4

Ecologically or Biologically Significant Marine Areas (EBSAs)

Special places in the world's oceans

NORTH PACIFIC

North Pacific Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas, Moscow, Russian Federation, 25 February to 1 March 2013.

UNEP

Convention on Biological Diversity

Japan Biodiversity Fund

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FOREWORD

Biodiversity is at the core of sustainable development. This fact is a central element of the Strategic Plan for Biodiversity 2011–2020 and the 20 Aichi Biodiversity Targets, which were developed and adopted by the Parties to the Convention on Biological Diversity (CBD) in 2010. The loss and degradation of biodiversity undermine the functioning of the Earth's life-support system and compromise the ability of marine and coastal ecosystems to support sustainable economic growth and human well-being.

In order to ensure that biodiversity can continue to support sustainable development, however, we must have a clear understanding of where to focus our attention and which areas are in most need of enhanced management and further research.

It is in this respect that the work of the CBD on ecologically or biologically significant marine areas (EBSAs) plays a key role. Since 2011, a series of regional EBSA workshops has been organized to describe the "special places" of the ocean and seas that are crucial to the healthy functioning of the global marine ecosystem. The work on EBSAs has significantly advanced our understanding of these "special places" in the ocean. It has provided a sound basis for actions by Parties and competent authorities to focus their existing efforts in meeting their commitments towards achieving the Achi Biodiversity Targets and Sustainable Development Goals in marine and coastal areas.

The EBSA process has also provided many tangible co-benefits—facilitating regional-scale collaboration and information-sharing, and catalysing new partnerships and research initiatives. It has been instrumental in identifying knowledge gaps, yielding important insights about the state of our knowledge of marine ecosystems and biodiversity.

Our work on EBSAs has taken an incredible journey since the adoption of the EBSA criteria at the ninth meeting of the Conference of the Parties in 2008. Working in close collaboration with Parties, United Nations agencies, international and regional organizations, and scientists, we have taken the EBSA process around the world, touching all corners of the globe.

EBSAs are more than just shapes on a map; they are reflections of living, breathing ecosystems. This booklet, which was produced with the kind support of the European Union, aims to paint portraits of the EBSAs described in the North Pacific, giving tangible character to the vast amounts of scientific data describing these precious ecosystems.

The North Pacific is home to an enormous range of species and habitats. It is a region of contrasts; spanning the tips of the tropical waters of the Pacific islands and the warm shores of Mexico, to the frigid cliffs of Alaska and the depths of the almost otherworldly deep seabed. It is a dynamic and turbulent region, with churning deep-sea hydrothermal vents, migratory species crossing the vast Pacific, and powerful ocean gyres and currents. The regional EBSA workshop for the North Pacific, co-chaired by Mr. Alexander Shestakov (Russian Federation) and Mr. Jake Rice (Canada), aimed to capture the significance of these unique and complex systems.

I encourage you to read this booklet and gain a greater appreciation of the breadth, depth and complexity of the unique features of marine and coastal ecosystems in the North Pacific region and their important roles in a healthy functioning planet.

Cristiana Paşca Palmer, PhD
Executive Secretary, Convention on Biological Diversity

A small Garibaldi fish enjoying its underwater palace. Photo © Octavio Aburto

EBSAs: AN INTRODUCTION

The ocean encompasses 71 per cent of the planet's surface and a large portion of its habitable space. Whereas life on land is almost exclusively contained within a thin strip of breathable atmosphere overhead, in the ocean it is found from the waves that wash against the shore to the deepest canyons that plunge thousands of metres beneath the sea floor.

Life is found throughout the ocean, from coastal zones to the open sea, from coral reefs to kelp beds, in forms as varied as algae that cling to the underside of polar ice floes, humpback whales that migrate from the Antarctic to the equator and back, and multitudes of marine viruses that, if laid end to end, would span farther than the nearest 60 galaxies.[1]

But the distribution of life in the ocean is varied. Whether caressed by currents, sheltered by the shore, nurtured by nutrients, or heated by hydrothermal vents on the sea floor, some areas boast life that is more plentiful, diverse or unique than others. For example, scientists with the Census of Marine Life found that white sharks congregate in an area off Hawaii that they dubbed the "white shark café", and that several species of whales, turtles, seabirds, seals and sharks all congregate at "hotspots", such as the California Current.

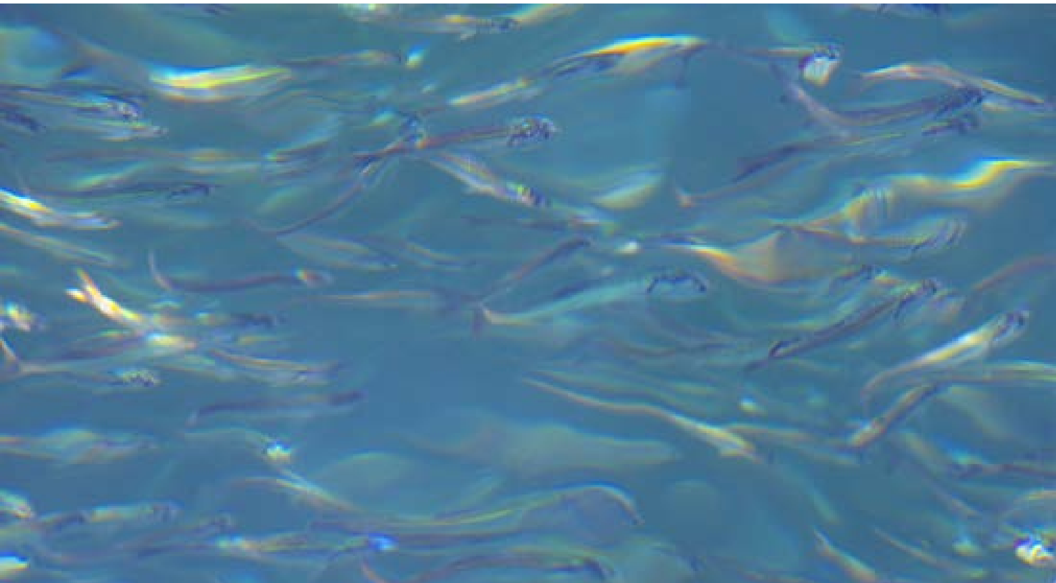
The top 100 metres of the open ocean hosts the great majority of the sea life with which we are more familiar—turtles, fish and marine mammals—as well as the microscopic plankton that form an integral part of the ocean food web and provide so much of the oxygen that we breathe. Far below the surface, in the dark depths, seamounts—underwater mountains that rise 1,000 m or more from the ocean floor—provide habitat for rich and diverse communities. Hydrothermal vents and cold-water seeps form the basis of unique ecosystems and species that might seem to belong more comfortably in a science fiction movie than the real world.

