsula each year (Pattison 2001). Rockfishes—such as bocaccio and the canary rockfish (*S. pinniger*), which spawns off northern Baja—are declining. The shallow bay of San Quintín is covered in eelgrass (*Zostera* spp.) and supports myriad aquaculture operations for species such as the giant Pacific oyster (*Crassostrea gigas*), a Japanese native.

Loggerhead sea turtles feed in the area during the spring and summer (Marquez 1990). It is possible that their arrival at these and other North American feeding grounds follows a cross-Pacific migration from as far away as Japan (Eckert 1993).

Seabirds visit the area in large numbers. Brown pelicans, Cassin's auklets (*Ptychoramphus aleuticus*), double-crested cormorants (*Phalacrocorax auritus*) and Xantus' murrelets once bred on San Martín, but these species are now locally extinct (Carter *et al.* 1996, BirdLife International 2000). The area is still important, however, for many seabird species such as northern fulmar (*Fulmarus glacialis*), several species of gulls (*Larus* spp.), and the approximately 25,000 black brants (*Branta bernicla*), which winter in San Quintín, feeding on the abundant eelgrass (Derksen and Ward 1993). Black brants nest in Arctic coastal lowlands in Canada, Alaska and Siberia, and migrate south along the Pacific Flyway to Mexico. In the late 1950s, their main wintering population dramatically shifted from California to Mexico as a result of disturbance by people. Significant numbers formerly wintered in coastal British Columbia, but now only a few stay in the Queen Charlotte Islands and Boundary Bay on the lower mainland, the vast majority traveling to Baja California and the coastal lagoons of western Mexico.

Pebble rock for landscaping is the greatest non-renewable resource extraction threat, and urban development continues to increase. Local support for conservation and available scientific information, however, is high and, beginning just north of Bahía El Rosario, the terrestrial-based Valle de los Cirios Protected Area (*Area de Proteccion de Flora y Fauna*) exists, providing the opportunity for legal protection of all coastal habitats. Despite this, the Nautical Ladder, *La Escalera Náutica*, might threaten these pristine marine and coastal ecosystems in the near future.



38. Inventories of species found in coastal habitats can be found at <http://www.cicese.mx/~proester/inv/contesp/introesp.htm>

Federal and International Designations

- None

Summary of Expert Selection Criteria

Important to MSCCC:

- seabirds: Xantus' murrelet
- sea turtles: loggerhead

Continental Uniqueness:

- intense upwelling, nutrient-rich runoff and eddy circulation create a unique ecosystem

Ecological Linkages:

- 25,000 black brants winter at San Quintín
- area of abundant fisheries, especially for Pismo clams
- important habitat for green and loggerhead sea turtles

Blacksmith (*Chromis punctipinnis*) amidst kelp forest (*Macrocystis pyrifera*)
Photo: Phillip Colla, OceanLight.com

PCA 20
Isla Guadalupe

Isla Guadalupe is one of the many volcanic islands along the Pacific Coast. The lava caves and tubes along its coastline attest to its origins. The island is due west of Punta Baja and is approximately 157 square kilometers (98 square miles) with offshore depths plunging to as much as 3.5 kilometers (two miles). Underwater, the island is lined with low-lying kelp and surfgrasses (*Phyllospadix* spp.); above water, the terrain is rugged. Endemism abounds on the island, as it is 257 kilometers (160 miles) away from mainland Baja California.

Great white shark (*Carcharodon carcharias*), considered vulnerable by IUCN, can be found feeding on seals in this area, and salmon shark (*Lamna ditropis*) move through the area along their migratory path from Alaska southward.

Seabirds, such as Xantus' murrelets, black-vented shearwaters (*Puffinus opisthomelas*), brown pelicans and Heermann's gulls (*Larus heermanni*), use the island for nesting. The 2,400 to 3,500 breeding Xantus' murrelets, for which the island is a key breeding habitat, and 2,500 breeding pairs of black-vented shearwaters on Isla Guadalupe are considered vulnerable by IUCN (BirdLife International 2000). The last remaining breeding pairs of the critically endangered Guadalupe storm petrel (*Oceanodroma macrodactyla*) may also exist on the island (BirdLife International 2000).

Isla Guadalupe hosts a wide variety of marine life. California sea lions breed, elephant seals breed and molt, and Guadalupe fur seals breed and pup on their namesake island, a key breeding habitat. Elephant seals and Guadalupe fur seals were nearly extinct in the 1900s due to over-exploitation, but the last existing individuals were safe from sealers on Isla Guadalupe, allowing the species to continue and the California sea lion and elephant seal eventually to flourish (Reeves *et al.* 2002).

Threats to the island are low, though introduced species have served to extirpate endemic species and this threat continues.

Federal and International Designations

- Isla Guadalupe reserved for the protection and development of its natural resources (1922)
- Isla Guadalupe and Surrounding Territorial Waters Hunting and Fisheries Reserve Area (1928)

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: Guadalupe fur seal
- seabirds: Xantus' murrelet

Continental Uniqueness:

- 257 kilometers (160 miles) offshore, endemism abounds on the island
- the last of the Guadalupe storm petrels may exist on the island
- one of the four breeding sites for Guadalupe fur seals

Ecological Linkages:

- key breeding habitat for thousands of seabirds, including Xantus' murrelets, Heermann's gulls and black-vented shearwaters

Guadalupe fur seal (*Arctocephalus townsendi*)
mother and pup
Guadalupe Island
Photo: Phillip Colla, OceanLight.com

PCA 21
Vizcaíno/Isla Cedros

Located in the central part of the peninsula of Baja California, this area is known as a transition zone between temperate and arid climates, resulting in a unique and diverse ecosystem. Vizcaíno is a large, open bay tucked behind Punta Falsa and positioned midway along the Pacific Baja California coast. El Vizcaíno is an internationally recognized whale sanctuary. The coastal lagoons of Ojo de Liebre and San Ignacio are important reproduction and wintering sites for the gray whale, harbor seal, California sea lion, northern elephant seal and blue whale. The lagoons are home to endangered marine turtles as well. Also in the area are Isla Cedros and Isla San Benito, which are situated just north of Punta Falsa and are volcanic islands, like most islands in the area. As a result of the bay and volcanic islands, rocky points, wetlands, beaches and a terrestrial plain that becomes the coastal zone can all be found in this area. This, along with the powerful coastal upwelling at Punta Abreojos, eddies, and unique current patterns, such as counterclockwise gyre systems, create an area of extreme productivity.

Kelp forests support a diversity of life, including black abalone, red and purple sea urchins, and spiny lobster, for which pot and hand fisheries occur. Longlining for bluefin tuna also exists, though overfishing has caused declines in this stock. The flora and fauna of Vizcaíno Bay were recently studied for the first time, and hundreds of new records and several new species were recorded, including 20 marine worms and three mollusc genera new to science (BIOPESCA 2002).

Green and olive ridley (*Lepidochelys olivacea*) sea turtles are found along the coastline and on Isla Cedros. The olive ridley also migrates to additional southern feeding grounds off Ecuador (Eckert 1993).

A diverse assortment of seabirds, such as the black brant, brown pelican and Herrmann's gull, use the region for nesting and/or overwintering. On Isla San Benito, approximately 500 pairs of Xantus' murrelets and several thousand pairs of black-vented shearwaters (BirdLife International 2000) breed each winter; both species are considered vulnerable by IUCN. The Craveri's murrelet (*Synthliboramphus wumizusume*), a species endemic to Mexico and also considered vulnerable by IUCN, breeds on San Benito as well.

Elephant seals breed on Isla Cedros and Isla San Benito, and a small colony of Guadalupe fur seals was discovered on San Benito in 1997. A major California sea lion rookery also occurs in the bay region. This area is part of the migratory pathway for gray and blue whales. Gray whales arrive to breed and calve in Laguna Guerrero Negro and Laguna San Ojo de Liebre in the winter, after traveling 22,000 kilometers (13,670 miles) from their summer feeding grounds in Alaska. Similarly, blue whales travel from their Arctic feeding grounds to breed and calve here.

Federal and International Designations

- El Vizcaíno Biosphere Reserve, MAB UNESCO
- Whale Sanctuary of El Vizcaíno, World Heritage Site, UNESCO
- Laguna Ojo de Liebre, Wetland of International Importance, Ramsar Convention
- Complejo Laguanar Ojo de Liebre (Guerrero Negro and Manuela) Biosphere Reserve

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: Guadalupe fur seal, blue whale, gray whale
- seabirds: Xantus' murrelet
- sea turtles: green, loggerhead

Continental Uniqueness:

- small colony of Guadalupe fur seals breeds on Isla San Benito
- transition zone between temperate and arid climates resulting in a unique ecosystem
- unique current patterns and eddies

Ecological Linkages:

- international whale sanctuary
- Isla Cedros is important area for sea turtle feeding and nesting
- area is well preserved with little development

California sea lion (*Zalophus californianus*)
mother and pup
Photo: Phillip Colla, OceanLight.com

PCA 22
Laguna San Ignacio

Laguna San Ignacio is located midway along Baja California Sur's Pacific Coast, between Punta Falsa and Cabo San Lázaroa, just east of the town of Punta Abrejos. This coastal lagoon reaches depths of two to four meters (7.5–13 feet) and is approximately six kilometers (four miles) wide and 35 kilometers (22 miles) long. The coast is lined with rocky shores and open beaches and remains one of the most pristine areas along the Pacific Coast. For species diversity, see the management plan of the Biosphere Reserve (Semarnat 2000, Ortega and Arriaga 1991).