Yet, much of this unique and special biodiversity is facing major threats, such as habitat destruction, overfishing, pollution and climate change. The global community has recognized the need to address these threats and to take measures to support the health and well-being of marine and coastal biodiversity.

In 2010, at its tenth meeting, the Conference of Parties to the Convention on Biological Diversity (CBD) adopted a new 10-year Strategic Plan for Biodiversity, including 20 "Aichi Biodiversity Targets". A number of these targets focus specifically on marine and coastal biodiversity, including targets to achieve sustainable fisheries and protect at least 10 per cent of the world's marine and coastal areas by 2020.[2]

But in order to protect and preserve marine biodiversity effectively, we need to know where to focus and prioritize conservation and management. We must have a good understanding of the many different types

Pacific sardine (Sardinops sagax). *Photo © Octavio Aburto*



of marine ecosystems in different regions, including which areas are the richest in life, which boast the greatest diversity and abundance of species, and which possess the rarest species and the most unique communities of marine flora and fauna.

It is in this respect that the CBD's work on ecologically or biologically significant marine areas (EBSAs) plays a key role. In 2008, the Parties to the CBD adopted a set of seven scientific criteria to be used in identifying EBSAs. The EBSA criteria are as follows:

1	Uniqueness or rarity
2	Special importance for life history stages of species
3	Importance for threatened, endangered or declining species and/or habitats
4	Vulnerability, fragility, sensitivity, or slow recovery
5	Biological productivity
6	Biological diversity
7	Naturalness

These criteria provide guidance on the key types of features to be considered when identifying areas that are critically important to the functioning of marine ecosystems.

In 2010, the Parties to the CBD requested the CBD Secretariat to collaborate with Parties, other Governments and a range of partners in different regions in convening regional workshops to facilitate the description of EBSAs using the EBSA criteria. Through an inclusive and science-driven process involving experts from all over the world and an enormous amount of scientific data, these regional EBSA workshops have described the areas of the oceans that are the most crucial to the healthy functioning of the global marine ecosystem.

EBSAs can be as varied as the life within them. They can address large ocean areas or individual features. They can be static or move with seasonal variations in certain oceanographic features. But they all, in one way or another, have been described as important in the context of one or more of the seven EBSA criteria.

Furthermore, there are many different types of measures that can be used in regard to the EBSAs. These include, but are not limited to, marine protected areas and other area-based management tools, impact assessments and fisheries management measures.

The description of an area as meeting the EBSA criteria is a scientific exercise aimed at supporting the prioritization of management efforts of governments and relevant authorities. It does not necessarily mean that new management measures will be put in place, and it does not prescribe what types of management measures should be used.

These booklets, one of which is being produced for each region in which an EBSA workshop has taken place, provide snapshot summaries of the pages upon pages of data compiled by participating experts, to provide a detailed guide to some of the most ecologically or biologically significant ocean areas in the world.

This booklet, the fourth in the series (see also Volume 1: Western South Pacific, Volume 2: Wider Caribbean and Western Mid-Atlantic and Volume 3: Southern Indian Ocean), provides summaries of the areas described during the North Pacific Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas, which took place in Moscow, Russian Federation, from 25 February to 1 March 2013. The workshop was organized in collaboration with the Food and Agriculture Organization of the United Nations (FAO), the Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP), the North Pacific Marine Science Organization (PICES), the IOC Sub-Commission for the Western Pacific (WESTPAC) and the North Pacific Fisheries Commission (NPFC). The workshop was hosted by the Government of the Russian Federation, with the financial support of the Government of Japan, through the Japan Biodiversity Fund. Scientific and technical support was provided by a team from the Marine Geospatial Ecology Lab of Duke University. To find out more about this and other EBSA workshops, see www.cbd.int/ebsa. The full report of this workshop is available at: https://www.cbd.int/doc/meetings/mar/ebsa-np-01/official/ebsa-np-01-04-en.pdf.

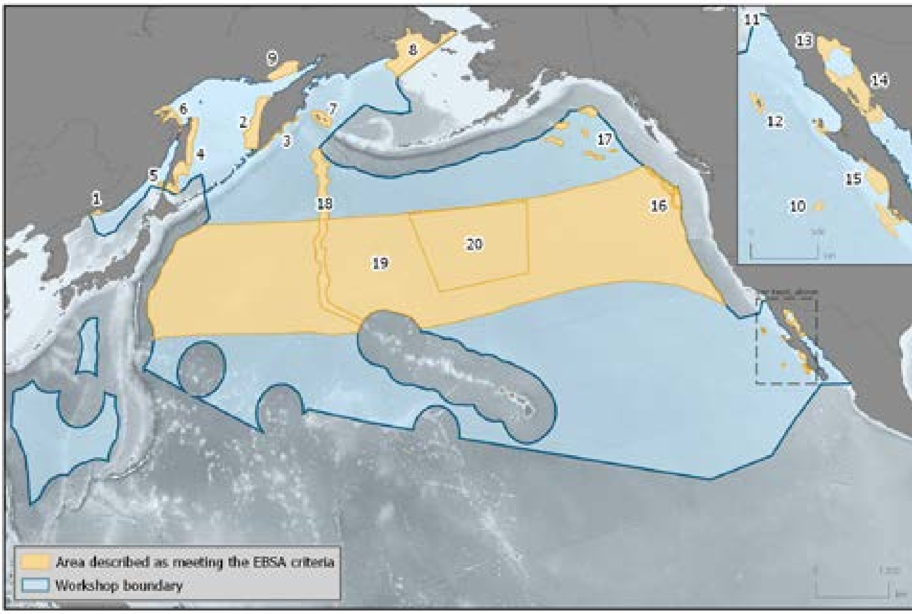
Elegant tern (Thalasseus elegans). *Photo © Octavio Aburto*

NORTH PACIFIC

At its northernmost extent, the North Pacific Ocean brushes against the Arctic, connected by the tiny sliver that is the Bering Strait, but otherwise largely sheltered by the protective embrace of Siberia and Alaska. At its southernmost reaches, it envelopes the Hawaiian Islands and blends gently into the equatorial tropics. In between, the region's waters encompass a wide variety of ecosystems that are home to an abundance of marine life.

The North Pacific encompasses the windswept cliffs of the Aleutian Islands and the sun-dappled shores of Baja California. It is a region where spotted seals breed and capelin spawn, home to key areas for migrating salmon and migratory seabirds. It boasts rare deep-water echinoderms and extensive beds of giant kelp, the world's largest benthic organism. Its volcanic islands are testament to a violent past, while the hydrothermal vents along Juan de Fuca Ridge are evidence of the turmoil that continues beneath Earth's crust.

The 20 EBSAs featured in this booklet are as varied as the region as a whole, from the 1,000 square metres of exposed rocky surface on the three principal members of the Alijos Islands, to the ever-shifting 9,000 km-wide North Pacific Transition Zone. One contains 99 per cent of the nesting sites of Laysan albatrosses and 95 per cent of those of black-footed albatrosses; while another hosts some 500,000 storm petrels and 260,000 Hermann's gulls, while two others are the only places to find the *Codium schmiederi* seaweed. One is home to the entire global population of the vaquita, a tiny porpoise with rapidly dwindling numbers and an uncertain future; but nearby are the breeding grounds of all the world's gray whales, once also thought to be on the road to extinction but now found at historic levels, their annual migrations thrilling whale watchers along the coast of North America and providing a tangible connection to the North Pacific and the life it supports.



Marine Geospatial Ecology Lab, Duke University (2018)

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Black-faced spoonbill. Photo © Francesco Veronesi

1

PETER THE GREAT BAY

Located at the southern limit of Russian territorial waters, just south of the port city of Vladivostock, Peter the Great Bay encompasses an area of approximately 5,000 sq. km.
A meeting place of cold water from the north and warmer water from the south, it is one of only eight breeding areas for the spotted seal, and is an important layover site for migratory waterbirds.

Peter the Great Bay is the largest bay within a largely enclosed flat basin that is effectively divided by ocean currents into two distinct areas: the southeastern warm water area bathed by the Tsushima Current that flows north from the East China Sea; and the colder, boreal waters of the Primorye (or Liman) Current.[1] As it enters the basin, the Tsushima Current breaks into three branches, and the northernmost of these, the East Korea Warm Current, brings salty water into Peter the Great Bay. The clash between warm and cold water creates a convergence zone between temperate and subtropical zones and results in a high diversity of species.

For example, 316 species of fish have been documented in the bay, as well as 40 species of sponge and 190 species of prosobranch gastropods, such as limpets, periwinkles and whelks.[2] [3] [4] Even in relatively tiny Vostok Bay, located towards the northeastern limit of this area, 128 species of fish and 630 macrobenthic species – including 69 species of decapods (e.g., crabs, shrimp), 128 species of molluscs and 170 types of seaweed – have been recorded.[5] [6] The variety of bird species here, as for the region in general, is profuse and includes a wide variety of breeding and migrant shorebirds and seabirds including, Japanese and pelagic cormorants, seven species of sea ducks, spectacled guillemots, ancient murrelets, least and rhinoceros auklets, black-tailed godwits and whimbrels, among many others.[7]

Spotted seal. Photo © WWF Russia / Andrey Gudkov

Within Vostok Bay, the Zaliv Vostok Marine Reserve is one of two marine reserves in Peter the Great Bay.[8] The more southerly Dalnevostochny Morskoi Zapovednik (or Far Eastern Marine Reserve) was the first such reserve established in Russian waters. It includes 11 islands, has an area of 643 sq. km and covers about 10 per cent of the bay.

Furugelm Island, located in the Far Eastern Marine Reserve, is the only known nesting site in Russia of the Chinese egret, which is listed as vulnerable on the IUCN Red List, and of the black-faced spoonbill, listed as endangered.[9] [10] It is also home to the largest colony of Japanese cormorants (approximately 1,000 breeding pairs) and black-tailed gulls (as many as 85,000 individuals) in the Russian Federation.[11] Indeed, the islands in Peter the Great Bay as a whole are recognized by BirdLife International as an Important Bird and Biodiversity Area, largely for their colonies of black-tailed gulls, spectacled guillemots and Swinhoe's storm petrels. One of the world's three largest colonies of the Swinhoe's storm petrel breeds on Verhofsky Island, while the bay contains the most northernmost colony of that species as well as Japanese murrelets and Audubon's shearwaters.[12]

Peter the Great Bay is also one of only eight breeding areas for spotted (or largha) seals.[13] Approximately 450 so-called resident seals live in the bay year-round, while overall numbers can swell to as many as 2,500 between fall and spring with the influx of migrants.[14] [15]

Black-tailed gull hatchling. Photo © Jordi Sargatal

Sockeye salmon. Photo © WWF-Russia / Sergei Shanin

2

WEST KAMCHATKA SHELF

Located in the eastern part of the Sea of Okhotsk along the western coastline of the Kamchatka peninsula, this is the richest fisheries area in the Russian Federation and one of the most biologically productive regions of the world ocean. It is a key area for feeding and pre-spawning migrations of various species of Pacific salmon, for spawning capelin and for all life cycles of the red king crab, and may serve as recovery habitat for three species of endangered whales. Covering an area of approximately 100,000 sq. km, this area stretches from approximately Cape Khayryuzova in the north to Cape Lopatka in the south and encompasses the shelf waters to the 200-metre isobath.

The waters above the West Kamchatka Shelf are energetic and frequently tempestuous. It is here that the relatively warm northward offshore West Kamchatka Current meets the cooler southward coastal Compensatory Current yielding a dynamic circulatory system that is further influenced by the inflow of river runoff, tidal oscillations, ice thaw, shelf topography and atmospheric conditions. The net result is a region of extreme productivity, on and off the shelf,[16] [17] [18] [19] that is considered Russia's richest fishing area.[20]

The waters are crucial for wild salmon of the western Pacific. Besides the fact that major spawning rivers of the Kamchatka peninsula flow into the waters of the shelf, West Kamchatka is also a key feeding ground for juveniles. The coastal waters of West Kamchatka harbour considerable numbers of the six Pacific salmon species – sockeye, pink, chum, chinook, coho and masu – during their early marine phase, though they can fluctuate widely from year-to-year.[21] [22] For example, trawl surveys conducted in July of 2010 resulted in an estimate of more than 85 million juvenile salmon, of which some 63 million were estimated to be sockeye.[23] Indeed, most juvenile sockeye in the Sea of Okhotsk inhabit the shelf encompassing this area.[24]

Sockey salmon. Photo © WWF-Russia/Viktor Zhivotchenko

The area is also of immense importance to Pacific capelin in the Sea of Okhotsk, which spawn in May and June along the many long sandy beaches of West Kamchatka. In some years, the density reaches 600-800 spawning fish per square metre, and the number of eggs deposited can reach as many as 7.2 million per square metre.[25] Aso found along the entire west Kamchatka shelf – and in commercial concentrations practically throughout – is the largest of the spider crabs, the red king crab. The species, found in shelf waters throughout their life cycle, can attain staggering numbers during particularly favourable years – 328 million in 1997, according to surveys, for example.[26]

Spotted seal. Photo © Yuri Kislyak

The Moroschechnaya River estuary, meanwhile, is one of the most important staging sites for shorebirds using the East Asian–Australasian Flyway, 26 species of which, including the endangered Nordmann's greenshank, have been recorded here. An estimated 300,000 birds use the area during their northward migration, and some 800,000 birds use the area on their journey south.[27] [28] [29]