This area represents the northern limit of mangroves along the Pacific Coast and the nutrients these forests provide, as well as the high levels of coastal upwelling, lead to elevated productivity. Kelp forests support abalone and other fisheries, such as those for Pismo clam and spiny lobster. Five fishery cooperatives operate in the area and aquaculture for commercial clams also occurs in the area.

The area is known to host several sea turtles, such as the green, loggerhead, olive ridley and occasionally the scarce hawksbill. Loggerheads arrive in the area following migration from Asian waters and olive ridleys characteristically travel southward, following nesting, to feed off Ecuador. Seabirds, such as Pacific loons (*Gavia arctica pacifica*) and blue-footed boobies (*Sula nebouxii*), use the area. Brown pelicans migrate from as far north as the Columbia River to breed in the Laguna San Ignacio area.

The lagoons in this area are important wintering sites for both gray and blue whales. It is here that they migrate from their Alaskan and Arctic feeding grounds to breed and calve, and this area is considered a key breeding and calving habitat for the gray whale. Bottlenose dolphins (*Tursiops truncatus*) are also common, along with harbor seals and California sea lions, which like to feed in the cool, upwelling water.

Federal and International Designations

- El Vizcaíno Biosphere Reserve, MAB UNESCO
- Laguna San Ignacio, Wetland of International Importance, Ramsar Convention

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: blue whale, gray whale
- sea turtles: green, loggerhead

Continental Uniqueness:

- area of high diversity

Ecological Linkages:

- critical habitat for gray and blue whale breeding and calving
- important feeding area for green and other sea turtles

Pacific bottlenose dolphin (*Tursiops truncatus*)
Photo: Phillip Colla, OceanLight.com

PCA 23
Bahía Magdalena

Bahía Magdalena is situated midway along the Pacific Baja California Sur coastline. This large bay is the largest wetland ecosystem on the west coast of Baja California. It is more than 50 kilometers (31 miles) long and is lined by barrier islands that protect the bay from the harsh Pacific waves. It is the shape of one of these islands, Isla Magdalena, which forms Cabo San Lázaro.

Lagoons and wetlands line Bahía Magdalena and kelp forests can be found along the southern end. This area is considered part of the biogeographic transition zone from temperate to tropical climates and is, therefore, nearly the northern-most extent of mangroves along the North American Pacific Coast. Coastal upwelling enhances the retention zone that the barrier islands and currents provide, and leads to a high level of productivity and diversity in the area. Attempts by the government to establish aquaculture for shrimp, fish and giant Pacific oysters have been unsuccessful, due to both environmental and also structural problems. Attempts at cultivating the native pearl oyster (*Pteria sterna*) are now underway. Much of the human population surrounding Bahía Magdalena relies on fisheries for such species as sardine, shrimp, squid (*Loligo* spp.), red crab (*Pleuroncodes planipes*) and abalone. Despite community dependence on fisheries, many are in decline, including those for long-lived, large species such as rockfish, swordfish and tuna.

Green and loggerhead turtles are among the species that feed in Bahía Magdalena, one of their key habitats. Some of the green turtle populations are resident, though loggerhead juveniles migrate to the area to feed on seasonally abundant red crabs. Leatherback turtles (*Dermochelys coriacea*) are also occasionally sighted during the fall and winter.

Heermann's gulls migrate to the area to breed during the winter, and pink-footed shearwaters spend their summers using the productivity of the area after migrating north from Chile (Harrison 1983). The wetland harbors the northernmost breeding colony of the magnificent frigatebird (*Fregata magnificens*) and the southernmost breeding site of the bald eagle (*Haliaeetus leucocephalus*). Brown pelicans that migrate north into California also breed here.

Magdalena is one of the most important destinations for blue and gray whales as they finish their migration from the Alaskan and Arctic feeding habitats. In the warm waters of the bay and the Santo Domingo Channel, they breed and calve during the winter months, making the region an increasingly popular tourist destination. Both Bahía Magdalena and Santo Domingo Channel are key breeding and calving habitats for the gray whale.

Certain threats in Bahía Magdalena are worsening with time, including exploitation of natural resources and coastal pollution. Damaging recreational use and ecotourism, such as birding and whale watching, continue to rise.

Federal and International Designations

- None

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: blue whale, gray whale
- seabirds: pink-footed shearwater
- sea turtles: green, leatherback, loggerhead

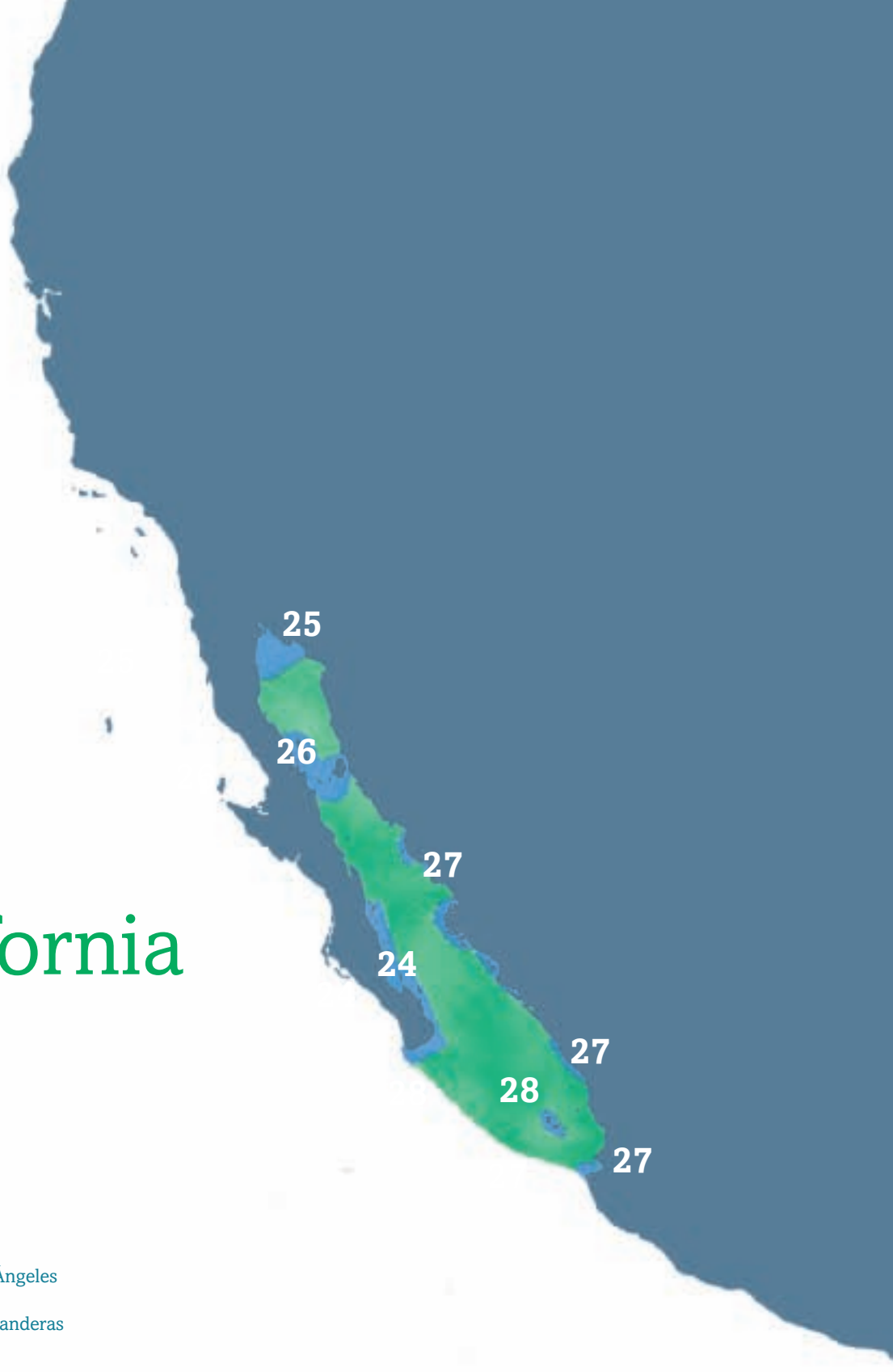
Continental Uniqueness:

- biogeographic transition zone from temperate to tropical climates

Ecological Linkages:

- fisheries important for the ecosystem and also the livelihood of human inhabitants (70 percent in fisheries)
- wetlands support many bird breeding colonies such as magnificent frigatebird and bald eagle
- key breeding areas for migratory gray and blue whales
- feeding habitats for green and loggerhead turtles