The west Kamchatka shelf is also prominent for various marine mammals. Fourteen cetacean species have been recorded here,[30] including summering beluga whales in the estuary of the Khairyuzova and Belogolovaya rivers, where as many as 250 to 300 individuals have been sighted.[31] Historical records and recent reports suggest that the shelf region could also serve as important recovery habitat for the Okhotsk Sea bowhead and western North Pacific right whales, both listed as endangered on the IUCN Red List, and the western gray whale, listed as critically endangered.[32] [33] And with the retreat of winter's ice cover can be found many thousands of spotted (or largha) seals relaxing in the numerous haul-out sites (land or sea-ice used for rest and reproduction) scattered along the coast.[34]

Sea otters. Photo © Sergey Kornev

3

SOUTHEAST KAMCHATKA COASTAL WATERS

This area extends from Cape Lopatka, the southernmost point of the Kamchatka Peninsula, northwards to the Kronotsky Peninsula region and encompasses the adjacent waters of the narrow shelf. The southeast Kamchatka coastal waters are vitally important for marine mammals such as orcas, sea otters and gray whales, and for tens of thousands of seabirds nesting on two small islands – Starichkov and Utashud – lying close to the coast.

Not all orcas – often referred to as killer whales – are the same. Different groups demonstrate different behaviours and organizational and dietary preferences, and can often be distinguished from each other by subtle physical differences. In the North Pacific, there are three such ecotypes of orcas. “Residents” are named for their tendency to visit the same areas consistently. They live in large, socially complex and matriarchal social groups called “pods”, each of which uses unique vocalizations, and they eat primarily fish. “Transients” (or “Bigg’s”) travel in smaller groups, vocalize less, travel more widely, often have more noticeably pointed dorsal fins and prey on marine mammals. “Offshore” killer whales, identified in 1988, combine elements of residents and transients: like transients, they live in small groups and tend to stay far from the coast, but they feed primarily on fish, as do residents, although they may also take marine mammals.[35] [36]

Both resident and transient orcas, particularly residents, are common in this region and are quite extensively studied.[37] [38] The Avacha Gulf area may be a “core” area for one community as well as a place where other communities visit or pass through.[39] There are about 300 orcas in the Avacha Gulf region, with regular residents numbering about 160 animals, arranged in 20 pods; the remainder, comprising 12 pods, are infrequent visitors though even they are typically observed within the general region.[40]

The area also includes feeding grounds for the critically endangered western North Pacific gray whale, at Olga Bay, and presumably at Vestnik and Nalycheva bays and Khalaktyrskyi Beach, where they are regularly seen. A few cow/calf pairs have also been documented at Olga Bay.[41] [42] [43] The North Pacific right whale – one of the most endangered whale species in the world – has also been observed at Vestnik Bay.[44]

Steller’s sea eagle with young in nest. Photo © Thomas Neumann

Stellar sea lions. Photo © Alexandra Filatkina

The attraction of the area to resident orcas in particular can be seen in the presence of several species of Pacific salmon – among them chum, sockeye, pink and chinook – found throughout this region. Salmon spawn in many of east Kamchatka's rivers,[45] [46] [47] [48] and as they swim along the coast, they attract a variety of predators in addition to the orcas, from Steller's sea eagles to spotted (or largha) seals. The Dolly Varden, another anadromous salmonid, is also common. It is found in most Kamchatka rivers where it spawns and overwinters before spending one to two months of the year at-sea, typically within 100 km of the coast.[49]

The tiny islands of Starichkov (Avacha Gulf) and Utashud (Vestnik Bay) – both listed as Important Bird and Biodiversity Areas by BirdLife International – are home to impressive concentrations of seabirds. Perhaps as many as 10,000 pairs of tufted puffins nest at Utashud,[50] while Starichkov has

Orcas, eastern Kamchatka. Photo © Tatiana Ivkovich, Far East Russia Orca Project (FEROP, WDC)

more recently been recorded with some 183,000 individuals comprising 13 breeding species, most of which are ancient murrelets and tufted puffins, with an estimated 85,000 and 77,000 individuals, respectively.[51]

Within this area, at Cape Kozlova, is a small rookery of Steller sea lions, with haul-out sites for the species scattered southwards along the coast.[52] Sea otters, numbers of which fluctuate because of emigration/immigration between the Northern Kuril Islands and Kamchatka, are sporadically found throughout the region. There are a number of important areas for otters, including the Cape Lopatka region at the southernmost section of Kamchatka, where numbers at times have approached some 7,000 animals; near Utashud Island, where numbers can reach more than 1,000 individuals; and in the Kronotsky Peninsula Biosphere Preserve, where almost 300 animals have been counted.[53]

4

Eastern shelf of Sakhalin island. Photo © Vladimir Filonov

EASTERN SHELF OF SAKHALIN ISLAND

Covering the eastern coast of Sakhalin Island out to the 200-metre isobath, this area includes an Important Bird and Biodiversity Area, vital feeding grounds for the critically endangered western gray whale and a major breeding site for the northern fur seal and Steller sea lion. Found here as well is the critically endangered Sakhalin taimen, a large salmonid that is one of the world's most threatened species.

It is not known how many gray whales there once were in the western North Pacific. It is known, however, that hand harpooning of the population began in the 16th century, that a branch of the population speculated to have bred in the Seto Inland Sea of Japan was gone by 1900, and that from the 1840s to about 1900, American and European whalers hunted gray whales in the Okhotsk Sea and western North Pacific.[54] Today, there are estimated to be no more than 130 whales here, making it one of the smallest cetacean populations in the world.[55] All of them, along with some members of the considerably more numerous eastern North Pacific population, spend the summer feeding in the water off the northeastern coast of Sakhalin Island.[56]


Ampelisca eschrictii. *Photo © Natalia L. Demchenko*

The cold, nutrient-rich East Sakhalin Current pushes sea ice away from the area in May and June, and a combination of strong winds, tidal mixing, upwelling and Amur River discharges over the northeastern Sakhalin Shelf lead to intense algae blooms. These in turn support the enormous densities, more than 16,000 individuals per square metre, of the amphipod *Ampelisca eschrichtii* — the principal prey of the North Pacific gray whale.[57] The "nearshore" and "offshore" feeding areas for gray whales, both of which are located near Piltun Bay,[58] are located in the region of highest primary and secondary production in the Okhotsk Sea.[59]

Unsurprisingly, the region supports vast numbers of other kinds of wildlife. Six species of pinnipeds are found here, as are high densities of ribbon seals during the sea ice season. Piltun Bay is the largest haul-out area in the region for ringed seals, and this is the core breeding region for one of the Sea of Okhotsk's two populations of spotted (or largha) seals.[60] Tyuleniy Island holds a major rookery for both northern fur seals (115,000 counted in 2013) and Steller sea lions, (2,250 individuals counted in 2013); it is one of only four rookeries for northern fur seals in Russian waters.[61]