Magnificent frigatebird (*Fregata magnificens*)
Photo: WWF/Gustavo Ybarra



Gulf of California Ecoregion

Priority Conservation Areas

24. Corredor Los Cabos/Loreto

25. Alto Golfo de California

26. Grandes Islas del Golfo de California/Bahía de Los Ángeles

27. Humedales de Sonora, Sinaloa y Nayarit/Bahía de Banderas

28. Islas Marías

PCA:

Threats:	Corredor Los Cabos/Loreto	Alto Golfo de California	Grandes Islas del Golfo de California/Bahía de Los Ángeles	Humedales de Sonora, Sinaloa y Nayarit/Bahía de Banderas	Islas Marías
Extraction of non-renewable resources	↓	=	=	=	=
Exploitation of renewable resources	↓	=	↓	↓	↓
Coastal land use change	=	↓	↓	↓	↓
Pollution at coast/ at sea	=	=	↓	↓	↓
Damaging recreational use	↓	↓	↓	↓	↓
Physical alteration of coastline	=	↓	↓	↓	↓

Intensity: low moderate high

Trend: ↑ improving = unchanged ↓ worsening

Beach near Loreto, Baja California Sur
Photo: Sabine Jessen, CPAWS

Regional Setting

The Gulf of California, also known as the Sea of Cortez, is a semi-enclosed sea known for its high productivity and biodiversity. It is a long narrow sea, approximately 1,000 kilometers (620 miles) long and 150 kilometers (90 miles) wide, bordered by the Mexican coastal states of Sonora, Sinaloa and Nayarit to the east, the Baja California Peninsula (Mexican) to the west, and the Colorado River and Delta to the north (Mexico/United States). Deep basins, steep slopes, both narrow and wide continental shelves, numerous islands, and coastal lagoons characterize the region. The Guaymas Trench has volcanic and hydrothermal vents, and supports biotic communities based on the use of hydrogen sulfide for energy, instead of sunlight. Major community types in the coastal areas include lagoons, the Colorado River delta, mangroves, sea grass beds, rocky shores, sandy shores and coral reefs. The region contains numerous offshore islands, steep slopes, seamounts and deep basins.

Although it is a west coast region, the moderating effect of the Pacific Ocean upon the climate is greatly reduced by an almost uninterrupted chain of mountains 1,000 to 3,000 meters (3,280 to 9,840 feet) high along the Baja California Peninsula. The climate of the region is therefore more continental than oceanic. Desert-like conditions are found in its northern end — annual rainfall less than 100 millimeters (4 inches) — while monsoon rainfall conditions are observed in the south — annual rainfall in the southeast increases to about 1,000 millimeters (40 inches). The region exhibits tropical characteristics during summer and temperate characteristics during winter.

Freshwater input by rivers has only local effect, because most river water has been impounded for agricultural and urban purposes (Santamaría-del-Ángel and Álvarez-Borrego 1994). The upper Gulf is an evaporative basin and exchange with the open Pacific is minor, although a net flow of water into the Gulf occurs. Over the shallow northern shelf, seasonal heating and cooling of the highly saline estuarine water of the Colorado River forces a complex surface pattern of turbidity gyres; this dense, cool water is the origin of the deep-water outflow of the Gulf (Lepley *et al.* 1975, Longhurst 1998). Wind-driven upwelling occurs on both the eastern (winter and spring) and western (summer) shorelines of the Gulf, but is better developed and extends over a greater distance along the west coast of the Mexican mainland than off Baja California (Lluch-Cota 2000). Tidal mixing is very strong in the northern Gulf, mainly in the region of the Midriff Islands — Tiburón and Ángel de la Guardia — and in the upper Gulf, where amplitudes of spring tides may be as much as nine meters (30 feet) over an area and three kilometers (two miles) wide (Álvarez-Borredo 1983, Hernández-Ayon *et al.* 1993). Very low oxygen concentrations at intermediate depths — 300 to 900 meters (980 to 2,950 feet) — are characteristic of the Gulf waters (Santamaría-del-Ángel and Álvarez-Borrego 1994).

Biological Setting

The Gulf of California is a subtropical system with exceptionally high rates of primary productivity due to a combination of its topography, its southern latitude and upwelling. Coastal strand and wetland habitats maintain high species diversity due to the transition between arid and tropical ecosystems (Moreno-Casasola *et al.* 1998). This high primary productivity supports sardines and anchovies that, in turn, are the main food of a whole array of species, including squid (*Loligo* spp.), fish, seabirds, sea turtles and marine mammals. The northern Gulf has many endemic species, including the endangered totoaba (*Cynoscion macdonaldi*) and vaquita (*Phocœna sinus*) — one of the rarest marine mammals in the world. Several species of rockfish are endemic to the Gulf, including *chancharro de boca negra* (*Sebastes sinensis*), *S. cortezi*, *S. spinorbis* and *S. varispinis* (Love *et al.* 2002). Fish species at risk in the Gulf of California include the Mexican rockfish (*Sebastes macdonaldi*), the Pacific seahorse (*Hippocampus ingens*) and the whale shark (*Rhinocodon typus*). The migratory whale shark, the largest fish in the world and considered vulnerable by IUCN, can be found in the Gulf for up to six months a year.

The Gulf and its islands also serve as breeding areas for sea birds. For instance, much of the world's population of Heermann's gull (*Larus heermanni*) and royal tern (*Sterna maxima*) breeds in the region. The region is also home to a whole suite of other species, including the California gull (*L. californicus*). The wetlands of the region are an important part of the Pacific Flyway used by ducks and geese such as the black brant (*Branta bernicla*), which arrives in the region after breeding in northern Alaska.

All sea turtles that frequent the Gulf are listed by IUCN as endangered, including the loggerhead (*Caretta caretta*), green (*Chelonia mydas agassizi*), leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*). The green sea turtle uses the Gulf of California as key feeding grounds. Nesting beaches of olive ridleys are scattered throughout the Gulf, though there is a significant concentration of olive ridley nests along the southern tip of the peninsula.

Human Activities

Marine mammals in the Gulf of California region include great whales such as minke (*Balaenoptera acutorostrata*), sei (*Balaenoptera borealis*), Bryde's (*Balaenoptera edeni*), fin (*Balaenoptera physalus*), gray (*Eschrichtius robustus*), north Pacific right (*Eubalaena japonica*), humpback (*Megaptera novaeangliae*) and sperm (*Physeter macrocephalus*); porpoises; dolphins; and killer whale (*Orcinus orca*). The blue whale (*Balaenoptera musculus*), considered endangered by IUCN, makes this region a migratory endpoint following its travels from Arctic and Alaskan feeding grounds, and humpback whales use this region for key mating, calving and nursery grounds. The largest rookeries for the California sea lion (*Zalophus californianus*) are in the Gulf. The Guadalupe fur seal (*Arctocephalus townsendi*), considered vulnerable according to the IUCN Red List and threatened under the US Endangered Species Act, inhabits the Gulf.

A regional planning study of this area coordinated by INE can be consulted at the Semarnat web site.[39] This study presents a review of the biodiversity and socio-economic issues in the coastal and marine region.

Although the Gulf of California has had a strong capacity for resilience—due in part to its coastal watersheds and the submarine topography that causes the upwelling of nutrients—factors such as fishing, water diversion, sedimentation and pollution have been altering the region's ecosystems. The decrease of fresh water input from the Colorado River has drastically changed the ecological conditions of what used to be an estuarine system, important for fish reproduction. It is now an area of high salinity. Many of the pollution problems in the region stem from agrochemicals and runoff from the Colorado River and watershed. Pesticides used in the agricultural areas of the Mexicali Valley, and Sonora and Sinaloa states also affect the quality of the ecosystem.

Fishing in the Gulf is of prime importance to neighboring communities and to Mexico in general. Some of the commercial fish species of the Gulf of California include shrimp, Gulf grouper (*Mycteroperca jordani*), sardine (*Sardinops sagax*), anchovy, squid, yellowfin tuna (*Thunnus albacares*), roosterfish (*Nematistius pectoralis*), wahoo (*Acanthocybium solandri*), dorado (*Coryphaena hippurus*), amberjack sailfish (*Istiophorus platypterus*), Indo-Pacific blue marlin (*Makaira mazara*) and striped marlin (*Tetrapturus audax*). There are abundant and healthy stocks of snappers, porgies and groupers. For many years, the use of hook-and-line gear was able to support a healthy fishery — one that depended on long lifespans and decades of egg production in an ecosystem subjected to relatively little fluctuation and environmental perturbation. As stocks declined, fishermen have moved to other gear. With higher rates of fishing mortality and the change of gear types to gill nets, trawls and longlines, a fairly rapid reduction in total standing stocks, changes in species dominance, and the loss of older age classes of larger fish have followed.

39. <http://www.semarnat.gob.mx/>

Exploitation is taking its toll on Gulf of California fishes. The totoaba fishery no longer exists, apex predators are at low population levels and stocks of highly migratory species (e.g., marlin, sailfish, tuna) are declining. Overfishing, the type of fish caught, bycatch mortality and the destruction of the bottom habitats all contribute to the situation. The continuing excessive mortality of the large pelagic predators and the shift in biomass dominance to planktivorous species could have substantial and possibly irreversible effects on the structure and function of the region, triggering a broad expansion of ctenophores, jellyfishes, squid and small pelagic fishes (e.g., sardines, anchovies).