Of the 14 known main staging sites (resting and feeding places) for shorebirds on the coasts of the Sea of Okhotsk, two are located on Sakhalin's eastern coast: Aniva Bay for birds migrating northwards (especially dunlin and red-necked stint), and Chayvo Bay for southward migration(especially dunlin and sanderling).[62] The northern end of Sakhalin Island may support half the world's population of breeding Aleutian terns (also known as the Kamchatka tern), the majority of which are found in colonies along Piltun Gulf.[63]

Southeastern Sakhalin and Aniva Bay are particularly important for salmon in Russia's Far East due to their high numbers of pink salmon.[64] Eastern Sakhalin is also home to what are likely genetically unique populations of Sakhalin taimen; one of the largest salmonids in the world, it can exceed a metre and a half in length and can live for more than 20 years, but is critically endangered and has been listed as one of the world's most threatened species.[65] [66] This primarily anadromous fish inhabits roughly 80 rivers draining eastern Sakhalin and can be found in estuaries and along the coast during its marine phase.[67]

Gray whale. Photo © Sergio Martínez/PRIMMA.

Steller sea lion. Photo © Mikhail Korostelev

5

MONERON ISLAND SHELF

The Moneron Island shelf is a biodiversity hotspot located in the Strait of Tatary, 45 km southwest of Sakhalin Island. The unique assemblage of invertebrates here represents seven biogeographical regions. Moneron Island and surrounding islets support more than 10,000 seabirds of 10 different species.

There are more than 900 species of chitons around the world. Chitons are large marine mollusks that cling to rocks, mainly in intertidal and subtidal zones, protected by eight interlocking plates across their backs that enable them to curl into a protective ball when threatened or dislodged. None are as large as the mighty gumboot chiton, a denizen of the coastal North Pacific, which can grow up to 36 cm in length, weigh over 2 kg and live for more than 40 years.[68] The gumboot chiton is found in relatively large numbers here. And while it is the largest type of mollusk in this area, it is not the only one.

There are at least 113 species of prosobranch gastropod mollusks alone, from 33 families in 13 orders,[69] testament to a particular convergence of conditions. Sheltered from the direct effect of cold Okhotsk waters by southern Sakhalin Island's Krilion Peninsula, the area is bathed in warm waters from the Tsushima current, which brings the planktonic larvae of subtropical species from adjacent areas of Hokkaido and northern Honshu. It then meets cold waters entering from the northern part of the Tatar Strait, creating high levels of local upwelling, resulting in productive vertical mixing and a high density of zooplankton.[70] Because of the confluence of currents and conditions, this area is home to a unique assemblage of invertebrates from seven different biogeographical regions, ranging from Arctic to Asian subtropical.[71] [72] [73] [74] [75]

Other characteristics further support the rich molluscan communities. There is a high prevalence of sediments with coarse-grain material, gravel and shingle, which provide ideal substrate for molluscan larvae, and exposed rock is common, both along the coast and to a depth of about 115 metres, providing an ideal substrate for adults.[76] Those same rock exposures also support exceptionally dense kelp growth.

The area is also home to a small rookery of Steller sea lions – the only one in the southern part of the Sea of Okhotsk – where some 25 pups are born each year.,[77] More than 10,000 seabirds belonging to 10 different species nest on Moneron Island and its surrounding islets.[78]

Ventral surface, gum boot chiton. Photo © Kira Hoffmann

6

Shantary Archipelago © Mikhail Skopets, courtesy of Wild Salmon Center.

SHANTARY ISLANDS SHELF, AMUR AND TUGUR BAYS

Covering some 44,000 square kilometres, this area is located in the southern and southeastern part of the Sea of Okhotsk. It encompasses the Shantary Archipelago and the western portions of the Gulf of Sakhalin and Strait of Tartary, including the Amur River estuary. It boasts large numbers of pinnipeds and cetaceans, the critically endangered kaluga sturgeon, and contains four of the main staging sites for shorebirds in the Sea of Okhotsk.

The Amur River is the tenth longest river in the world, rising in the hills of western Manchuria and forming the border between Russia and northeastern China as it flows east, ultimately emptying into the southwestern extremity of the Sea of Okhotsk. Its lower reaches, estuary and adjacent coastal brackish waters host the anadromous (river spawning) form of the endemic (existing only here) and critically endangered kaluga sturgeon. Three species of Pacific salmon, pink, chum, and masu, spawn in its waters.[79]

In pursuit of salmon, as well as other anadromous fish, such as herring, smelt and capelin, beluga whales aggregate in the region's coastal waters in summer months, particularly where rivers enter bays and estuaries, such as the bays of the Shantar region – notably Udskaya and Ulbansky bays – and the border between Sakhalinsky Bay and the Amur Estuary. In each place, more than 1,000 belugas can be found at a time, making this region one of the key summering locations for the species within the Sea of Okhotsk.[80] It seems likely that the belugas in this area are from a distinct population, with features or habits that are different from those of belugas in other areas.[81]

Kaluga sturgeon. Photo © Bart Wickel

Bowhead whale, Sea of Okhotsk. Photo © Olga Shpak

The region, particularly in the Academy Bay region, is also a major summer feeding area for the Sea of Okhotsk bowhead whale, a population listed as endangered by the IUCN.[82 83] Bowheads are probably the longest-lived mammals on Earth: based on the age of harpoon heads that have been recovered from individual whales, it is believed bowheads may be able to live in excess of 200 years.[84] Their numbers were greatly reduced by commercial hunting and while recovery in the North Pacific has been robust,[85] the state of the isolated population in the Sea of Okhotsk – numbering perhaps some 400 individuals – remains perilous.[86] A North Pacific right whale, a species also listed as endangered by the IUCN, was recently documented in the Shantary Archipelago.[87] North Pacific right whales were regularly seen in this region before their numbers were also greatly reduced by commercial hunting. The western North Pacific population, which summers in the Sea of Okhotsk, is by far the largest of the two remnant populations, even though it probably comprises far fewer than 1,000 individuals.[88]

Large numbers of seals are found in the Shantary Archipelago region through much of the year. Mass aggregations of molting ringed seals live here in June before the species disperses along the coast throughout the Sea of Okhotsk; as for spotted (or largha) seals, they can be found in numerous haul-out sites after the retreat of ice cover; and finally, bearded seals can be found in the Gulf of Sakhalin during winter and around the archipelago during late summer and autumn.[89] The Shantary region is also occupied by orcas during summer, when they can rely on large numbers of seals and whales to keep them fed.[90]