The Baja California Peninsula is an area of sparse population and fishing villages. Until now, the only development-related problem has been that of urban waste. Urban development, in general, has not been a major threat to the region. However, the *Escalera Náutica*, or "Nautical Ladder" coastal development — a mega development project aimed at luring 1.6 million boat owners along the Baja California Peninsula — will increasingly be an issue for biodiversity conservation.[40] This grand system of harbors, wharves, hotels, restaurants, airports and airstrips would touch both coasts and the interior of the peninsula, as well as the coasts of Sonora and Sinaloa, and, depending on how development is implemented, could severely affect the region.

40. <http://laescaleranautica.com/>

PCA 24
Corredor Los Cabos/ Loreto

The Gulf coast from Corredor Los Cabos to Loreto consists of a series of lagoons and islands, ranging from Isla Carmen in the Gulf of California and the city of Loreto on the peninsula to Cabo San Lucas at the southern tip of Baja California. Depths off the coastline of this area are much greater than those along the Pacific coastline and elsewhere along the Gulf of California coast. Several seamounts, such as the Roca Montaña and Gorda seamounts, are found in this area. One of the most productive seamounts, Espíritu Santo, exceeds 890 meters (2,920 feet) in height. This area is also flanked by strong tidal currents and winds, as it serves as a dividing point between the Gulf of California and the larger Pacific Ocean.

Coastal species show high levels of endemism, and most are threatened by urban and tourism activities (León de la Luz *et al.* 2000). The northernmost tropical coral reef in the eastern Pacific—the only tropical coral reef in the B2B region—occurs at Cabo Pulmo. This is also one of the most diverse and endemic areas of the B2B region, supporting a number of species such as *Montipora fragosa*, a species of coral endemic to the area. Near the reef, large aggregations of reproductive fish are found. This area has some of the greatest reef-fish species richness in the Gulf of California (Sala *et al.* 2002). Several of the seamounts, such as Espíritu Santo and Gorda seamounts, attract large pelagic fishes such as striped marlin (*Tetrapturus audax*), black marlin (*Makaira indica*) and several species of shark, making it a favorite area for sportfishers. Many productive commercial fisheries for species such as anchovies and sardines also exist. During the 1990s, Mexican anchovy landings averaged 3,600 tonnes (7,936,640 pounds) per year (Bergen and Jacobson 2001) and sardines averaged 42,000 tonnes (9,259,410 pounds) per year (Wolf *et al.* 2001). Some fisheries, such as those for sharks and totoaba, are collapsing in the area because of overfishing.

Marine mammals, such as Bryde's whale, the resident bottlenose dolphin (*Tursiops truncatus*) and the California sea lion, can be found in this area. The area is also a breeding and calving destination for blue and gray whales following the summer feeding season in the Arctic, as well as a breeding area for humpack whales. A small colony of Guadalupe fur seals is found on Los Islotes. This is one of only three colonies of these fur seals that currently exist outside of Isla Guadalupe.

A large assortment of seabirds is found in the area, including blue-footed (*Sula nebouxii*) and brown (*S. leucogaster*) boobies, and Heermann's gull. This is a breeding ground for a number of species, including the brown pelican (*Pelecanus occidentalis*), which travels here from as far away as the Columbia River at the Washington/Oregon border. The olive ridley turtle nests in the area. Leatherback sea turtles occasionally do so as well, but the population is so critically endangered that it is on the verge of extinction. This is partly due to mortality caused by encountering such fishery practices as longlining and gill netting during their cross-ocean migrations, the longest of any marine turtle in the world (Spotila *et al.* 2000). Loggerhead turtles feed in the area.

The reef, as well as the high diversity of cetaceans, sharks and marine turtles in the area have helped the tourist industry to flourish. Over-exploitation of renewable resources and damaging recreational uses, including sportfishing and tourism, continue to rise. The natural beauty of the area draws tourists, but sustainable business practices and local support for conservation have yet to take a strong hold.

Federal and International Designations

- Cabo Pulmo National Park
- Cabo San Lucas Flora and Fauna Protection Area
- Islas del Golfo de California Flora and Fauna Protection Area, MAB Biosphere Reserve
- Bahía de Loreto National Park, Wetland of International Importance, Ramsar Convention

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: Guadalupe fur seal, blue whale, humpback whale, gray whale
- sea turtles: green, leatherback, loggerhead

Continental Uniqueness:

- one of highest diversity and endemic areas of B2B
- productive seamounts
- dividing point between Pacific Ocean and the Gulf of California
- northernmost coral reef in the eastern Pacific and only coral reef in B2B region
- one of four colonies of Guadalupe fur seals exists on Los Islotes

Ecological Linkages:

- important site for sportfishing and tourism
- breeding and calving destination for migratory blue, gray and humpback whales
- nesting of several sea turtle species occurs here

Blue shark (*Prionace glauca*)
and offshore drift kelp
Photo: Phillip Colla, OceanLight.com

PCA 25
Alto Golfo de California

The Upper Gulf of California is a unique oceanographic area. This area has some of the largest tides to be found anywhere in the world, with vertical displacement of as much as six to nine meters (20 to 30 feet), while the total depth of the region only reaches approximately 200 meters (650 feet). Sea surface temperatures vary greatly due to seasonal changes, and the waters are highly saline, especially along the shallower coastlines where evaporation rates are high. It is near the mouth of the Colorado River, where hypersaline water from the tidal flats in the region meets the cooler, less saline water from the south. The area is considered an inverse estuary because evaporation exceeds input from precipitation and because of the minimal input of freshwater from the Colorado River.

Coastal strand species are dominated by *Atriplex* and *Ambrosia* species, and the endemic pickleweed (*Suaeda puertopenascoa*) is known only from estuaries in Sonora (Felger 2000). Due to trenches and basins nearby, this area experiences intense upwelling, along with strong tidal mixing, which creates one of the most productive areas in the Gulf of California. Commercial fishing, such as shrimp trawling and hand diving for blue crab (*Callinectes bellicosus*), is practiced here. This area is characterized by endemic species, among them 22 endemic fish species, including the critically endangered totoaba.

A wide variety of seabirds, such as brown booby, black skimmer (*Rynchops niger*) and occasionally Heermann's gull, nest on the islands in the area. Isla Montegue is one of only five known breeding sites for elegant tern (*Sterna elegans*). The green sea turtle uses the resources in this area for feeding, and juvenile loggerheads are also occasionally seen in these waters following possible migratory paths from as far away as Japan.

The only marine mammal endemic to the Gulf of California is the vaquita, a small porpoise. A recent estimate suggests fewer than 600 individuals remain in the population, restricted to a small area of the upper Gulf north of Puertecitos (30°45'N) (Jaramillo-Legorreta *et al.* 1999). Eight other marine mammals are found in this region, including the fin whale, bottlenose dolphin and California sea lion.

Despite some local support, funding and available information for management and conservation, destructive coastal land use continues to rise, and conflicts between fisheries and conservation still exist. This is especially true regarding commercial fishing in areas with vaquita. The limited freshwater input from the Colorado River due to high usage upstream by the United States is a major threat to ecosystem stability.

Federal and International Designations

- Alto Golfo de California y Delta del Rió Colorado Biosphere Reserve, MAB UNESCO
- Humedales del Delta del Río Colorado, Wetland of International Importance, Ramsar Convention
- El Pinacate y Gran Desierto de Altar Biosphere Reserve, MAB UNESCO

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: vaquita, humpback whale
- sea turtles: green, loggerhead

Continental Uniqueness:

- unique oceanographic area, including the presence of an inverse estuary
- Isla Montegue is one of only five known breeding sites for elegant terns
- more than 20 endemic fish species
- home to the only endemic marine mammal in the B2B region and one of the most endangered marine mammals in the world, the vaquita
- endangered fish, the endemic totoaba found in this area

Oceanographic Uniqueness:

- one of the highest areas of primary productivity in the Gulf of California

Four dead **vaquita** on beach
Alto Golfo de California
Photo: A. Robles

PCA 26
Grandes Islas del Golfo de California/ Bahía de Los Ángeles

This region, called "the Galapagos of Mexico" by John Steinbeck in *The Sea of Cortez*, is located in the north-central portion of the Gulf of California. It is composed of the large island group in the center Gulf, frequently referred to as the Midriff Islands, and Bahía de Los Ángeles, along the eastern coast of the Baja California Peninsula. Bahía de Los Ángeles is comprised of hills and mudflats, while the Midriff Islands are lined with rocky reefs. Most of the islands were formed when they broke off from the peninsula early in its history, although some, such as Isla Partida, are volcanic.

Trenches and basins line the ocean floor in this area. The two basins along Isla Ángel de la Guarda and Isla San Lorenzo are 1,650 and 800 meters (5,410 and 2,620 feet) deep, respectively. Upwelling results from these deep pockets in the seafloor, such as the trench that runs from Isla Pelicano in the upper reaches of the Gulf of California to the north end of Wagner Basin in the Midriff Islands. This upwelling results in rich nutrient inputs. Strong tidal currents and winds are also present, resulting in increased productivity. Bahía de Los Ángeles experiences coastal currents and that, along with its shape, makes it a coastal retention zone. The area as a whole is extremely productive of biomass and contains a high degree of biological diversity and endemism.