The Shantary region also holds four of the main staging sites in the Sea of Okhotsk for shorebirds – primarily dunlins, great knots, Terek sandpipers and black-tailed godwits – on their southward migration.[91] Colonies of at least 11 seabird species are located on the sheer coastal cliffs of the islands, including some 17,500 pairs of spectacled guillemots on Utichiy Island, the largest colony in the Russian Far East . Seven to eight thousand common black-headed gulls are scattered throughout the islands during breeding season, along with smaller numbers of, for example, Aleutian terns, tufted and horned puffins and common murres.[92 93]

Shantary Islands. Photo © WWF Russia / Pavel Fomenko

Humpback whale. Photo © Catherine Holloway / WWF

7

COMMANDER ISLANDS SHELF AND SLOPE

The Commander Islands are located on the geographical boundary of the western Bering Sea and the Pacific Ocean and include two large islands (Bering and Mednyi), two smaller islands (Toporkov and Ariy Kamen') and several rocks that are a continuation of the Aleutian Islands. The area covers the insular shelf and slope down to a depth of 4,000 metres; it shows remarkable uniqueness and a high level of not yet fully documented marine biodiversity, plays an extremely important role in maintaining populations of a number of marine species, and is crucial with regard to protection of endangered and threatened species.

On December 8, 1741, weak and wracked with scurvy, Vitus Bering, Danish commander of a Russian expedition, died on board his ship, the *St. Peter*. His crew buried him on what is now Ostrov Beringa, or Bering Island, one of the Commander Islands, where the vessel, battered and no longer seaworthy after a grueling, storm-filled voyage, had taken refuge. Not until September 1742 would the surviving crew make their way back to Kamchatka in a 40-foot boat they had fashioned from the wreck of the *St. Peter*. Others would soon return to Ostrov Beringa, because during their stranding, Bering's crew had feasted on enormous, blubbery, marine mammals that wallowed in the island's fringes. Dubbed "Steller's sea cow" after the expedition's chief scientist, its blubber was reportedly "most delicious", its meat "exceedingly savory", and the ease with which it was hunted was so great that by 1768 it was completely extinct.[94]

Bones of this unfortunate species can still be found in coastal deposits around Bering and Mednyi islands, where it was likely endemic. But even in the sea cows' absence, the shelf and slope areas of the Commander Islands remain rich in flora and fauna.

Coastal waters are spawning grounds for capelin, while surrounding pelagic waters are important feeding grounds for all salmon species, particularly sockeye.[95] [96] The waters around the islands are home to orcas, and other cetaceans commonly or regularly seen in this area include minke, Baird's beaked, sperm, Cuvier's beaked, fin and gray whales, harbour and Dall's porpoises and even small numbers of endangered North Pacific right whales.[97] In addition, the area is one of three main feeding grounds of humpback whales in the Russian Far East.[98]

The islands also support the world's second-largest breeding population of endangered northern fur seals;[99] a major Steller sea lion rookery on the southernmost tip of Mednyi Island, where about 200 pups are currently born annually;[100] and a combined estimate of 4,000 to 4,300 spotted (or largha) seals and the Kuril subspecies of harbour seal.[101] The largest population of sea otters in Russian waters is here as well, approximately 7,000 animals or about six per cent of the global population.[102]

Mednyi Island is home to more than 500,000 seabirds, and the Commander islands in total host 17 seabird species numbering almost 1.3 million individuals.[103] The islands are the only location of nesting red-legged kittiwakes in the Russian Far East: more than 16,000 pairs, the vast majority of which nest on Bering Island.[104 105] The islands are also home to more than 55,000 pairs of common murres; about 400,000 individual northern fulmars; some 40,000 pairs of black-legged kittiwakes; about 164,000 individual thick-billed murres; some 127,000 pairs of tufted puffins; and several thousand pairs of whiskered auklets – a rare species in the Russian Far East. The islands are also one of the few wintering areas for ancient murrelets, the northernmost breeding locale for the fork-tailed storm petrel and the only known location of nesting glaucous-winged gulls in the Russian Far East.[106 107]

Whiskered auklet. Photo © Glen Tepke

East and South Chukotka coast. Photo © Victor Nikiforov

8

EAST AND SOUTH CHUKOTKA COAST

The area extends from Krest Bay (Zaliv Kresta), the northwestern part of the Bay of Anadyr, along the complex coastline of the Chukotka Peninsula to Dezhnev Cape. The uniqueness of the coastal waters of the western Bering Strait and the southern Chukotka Peninsula is associated with the largest and best-known polynya system in the North Pacific and the Chuckchi Sea. This is a wintering area for bowhead whales, beluga whales, Pacific walruses and numerous seabirds.

The waters of the Bering Sea basin are rich in nutrients. The currents of the Great Ocean Conveyer — a constantly moving system of deep-ocean circulation driven by temperature and salinity — deposit nitrates, silicates and phosphates in such levels that their concentrations in the deep waters of the region are among the highest recorded anywhere.[108] From there, regional circulation transports them northward to the narrow, shallow shelf of the northwestern Bering Sea, creating "hotspots" with a high diversity of benthic marine life that in turn support huge numbers of seabirds and marine mammals.[109]

In summer the region harbours breeding colonies of black-legged kittiwakes, common and thick-billed murres, and crested and least auklets, as well as northern fulmars, pelagic cormorants, parakeet auklets, pigeon guillemots, and horned and tufted puffins.[110] The colonies of the southern Chukotka coast tend to be larger than those along the eastern side (i.e., Bering Sea) but less numerous, with fulmars and auklets occurring mostly on the southern part of the peninsula. In total, there are about 80 seabird colonies on the rocky slopes along the east coast, with planktivorous seabirds and fulmars being the most numerous residents.[111] It has been estimated that the region contains more than 3,000,000 breeding seabirds belonging to 13 species, with an additional 13 migrant or vagrant (outside their normal range) species.[112]

Least auklets. Photo © Josh Keaton NOAA/NMFS/AKRO/SFD

Chukotka. Photo © Vladimir Sertun / WWF-Russia

The eastern Chukotka Peninsula is considered a highly important summer feeding ground for Eastern Pacific gray whales. Although we don't know how many live there, there is likely to be a substantial number, given that more than 3,400 have been hunted by aboriginal subsistence whalers since 1985. [113] [114] Gray whales also face a considerable threat from orca predation here. Two-thirds of approximately 100 reported orca attacks on marine mammals along Chukotka over a 10-year period were on gray whales. They continue to return year after year, given the importance of the region for feeding.[115] Indeed, it has been estimated that an individual gray whale here consumes about 409 kg of benthic prey (almost exclusively amphipods) each day — or about 61 tonnes over its five-month feeding period along the Chukotka coast.[116]