Fish spawning aggregations and the high abundance of pelagic fishes, such as sardines and anchovies, which together represent thousands of tonnes of Mexico's annual fish catch, are just two of the reasons for the successful fisheries here.

Craveri's murrelet (*Endomychura craveri*), which is endemic to Mexico and listed as vulnerable on the IUCN Red List, nests on Isla San Esteban and Isla Tiburón, among others. Isla Rasa is home to 90 percent of the world's Heermann's gull breeding population (approximately 150,000 pairs) and up to 95 percent of the world's elegant tern breeding population (approximately 30,000 pairs) (BirdLife International 2000). More than 50 species of birds, including the brown pelican from as far north as the Columbia River in the United States, can be found in this area.

The bays and area surrounding the islands are also important feeding and overwintering grounds for marine turtles that spend part of the year in the Gulf (green, loggerhead and olive ridley). Whale sharks can be found in Bahía de Los Ángeles.

A unique biotic association of marine mammals occurs in this area, including the blue whale, the common dolphin (*Tursiops truncatus*), which forages in the area, and a large sea lion rookery on the Baja California Sur mainland, just west of Isla Ángel de la Guarda.

Along the mainland, resource over-exploitation, coastal alteration and pollution, and damaging recreational use are minimal but on the rise, while on Las Grandes Islas del Golfo de California, these threats are expected to remain low. A management plan for the Biosphere Reserve is available that discusses the biodiversity and threats to the area (Conanp 2003).

Federal and International Designations

- Islas del Golfo de California Flora and Fauna Protection Areas, MAB Biosphere Reserve
- Isla Tiburón Natural Reserve and Wildlife Refuge
- Isla Rasa Natural Reserve and Bird Refuge
- Valle de los Cirios Flora and Fauna Protection Area
- Isla San Pedro Mártir Biosphere Reserve, Wetland of International Importance, Ramsar Convention

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: blue whale
- sea turtles: green, loggerhead

Continental Uniqueness:

- home to 90 percent of world's breeding Heermann's gulls and 95 percent of world's breeding elegant terns
- region of high endemism and biodiversity
- unique biotic association of marine mammals

Ecological linkages:

- abundance of pelagic fish
- more than 50 species of birds found in this area
- important area for sea turtles
- abundance of whale sharks occupy this region for up to six months of the year
- trenches and basins result in intense upwelling

Whale shark (*Rhincodon typus*)
Photo: Phillip Colla, OceanLight.com

PCA 27
Humedales de Sonora, Sinaloa y Nayarit/ Bahía de Banderas

This area, the wetlands (humedales) along the coasts of Sonora, Sinaloa, Nayarit and Jalisco, incorporates the remnants of some of the most important wetlands along Mexico's entire coastline, including the Marismas Nacionales, a Ramsar Convention-designated wetland.[41] These wetlands provide valuable ecosystem functions, including stabilizing the coasts, capturing sediments, fixing nutrients and recharging aquifers. Altata-Ensenada Pabellion, Piuaxtla-Huiza, Marismas Nacionales and Bahía Banderas are four of the largest mangrove systems in the B2B region, and Altata-Ensenada Pabellion, as well as Bahía Santa María, incorporate coastal lagoons that stretch into tidal flats and mangrove forests. Bahía de Banderas contains a great diversity of habitat and its coast, like that of Piuaxtla-Huiza, are lined with rocky and sandy beaches. Situated between the Mayo and Fuerte Rivers, Agiabampo's coast is lined with mangroves. The high productivity of such wetlands results in biomass exportation that feeds all of the Gulf of California and results in this area being an important nursery, feeding and breeding site for numerous commercial fish species, such as sardines, and for invertebrates. Shrimp aquaculture is well developed, resulting in both economic livelihoods and environmental threats to the area.

The Marismas Nacionales and the adjacent beaches of this region are nesting sites for sea turtles such as the green and olive ridley. The freshwater marsh regions of the Marismas Nacionales are also home to several crocodile species. The wetlands of this area provide a vital feeding and breeding corridor for an abundance of migratory seabirds and waterfowl, such as black brant, roseate spoonbill (*Ajaia ajaja*), American oystercatcher (*Haematopus palliatus*) and snowy plover (*Charadrius alexandrinus*). At least 30 percent of the Pacific Flyway shorebirds that breed in Alaska, western Canada and the United States overwinter along the Sinaloa coast. The mangroves of Nayarit and Sinaloa contain high concentrations of migratory birds, and the Sonoran coastline harbors more than 120 bird species, of which 73 percent are aquatic.[42]

Bahía de Banderas and Bahía Santa María are the destinations for the long distance migrations of various whale species, after their journeys from northern feeding grounds. Bahía de Banderas is a site of humpback whale breeding, and Bahía Santa María is a gray whale nursery and breeding ground.

Pollution, exploitation and degrading land use, such as the destruction of wetlands for shrimp farming, are on the rise in this area.

41. <http://www.wetlands.org/RSDB/default.htm>
42. <http://www.iucn.org/bookstore/bulletin/1999/wc2/content/communities.pdf>

Federal and International Designations

- Meseta de Cacaxtla Flora and Fauna Protection Area
- Playa Ceuta Sanctuary (Sea Turtle)
- El Verde Camacho Sanctuary (Sea Turtle), Wetland of International Importance, Ramsar Convention
- Marismas Nacionales Wetland of International Importance, Ramsar Convention
- Laguna Playa Colorada – Santa María La Reforma Wetland of International Importance, Ramsar Convention
- Isla Isabel National Park, Wetland of International Importance, Ramsar Convention
- Islas Marietas National Park, Wetland of International Importance, Ramsar Convention
- Arcos de Vallarta Refuge for Marine Flora and Fauna Protection

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: humpback whale, gray whale
- sea turtles: green

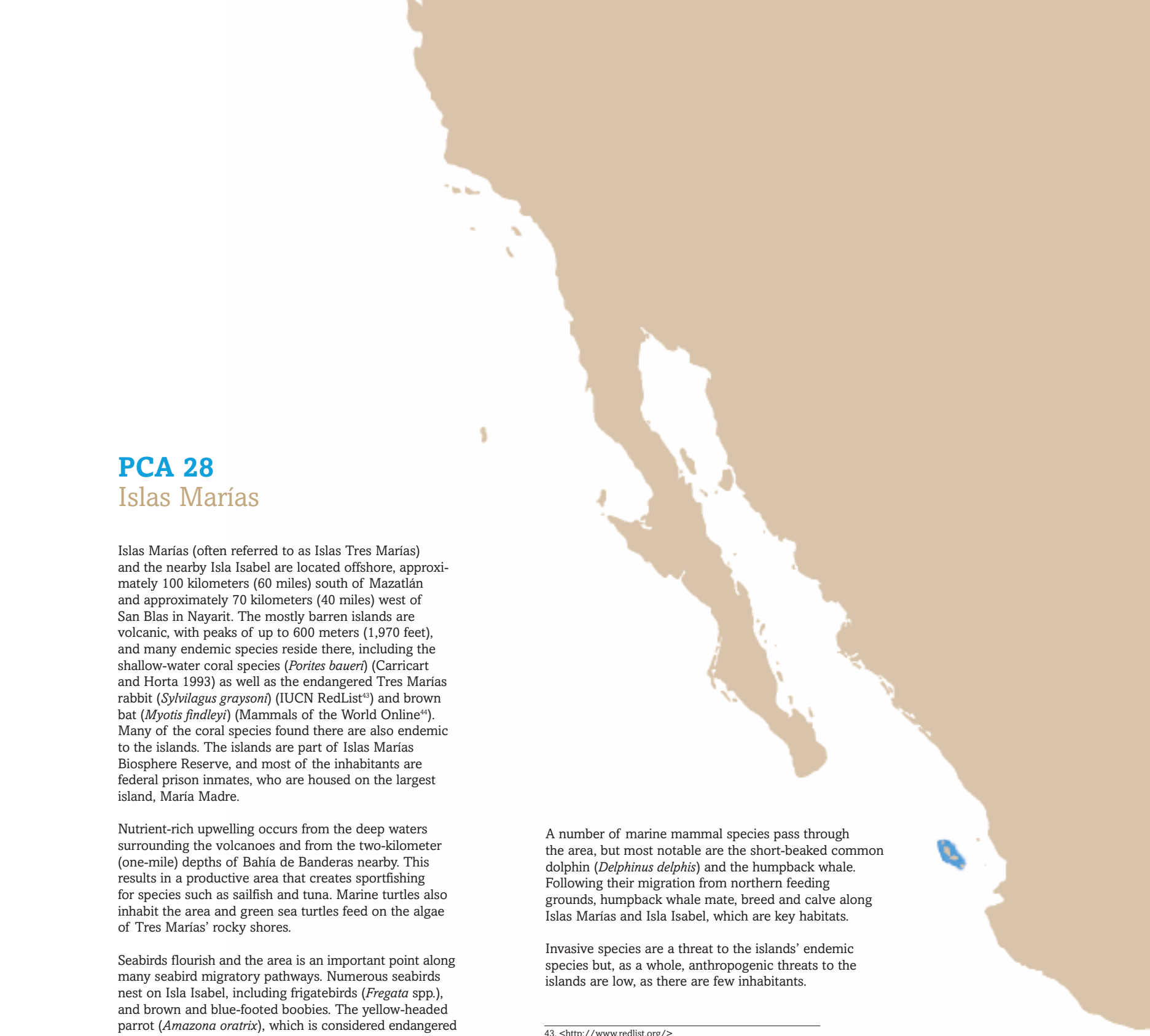
Continental Uniqueness:

- includes some of the largest mangrove expanses in the B2B region

Ecological Linkages:

- remainder of most important wetland habitats in Mexico
- vital feeding and breeding corridor for abundance of migratory seabirds and waterfowl

Green sea turtle (*Chelonia mydas*)
Photo: Phillip Colla, OceanLight.com



PCA 28
Islas Marías

Islas Marías (often referred to as Islas Tres Marías) and the nearby Isla Isabel are located offshore, approximately 100 kilometers (60 miles) south of Mazatlán and approximately 70 kilometers (40 miles) west of San Blas in Nayarit. The mostly barren islands are volcanic, with peaks of up to 600 meters (1,970 feet), and many endemic species reside there, including the shallow-water coral species (*Porites baueri*) (Carricart and Horta 1993) as well as the endangered Tres Marías rabbit (*Sylvilagus graysoni*) (IUCN RedList[43]) and brown bat (*Myotis findleyi*) (Mammals of the World Online[44]). Many of the coral species found there are also endemic to the islands. The islands are part of Islas Marías Biosphere Reserve, and most of the inhabitants are federal prison inmates, who are housed on the largest island, María Madre.

Nutrient-rich upwelling occurs from the deep waters surrounding the volcanoes and from the two-kilometer (one-mile) depths of Bahía de Banderas nearby. This results in a productive area that creates sportfishing for species such as sailfish and tuna. Marine turtles also inhabit the area and green sea turtles feed on the algae of Tres Marías' rocky shores.

Seabirds flourish and the area is an important point along many seabird migratory pathways. Numerous seabirds nest on Isla Isabel, including frigatebirds (*Fregata* spp.), and brown and blue-footed boobies. The yellow-headed parrot (*Amazona oratrix*), which is considered endangered by IUCN, also inhabits the islands.

A number of marine mammal species pass through the area, but most notable are the short-beaked common dolphin (*Delphinus delphis*) and the humpback whale. Following their migration from northern feeding grounds, humpback whale mate, breed and calve along Islas Marías and Isla Isabel, which are key habitats.

Invasive species are a threat to the islands' endemic species but, as a whole, anthropogenic threats to the islands are low, as there are few inhabitants.

43. <http://www.redlist.org/>
44. <http://www.press.jhu.edu/books/title_pages/2993.html>

Federal and International Designations

- Islas Marías Biosphere Reserve, MAB UNESCO

Summary of Expert Selection Criteria

Important to MSCCC:

- marine mammals: humpback whale
- sea turtles: green, leatherback

Continental Uniqueness:

- second-largest nesting population of magnificent frigatebirds in the world
- high endemism

Ecological Linkages:

- key breeding and calving habitat for humpback whales
- large concentrations of nesting seabirds

North Pacific humpback whale (*Megaptera novaeangliae*), cow and calf
Photo: Phillip Colla, OceanLight.com

Conclusion

Discussion and Future

The 28 priority conservation areas identified in this report are those which marine experts consider essential to safeguarding the biological diversity of the Baja California to Bering Sea region of North America. These sites encompass unique areas (e.g., Patton Seamount complex, sponge reefs of Hecate Strait, and the upper Gulf of California, home to the only marine mammal endemic to North America, the vaquita), areas especially important as locations along migratory corridors (e.g., Unimak Pass, Channel Islands, Laguna San Ignacio) and areas particularly rich in biological diversity (e.g., Aleutian Archipelago, Queen Charlotte Strait, Monterey Bay, Corredor los Cabos). PCAs vary significantly in the degree to which they are threatened and in their protection status, but they represent a vision shared by experts on places critical for conserving North America's biological diversity.

The CEC, through convening and coordinating NAMPAN, is developing capacity for a network of MPAs to span the jurisdictions of the three CEC member countries. The aim of NAMPAN is to enhance and strengthen the conservation of biodiversity in critical marine habitats throughout North America by creating a functional system of ecologically based MPA networks that cross political borders and depend on broad cooperation. The identification of these PCAs is not intended as the MPA network design, but is rather a portfolio of continentally significant sites that can serve as nodes around which a network of reserves can be built. Networks of reserves are important tools for conserving biological diversity (Lubchenco *et al.* 2003) and these PCAs should be viewed as places to begin building a more comprehensive, effective MPA network for North America. Although these PCAs are science-based and anchored in a continental perspective, they are not intended to be a marine reserve network design as envisioned by others (e.g., Margules and Pressey 2000, Possingham *et al.* 2000). Rather, the workshop organizers and participants clearly intend this report to be a first step towards a continental conservation strategy for B2B species and ecosystems. We hope that these priority areas for conservation will be used in formulating MPA networks based on broad input from all interested sectors.

PCAs are particularly important to the functioning of the entire region — and are the logical level below the network in a hierarchical system. Unlike single-species conservation plans that have failed to maintain and recover a large number of populations, PCAs identify unique and diverse communities that are known to be important to the survival of migratory and wide-ranging species. Some are critical spawning aggregation areas, migratory bottlenecks, or breeding or feeding grounds. Some provide key ecosystem services in areas such as coral reefs or kelp forests that help protect adjacent sandy beaches or rocky coasts from wave action, estuaries that provide nutrients to more offshore sites, and marshes that help to purify water from land-based sources.

Many important species of the B2B region migrate to other regions: short-tailed albatross nest in Japan, humpback whales calve in the waters near Hawaii and Central America, while shearwaters spend the winters in the waters of Chile. As our experts noted, the Beaufort Sea is a logical extension of the B2B region because of its significant numbers of migrating sea and shore birds.

Landscape ecology provides a new conceptual basis for continental conservation plans. Species occurring in one locality can have major significance far beyond that region. Most conservation efforts have reflected a focus on individual populations, often protecting small areas that can safeguard only a small portion of the total population (Soulé *et al.* 2003). But outside small, isolated reserves, contamination and fragmentation of ecosystems and the death of individuals occur daily. Thus, we should look to maintain ecological processes across the entire seascape.

Clearly, protecting individual areas or even networks of areas is not enough. Effective management requires effective ways of addressing the impact of human activities occurring outside protected areas. This is true not only because most of the areas identified in this report will be too small to maintain populations, but also because they are divided by human activities such as fishing, maritime transportation corridors, oil wells and coastal development. Even if all of these 28 PCAs become bases for networks of marine reserves, scientific research and monitoring will be needed to determine the degree to which they are maintaining the populations and ecological processes of the B2B region, and adaptive management will be necessary.

While it is important to look to continental-scale efforts, we must recognize, as do Soulé and Terborgh (1999), that "not every conservation goal can be — or should be — addressed at the regional or continental scale. The challenges at the local level are profound and important, and must not be neglected." Local efforts are essential complements to continental-scale efforts at conservation, as embodied in these PCAs. Many excellent transnational, national, regional and local efforts are underway across the B2B region. It is promising to note that this present analysis is consistent with many previous analyses and priority-setting exercises. These include The Nature Conservancy's Marine Ecoregional Planning, World Wildlife Fund's Beringia Ecoregion efforts, National Wildlife Federation's Prince William Sound Plan, Canadian Parks and Wilderness Society's plans for British Columbia, Living Ocean Society's Science-Based Conservation Hotspots of the South Central Coast of British Columbia, The Canadian Government's Coastal Information Team, US National Marine Sanctuary Program, Conabio in Mexico, WWF-Mexico and Conservation International's plans for Gulf of California, the *Ordenamiento Ecológico de la Región del Mar de Cortes y Litoral del Pacífico*, and science reports such as Ardron *et al.* (2002), Sala *et al.* (2002), Sullivan-Sealey and Bustamante (1999), Enríquez-Andrade *et al.* (submitted). These efforts display a generally high level of consistency with the areas highlighted in this report, despite different geographical scopes and methodologies used by these diverse agencies and nongovernmental organizations. This is true for Mexico, where the Gulf of California Midriff region, the coast of Sinaloa, the Gulf coast of Baja California Sur and Magdalena Bay on the Pacific Coast are all consistently identified. It is also true of British Columbia, where the Scott Islands, Queen Charlotte Strait and the Hecate Strait Sponge Reef regions are consistently highlighted.

PCAs within the B2B region vary considerably along multiple axes of threat, opportunity, fragility, resilience and present condition. For example, coastal development pressure in southern California is probably the most intensive in the B2B region, but nearly all areas are experiencing growing pressures. Identifying conservation targets requires knowledge of the ecological integrity of a site at present, but is helped greatly if there is a historical baseline that provides a clear target for conservation efforts. Managers and conservationists need to realize that each location has had its own distinctive trajectory, which affects formulation of conservation objectives. Thus, a PCA such as the Queen Charlotte Islands may be sufficiently intact to provide habitat for sea otters and afford opportunities for sustainable fisheries, while San Diego Bay, which once abounded with green sea turtles and gray whales, appears unlikely to see their return. Management goals for these PCAs should reflect local and regional capacity to safeguard the area's biological diversity and integrity, and local demands for goods and services.