One of the three main feeding grounds for humpbacks in the Russian Far East is located here, in the coastal waters of the Gulf of Anadyr[117]. The region is also home to a stock of at least several thousand beluga whales, which summer in the Anadyr estuary and overwinter in the pack ice of the Gulf of Anadyr. [118] [119] [120]

The belugas are able to spend their winters in the pack ice due to the presence of a large polynya system that develops in the area each year. Polynyas, areas of persistent open water where one would expect to find sea ice, can be formed by winds and currents pushing ice away, or by warm water upwelling from below causing it to melt.[121] While the appearance of some is hard to predict, others occur in the same area year after year, among them the Anadyr'–Sireniki polynya system, in which an extensive belt of open water or water covered by thin nilas ice develops between landfast ice and drifting ice floes.[122] In fact, the continuity of polynyas in this area over more than a thousand years is indicated by archaeological records of ancient Inuit culture exploiting the highly productive marine ecosystems associated with them.[123] [124]

Polynyas can act as oases for marine life, and the Anadyr'–Sireniki polynya system is extremely important for the life-history stages of numerous species, including threatened, endangered and declining ones. Several species of seabirds overwinter there, including long-tailed ducks, king eiders and various alcids.[125] The polynya is an important wintering site for Pacific common eiders, which forage on benthic invertebrates in the intertidal and shallow subtidal waters.[126]

It is also an important wintering ground for bowhead whales,[127] – which have been recolonizing an area they previously occupied in abundance[128] – and Pacific walruses, which breed on the ice floes of Anadyr Bay, to the south of developing polynyas.[129] [130]Typically, walruses leave the Bering Sea in spring, after the pack-ice deteriorates, for summer feeding areas in the Chukchi Sea. However, two populations of several thousand walruses remain in the Gulf of Anadyr and in Bristol Bay during the summer, where they forage from coastal haul-outs.[131]

Pacific walrus. Photo © Joel Garlich Miller, U.S. Fish and Wildlife Service

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Pacific herring. Photo © Ian McAllister / Pacific Wild

YAMSKIE ISLANDS AND WESTERN SHELIKHOV BAY

Shelikhov Bay, which is characterized by upwelling of deep, cold, nutrient-rich water, strong tidal currents and unusual ice conditions, is located in the northwestern Sea of Okhotsk. The Gizhiga, Penzhina, Yama and Malkachan rivers flow into the bay, which is ice-covered from December to May. The Yamskie Islands shelf serves as an important area for cetaceans, while the island shores themselves are occupied by millions of seabirds.

Surrounded by drifting ice for nine months of the year, the Yamskie Islands are barely more approachable in the short summer season. The sea is subject to a tidal range of 7 to 8 metres and currents that, at up to 9 knots, are faster than many mountain streams on the islands themselves. Even on clear days, winds rush forth from the ravines of Matykil Island, one of two large islands (and five overall) in the archipelago; in stormy weather, wind speeds can reach 35 metres per second. Sailors, it has laconically been observed, "try to avoid these waters."[132]

While the waters of Shelikov Bay are hostile to humans, they are home to an abundance of marine life. A combination of tidal fronts, upwellings and the sea ice cycle results in profuse phytoplankton productivity, which in turn leads to large numbers of krill and, accordingly, multiple species that feed on one or both. Significant aggregations of the Gizhigin-Kamchatka population of Pacific herring are found in the northeast section of Shelikhov Bay and include, for example, foraging yearlings during spring and immatures during winter.[133] Pollock, Pacific salmon, sculpins and cephalopods are also all found in abundance in the region.[134] They in turn are preyed upon by Steller sea lions, a large breeding colony of which is located on Matykil Island, with some 1,000 adults and a pup production of about 465 annually. It is the northernmost breeding site for Steller's sea lions in Russia, and one of the most northerly in the world.[135]

Tufted puffin. Photo © Yuri Artukhin / WWF-Russia

Parakeet auklet. Photo © Glen Tepke

Summering beluga whales are found in Gizhiginskaya Bay, particularly in northern Avekova Bay, where they congregate in the estuaries of the Gizhiga and Avekova rivers during the smelt run in early summer and during July and August for the pink and chum salmon runs.[136] And Shelikhov Bay is one of just two areas where the endangered Okhotsk Sea subpopulation of bowhead whales is known to concentrate during spring and summer.[137]

The area is perhaps best known for its enormous aggregations of seabirds. The capes and islands of Gizhiginskaya Bay host a total of some 450,000 to 500,000 birds: primarily large colonies of murres, with black-legged kittiwakes, pelagic cormorants and slaty-backed gulls also very common, and several dozen smaller but still considerable colonies of horned and tufted puffins and spectacled guillemot.[138] Those numbers pale, however, when set against those on Matykil Island, which is home to at least 4.8 million individual birds belonging to 12 different species. The most common are the least and crested auklets, which number in excess of 2.4 million and 1.75 million respectively, but common and thick-billed murres, northern fulmars, black-legged kittiwakes, horned puffins and parakeet auklets are also plentiful.[139]

Alijos Islands. Photo © Bob Pitman / NOAA

10

ALIJOS ISLANDS

Located in the eastern Pacific Ocean, about 340 km west of the Baja California Peninsula, this area encompasses approximately 1,600 square kilometres and includes the three Alijos Islands and surrounding waters. The flanks of the islands themselves are escarpments, part of an underwater volcano rising from the ocean floor from depths of around 3,500 metres. The total surface area of the top of the three main exposed rocks is less than 1,000 square metres – yet they host a tiny, recently established colony of Laysan albatross along with small numbers of other seabirds. The area appears to be a refuge for rare deep-water echinoderms and includes a remarkable taxonomic spectrum of marine algae.

The Alijos Islands (Rocas Alijos) of Mexico thrust upward through the waves like the gnarled fingertips of an ancient, rocky underwater giant, three prominent rocks and numerous smaller ones in an isolated patch of the Pacific Ocean, approximately 340 km west of Baja California. The earliest known written description of them is from a 1605 reference to "rocks which were like ships under sail," and they were named "Farallon de los Alijos" sometime between 1734 and 1743.[140]The three islets are remnants of a volcanic island and have a combined top surface area of slightly less than 1,000 square metres; the highest, South Rock, rises just 34.5 metres above the sea. A few tall, narrow pinnacles – typically 10 metres in diameter and reaching as high as 40 metres – lie submerged around the islets,[141] their sheer basalt walls colonized by particularly abundant numbers of sessile invertebrates.[142] A somewhat unusual feature of Rocas Alijos is the relative bareness of the rock face stretching from the intertidal zone down to about 25 metres, where lush communities of algae and epifauna come into view.[143]

Because of their small surface area, there is little marine life on the rocks themselves. However, the zoogeographic affinities of some of the floral and faunal groups is considerably mixed as a result of the area's location at the transition zone between the temperate California province and the tropical Panamic province,[144 145] at a latitude where the Pacific Current turns westward to form the north Pacific trans-oceanic current.