It is important to recognize the differences in the human aspects of the conservation landscape between the three CEC countries. Conservation in a region with three different countries and many different cultures makes even seemingly simple tasks complex. Who will bear the cost of conservation is an important question. In areas where communities are reliant on subsistence fisheries and coastal resources, conservation may seem a luxury. Most decision makers, excepting a very few governmental ministries and agencies, consider protected areas (i.e., reserves) primarily as a loss of income. Fishermen and others dependent on local coastal resources often see few short-term economic benefits to conservation activities. If wealthy users do not pay the costs of using the ecosystem goods and services, conservation will be seen as a luxury forever, even as local and subsistence economies find their own situation worsening due to environmental degradation.

The cost of conservation remains as much an energy question as a population question. There is often a large disconnect between developed and urban areas, and the less developed and rural areas. Developed regions need to assume that most of the exploitation of natural resources and, thus, ecosystem degradation occurs because of their own continuing energy and food needs. Management plans should seek to increase practices for sustainable and renewable natural resources in addition to placing conservation demands on resource extractors as one option to bridge this disconnect.

Throughout the B2B region, protecting biological diversity is one economically and socially important activity among others, including tourism, aquaculture, fishing and recreation, that depend on a healthy environment. Thus, a move toward integrated coastal zone management is critically needed. Policymakers and managers need to move away from a sector-by-sector approach to managing marine resources and toward an integrated, total ecosystem-based strategy for managing coastal development, fishing, aquaculture and other activities affecting marine biodiversity. Such an approach is necessary to balance conservation needs with the economic and social demands of people living within coastal zones and areas adjacent to marine habitats. For this reason, identifying these PCAs, and other national and continent-wide efforts are key elements in the environmental planning process of North America.

In the future, the B2B vision needs to be supported by studies that address not only the prospects for success in each of the regions, but also the discrepancies between the three countries in conservation needs. Planning should incorporate proposals for both use and no use, including different intensities of use. One way to address conservation while maintaining multiple uses is through comprehensive ocean zoning. Comprehensive zoning can alleviate conflicts in areas with high conservation value that also have high socioeconomic importance due to the flow of ecological goods and services. Conservation strategies in PCAs will be challenging because many, by definition, include areas with high anthropogenic pressure, and thus any strategy proposed must not only maintain biodiversity but also assure a sustainable economy.

Finally, there is a need for the human communities of the B2B region to stay connected and to embrace a common vision of our North American ocean heritage. It is the work of the many institutions within the B2B region to coordinate their efforts, such as in the NAMPAN initiative, and work towards implementation of conservation strategies and a network of marine protected areas, including marine reserves. This portfolio of priority conservation areas should be a first step towards building this community, and this effort points to the need for the CEC or another trinational forum, such as the Baja California to Bering Sea Marine Conservation Initiative, to foster the development of cooperation and stewardship of the B2B region.

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Appendices

Appendix 1.
Scale of Appropriate Physiographic and Oceanographic Features

Local 1–10 km²	**Biogenic Habitats**	Coral and sponge reefs, kelp forests, mangroves, sea grass beds
	Physiographic Features	Habitats: mudflats, banks, sandy beaches, hydrothermal vents, pinnacles, salt marshes, shoals, sills, tidal flats, rocky reefs, rocky shores, estuaries
	Oceanographic Features	Turbulence (island wakes, headland eddies), internal waves, estuarine circulation, tides, tidal races, river plumes, cold seeps, tidal fronts
	Population Phenomena	Patch, larval dispersal, home range, nesting sites, rookeries, haulouts, feeding areas, spawning aggregations
Subregional 10–100 km²	**Biogenic Habitats**	Kelp forests, mangroves, coral reefs
	Physiographic Features	Anoxic basins, banks, basins, bays, calderas, canyons, escarpments, estuaries, fans, seamounts, hills, headlands, ridges, terraces, troughs, valleys
	Oceanographic Features	Turbulence (island wakes, headland eddies), Taylor columns, estuarine circulation, tides, river plumes, coastal currents, internal waves, upwelling jets, coastal retention zones, fronts
	Population Phenomena	Metapopulations, larval dispersal, home range, feeding areas
Regional 100–1,000 km²	**Physiographic Features**	Island archipelagos, seamount chains, trench
	Oceanographic Features	Mesoscale circulation fronts, eddies, plumes
	Population Phenomenon	Regional population, species range, migration routes, larval dispersal
Continental 1,000–10,000 km²	**Physiographic Features**	Abyssal plain, shelf break, continental shelf
	Oceanographic Features	Ocean gyres, major currents, ocean basin circulation
	Population Phenomena	Zoogeographic province, species range, migration routes

Experts at the B2B PCA Workshop were asked to identify subregional and regional features appropriate to continental planning, i.e., those on the order of 10–1,000 square kilometers.

Appendix 2.
Marine Species of Common Conservation Concern List

Common Name	Scientific Name
leatherback turtle	*Dermochelys coriacea*
hawksbill turtle	*Eretmochelys imbricata*
Kemp's ridley turtle	*Lepidochelys kempii*
East Pacific green turtle (black)	*Chelonia mydas agassizii*
loggerhead turtle	*Caretta caretta*
right whale	*Eubalaena glacialis and E. japonica*
gray whale	*Eschrichtius robustus*
humpback whale	*Megaptera novaeangliae*
killer whale	*Orcinus orca*
blue whale	*Balaenoptera musculus*
Guadalupe fur seal	*Arctocephalus townsendi*
sea otter	*Enhydra lutris*
vaquita	*Phocoena sinus*
pink-footed shearwater	*Puffinus creatopus*
short-tailed albatross	*Phoebastria albatrus*
Xantus' murrelet	*Synthlibiramphus hypoleucus*

Appendix 3.
B2B CD-ROM Data Sets

Information relevant to the establishment of PCAs in the B2B region was classified into one of three categories: physical, biological or social. These data are available on CD-ROM from MCBI at <www.mcbi.org>.

Physical Data
Surface Currents
Sea Surface Temperature
ETOPO2 Bathymetry
Seamounts
World Vector Shoreline
GTOPO30 topography

Biological Data
Chlorophyll
Mammals
Turtles
Deep Sea Corals

Social Data
Ports and Harbors
MPAs
EEZ
Local priorities
Population
Mapgrid

Folder Contents and Descriptions

Phy	Physical data
altimetry	Surface currents derived from sea surface height

CCAR: These data are a blended product of ERS-2 and TOPEX/Poseidon altimetry from the Colorado Center for Atmospheric Research. The data are presented as biweekly averaged magnitude (raster) and direction (point file) for the years 1996–1999 at 0.25 degree resolution. The zipped files are in geographic projection. This data set was custom made for MCBI and B2B, but real time Bering Sea altimetry and CCAR contact information can be found at <http://www-ccar.colorado.edu/~realtime/bering/>.

NLOM: The 1/16 degree US Navy Layered Ocean Model is a six-layer global reduced gravity thermodynamic "deep water" model that uses the 200-meter isobath as the land-sea boundary. Enclosed here is Postscript output of the first layer of the model, which averages about 70 meters. NASA's Jet Propulsion Laboratory produced a special web site with daily output for the B2B region. These .ps files are for reference only and may be viewed using the Ghostview utility available at <http://www.cs.wisc.edu/~ghost/>. NLOM output is available at: <http://www7320.nrlssc.navy.mil/global_nlom/globalnlom/b2b.html>.

JODC: The Japanese Oceanographic Data Center keeps a unique data set of ship-based measurements of surface current direction and velocity in a global one-degree mesh. Cells in this grid include information on 50 years of averaged velocity and direction, as well as the number of measurements which contributed to that average. The .gif files are for reference only, to enhance understanding of long-term average circulation patterns. To access the original data: see <http://www.jodc.go.jp/aboutJODC_work_data.html>.

avhrr Sea surface temperature — advanced very high resolution radar

These data are from the US Navy Jet Propulsion Laboratory (JPL) Physical Oceanography Distributed Active Archive Center (PO.DAAC). Enclosed in this folder are monthly mean day and night SST value rasters and contours in degrees centigrade for the years 1996–1999 at nine-kilometer resolution. Years 1996–1998 are compressed .zip files. Winzip, a decompression utility, is available at <www.winzip.com>. These data were downloaded from <http://seablade.jpl.nasa.gov/gui/>.

bathy ETOPO2 satellite derived bathymetry

These data were derived from satellite altimetry observations combined with carefully, quality-assured shipboard echo-sounding measurements by Dr. Walter H.F. Smith of the NOAA Laboratory for Satellite Altimetry and Dr. David T. Sandwell of the Institute of Geophysics and Planetary Physics at the University of California, San Diego. The data presented here are from the entire northeast Pacific (0 to 72N, -90 to -180 W) as a two-minute resolution grid with 100-meter contours.

For reference on generation of these data, consult: W.H.F. Smith and D.T. Sandwell. 1997. Global Sea Floor Topography from Satellite Altimetry and Ship Depth Soundings. Science 277(5334). The information can be downloaded at: <http://topex.ucsd.edu/cgi-bin/get_data.cgi>.

hydro1k US Geological Survey streams and watershed boundaries for North America

HYDRO1k, developed at the US Geological Survey's (USGS) EROS Data Center, is a geographic database providing comprehensive and consistent global coverage of topographically derived data sets. See <http://edcdaac.usgs.gov/gtopo30/hydro/>.

seamounts Seamount names and coordinates

These data were assembled from the various sources, including the General Bathymetric Chart of the Oceans (Gebco) Digital Atlas, the Scripps Institution of Oceanography Atlas of the North Pacific, and the NOAA Office of Ocean Exploration Gulf of Alaska Seamount expedition. This data coverage is a point file of peak coordinates, feature name and minimum depth by source. This information is not online, but the Gebco CD-ROM may be ordered from <http://www.bodc.ac.uk/>

wvs World Vector Shoreline

WVS is a digital 1:250,000 scale NIMA (National Imagery and Mapping Agency) product in ASCII-coded Standard Linear Format (SLF) that has been in existence since the late 1980s. It contains shorelines derived from Digital Landmass Blanking (DLMB) data and supplemented by Operational Navigation Charts (ONCs) and Tactical Pilotage Charts (TPCs). This North American WVS came from the NGDC ETOPO2 CD-ROM, available at <http://www.ngdc.noaa.gov/mgg/fliers/01mgg04.html>

Bio Biological Data

Chl_a Seawifs

The purpose of the sea-viewing wide field-of-view sensor (Seawifs) Project is to provide quantitative data on global ocean bio-optical properties to the earth science community. The grids presented here are derived from monthly nine-kilometer Level 3 Standard Mapped Images of global chlorophyll concentration in mg/m3. Seawifs was launched in April 1997, and we present the earliest retrievable ocean color data from that year through the year 1999. File name convention is based upon Julian date. The information is available for registered users online at <http://seawifs.gsfc.nasa.gov/cgi/level3.pl>.

DSC Deep Sea Corals

The US National Marine Fisheries Service has declared several families of deep sea corals and octocorals to be essential fish habitat under the Magnuson Stevens Act of 1996. US Congress defined essential fish habitat for federally managed fish species as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 USC 1802(10)). The families included here have been identified by experts at the Smithsonian Institution as "habitat forming." The records included here are a compilation of records from the Smithsonian, California Academy of Science, NMFS Racebase, Scripps Institution of Oceanography, Monterey Bay Aquarium Research Institute, REEF Foundation, NOAA Office of Ocean Exploration and Santa Barbara Museum of Natural History.

Mammals Blue whale tracks from Bruce Mate and Tom Follett at Oregon State University

Professor Bruce Mate is best known for tracking whales via radio signals beamed off satellites by lightweight radio transmitters he attaches to the animals' backs. From his laboratory at the Hatfield Marine Science Center, Dr. Mate has tracked the movements of bowhead whales, manatees, gray whales, blue whales, humpback whales, right whales, bottlenose dolphins and pilot whales. The radio tags are designed to relay information on dive duration, water temperature, and dive depth and location. This information is used to determine critical habitats for feeding, calving, breeding and migration. Enclosed in this CD-ROM are blue whale tracks from 1997 to the present.

Turtles Tracks and distribution

Loggerhead turtle tracks from Evan Howell at Jeff Polovina's NOAA Fisheries Southwest laboratory in Hawaii. Jeff has been combining satellite tagged loggerhead turtle migration tracks with physical oceanography data in the north Pacific with some exciting results that seem to indicate an affinity for temperature fronts in the northeastern Pacific at 17° and 21° Celsius.

CI/WWF Habitat information for Baja from the Coalicion para la Sustenabilidad del Golfo de California.

Soc Social data

EEZ Exclusive economic zones

Polygon files of the West Coast EEZs of the three countries party to the North American Free Trade Agreement (NAFTA).

This particular information was not derived from online resources.

mapgrid B2B extent

A polygon grid of 10-degree by 10° cells that covers the B2B extent, 12°N to 72°N and -90°E to -180°E. This grid was developed to provide convenient subsets to global data sets such as ETOPO2.

MPA Marine protected areas

Canada

For Canada and the Province of British Columbia, Provincial Parks, Ecological Reserves, Wildlife Areas, Wildlife Management Areas, National Park Reserves, Conservation Study Areas, and Migratory Bird Sanctuaries were all considered MPAs. This information was derived from The Canadian Conservation Areas database: <http://geogratis.cgdi.gc.ca/frames.html>.

Mexico

For Mexico, the National Marine Protected Area strategy is well documented and the projected shapefile is provided to us by WWF-Mexico. This information should soon be available online.

United States

For the United States, National Marine Sanctuaries, NOAA Fisheries Managed Areas, National Estuarine Research Reserves, National Wildlife Refuges, and National Park Service sites (national parks, historic parks, seashores, lakeshores (Great Lakes), historic, and ecological preserves are all under consideration for inclusion in the US Government's Inventory of Marine Protected Areas). None of these boundaries are to be used for legal purposes. Please see the data provider or agency for caveats to the data. More information can be found regarding the inventory effort at: <http://www.mpa.gov/>.

The National Marine Sanctuaries Boundaries at <http://www.sanctuaries.nos.noaa.gov/>, and National Estuary Program at <http://www.epa.gov/owow/estuaries/> boundaries are NOT official. These boundaries and datafiles were part and parcel of the Pacific States Marine Fisheries Commission report "Marine Protected Areas of Washington, Oregon and California," compiled by Al J. Didier, Jr., December 1998. This report is included as <psmfc_designations.pdf> on this CD-ROM.

The National Park Service sites are available for download at: <http://www.nps.gov/gis/national_data.htm?>.

The National Wildlife Refuge sites are available for download from the region 1 office at: <http://www.fws.gov/data/datafws.html>.

NOAA Fisheries sites were created using the US Code of Federal Regulations and NOAA charts by Dave Canny, and were edited by Julia Brownlee.

National Estuarine Research Reserve boundaries are available for download at <http://www.csc.noaa.gov/pagis/html/download.htm>.

pop Population

Derived from ESRI standard global data sets and national censuses.

ports Ports and harbors

These point data sets of ports and harbors for the west coast of the United States, Canada and Mexico are derived from several resources. Canada and Mexico apparently have not documented these resources or, if they have, this information was not publicly available at the time of the CD printing.

US Ports and Harbors are derived from the Pacific Fisheries Information Network (Pacfin), which provides timely and accurate data essential for effective fisheries management. The nation's first regional fisheries data network, Pacfin provides information enabling agencies and industries to track commercial fish catches by area, and to manage and plan more effectively. This point data set includes fields for total number of permits, total number of registered vessels, number of trips and number of trawlers by port. To be defined as a port or harbor, in general, some fishing activity had to be documented for that port or harbor.

Pacfin is a project of the Pacific States Marine Fisheries Commission, online at <http://www.psmfc.org/pacfin>.

Canadian ports and harbors were developed by Jeff Ardron of the Living Oceans Society. Some of this information came from <http://www.shipnet.com>.

Mexican ports and harbors were derived from a document titled "Proyecto Escalera Náutica del Mar de Cortes" by the Fondo Nacional de Formento al Turismo (Fonatur) of Mexico. This data layer includes existing and proposed ports and harbors.

Priority Institutional priorities

Priority-setting efforts on an international scale cannot be effective if they do not recognize national and local priority-setting efforts. For this reason, we enclose data sets derived from the TNC/WWF priority-setting exercises for the Bering Sea, the People for Puget Sound's priority efforts for Puget Sound, Washington State, here presented as the Orca Pass Initiative, the WWF/Conservation International Areas of Biological Importance for the Gulf of California, and the priorities identified by Conabio.

This information is not available online, except for the Conabio information available at <http://www.conabio.gob.mx>.

About MCBI

Founded in 1996 by Dr. Elliott Norse, the Marine Conservation Biology Institute (MCBI) is a nonprofit, tax-exempt scientific and conservation advocacy organization. MCBI focuses its activities on promoting cooperation essential to protecting and restoring the Earth's biological integrity, and advancing the new science of marine conservation biology. From our headquarters in Redmond, WA, and our Washington, DC, and California offices, we work to protect and restore marine life on the West Coast, around the United States and beyond by encouraging research and training in marine conservation biology, bringing scientists together to examine crucial marine conservation issues, doing policy research to frame the marine conservation agenda, conducting outreach to educate scientists, the public and decision makers on key issues, and building partnerships to solve problems affecting marine life and people.

About the CEC

The Commission for Environmental Cooperation (CEC) is an international organization created under the North American Agreement on Environmental Cooperation (NAAEC) by Canada, Mexico and the United States to address regional environmental concerns, help prevent potential trade and environmental conflicts and promote the effective enforcement of environmental law. NAAEC complements the environmental provisions established in the North American Free Trade Agreement (NAFTA) to which it is a side accord.


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