Though the few surveys conducted at Rocas Alijos are only preliminary, some intriguing results have been reported. Of the 15 species of echinoderms (e.g., sea stars, sea urchins, sand dollars, sea cucumbers)

Laysan albatross. Photo © Bob Pitman / NOAA

Giant manta ray. Photo © Elias Levy, licensed under CC by 2.0
www.flickr.com/photos/elevy/18997872598

documented, three were considered to be endemic, a percentage even higher than that of echinoderms at the Galapagos Islands, Ecuador. The area also appears to be a refuge for rare deep-water types as well.[146] There are only about 50 species of marine algae at Rocas Alijos, however they are considered “remarkably diverse” , especially when considering the few habitat types available.[147] No endemic algae have been found here, however one (*Codium schmiederi)* is found only here and at Guadalupe Island (area no. 12).[148] Five mollusks, also shared only with Guadalupe, have been recorded as well.[149]

Sixty fish species have been documented thus far from around the islets,[150] including the giant manta ray, which is classified as vulnerable on the IUCN Red List,[151] and the yellowfin tuna. Large aggregations of the latter were discovered here by the California tuna fleet in 1929.[152] Also found at Rocas Alijos are at least 165 species of mollusks,[153] 20 species of decapod crustaceans (e.g., crabs, shrimps),[154] and a variety of anthozoans (e.g., sea fans, sea anemones), hydroids, polychaetes (bristle worms), sponges, bryozoans, corals and many others.[155]

Historical records show a much smaller fourth rock once rising from the waves, which must have toppled under the pounding onslaught of the ocean surf,[156] likely presaging the future of the remaining three. In the meantime, Rocas Alijos remains home to a few breeding seabirds, including a tiny, recently established colony of Laysan albatross,[157] while the vast submerged section of the seamount and surrounding waters await further discoveries.

California sea lions. Photo © Daniel Costa, University of California, Santa Cruz.

11

CORONADO ISLANDS

The Coronado Islands are an archipelago of four islands located 13.6 km off the Mexican mainland near Tijuana, northern Baja California. The islands support unique assemblages of rocky reef fishes and one of the most diverse seabird colonies of California and Baja California, including perhaps the world's largest colony of Scripps's murrelet, a species classified as vulnerable on the IUCN Red List. Extensive beds of the ecologically important giant kelp – the world's largest benthic organism – are found in the subtidal zone.

Initially known only as "deserted islands", this archipelago of exposed continental blocks was first named in 1602 when Sebastian Vizcaino named them "Cuatro Coronados". The name changed throughout the centuries to "Los Obispos" (The Bishop islands), "Las Coronadas" (the Crowned Islands), and many others. Ranging in size from 7 ha to 183 ha, the steep, rugged islands are located on the narrow continental shelf and bathed by the California Current and California Countercurrent.[158] On their western side, underwater cliffs border a deep channel that plunges downwards to depths of more than 1,100 metres. To the south and east, the depth of the sea floor does not exceed 50 metres.

The coastal zone of the islands comprises soft bottom environments, rocky reefs, kelp forests, cliffs, dunes, lagoons and bays, and much more. This habitat diversity along with temperatures and patterns of currents explains much of the islands' unique assortment of marine species.[159 160 161] Near-shore rocky reef fish assemblages at the Coronados (along with San Clemente and Santa Catalina Islands further north), for example, are more warm-water related, unlike those of the five remaining islands, lying both north and south, making up the southern California and Baja islands.[162]

The Coronado Islands are also notable for their extensive beds of giant kelp – the world's largest benthic organism – which grow in dense subtidal forests. Not only does the kelp provide food and shelter for numerous pelagic and benthic fauna, it is considered something of a foundation species; by reducing sunlight and currents and increasing sedimentation, it provides a more habitable environment in which other species can gain a toehold.[163 164]

Breeding rookeries of California sea lions are located here, part of the "Pacific Temperate" population, which includes animals from San Miguel and San Nicolas islands further north. This is one of only two populations of this species in the Pacific (three other populations occur within the Gulf of California).[165 166] Each sea lion population appears to be contained within a different oceanographic regime, in this case the Southern California Eddy (a component of the California Current),[167] showcasing the species' well-documented ability to thrive in a range of environmental conditions.[168]

Small numbers of northern elephant seals breed here,[169] as do some 4,000 seabirds encompassing 11 species,[170 171] though numbers of most have decreased significantly over the last few decades.[172] Indeed, the islands support one of the most diverse seabird colonies of California and Baja California.[173] Tucked in among rock burrows is the southernmost breeding colony of the rare ashy storm-petrel,[174] and one of the world's largest colonies of Scripps's murrelet, a species classified as vulnerable on the IUCN Red List, is found on steep cliffs in small crevices and caves.[175] Black and Leach's storm-petrels, western gulls, three species of cormorants (double-crested, Brandt's and pelagic), brown pelicans and Cassin's auklets are here, as is, for the last decade or so, the brown booby. The first case of nesting on the Coronados of the latter was confirmed in 2005, and is the northernmost breeding colony in the northeast Pacific Ocean.[176]

Giant kelp (macrocystis pyrifera). *Photo © Ronald H. McPeak underwater and coastal California photographs, Mss 292. Department of Special Research Collections, UC Santa Barbara Library, University of California, Santa Barbara*

White shark. Photo © Sergio Martínez/PRIMMA

12

GUADALUPE ISLAND

Guadalupe Island is an oceanic island of volcanic origin, 241 km to the west of the Baja California Peninsula. The immediate oceanic system is highly productive due to upwelling and supports large populations of endemic seabirds along with a variety of invertebrates, fish and marine mammals. The island's coastal waters also support one of only two known aggregation sites for adult and subadult great white sharks in the northeastern Pacific.

When hunters descended upon Guadalupe Island in the 19th century, they would not have known — or cared — that the fur seals they attacked were of a species whose centre of abundance was right there, on Guadalupe's shores. They knew only that the pinnipeds

Northern elephant seal. Photo © Sergio Martínez/PRIMMA

possessed a luxurious fur that would fetch a great deal of money. Between 1843 and 1881, at least four sealing stations existed on the island. The last known seal hunting occurred in 1884, by which point the species was believed to be extinct throughout its range, which extended from the San Benito Archipelago to the islands in southern California. The official description of the Guadalupe fur seal came from four skulls collected in 1892, and for more than 30 years it was known only from such specimens.[177] In 1926, however, it was found to have survived, yet by the middle of the 20th century, its total population was estimated at 200 to 500, far less than pre-exploitation estimates of 100,000 to 200,000. Those numbers have since climbed steadily and now stand at around 20,000.[178]

The story is much the same for the northern elephant seal, though its range encompassed much of the eastern North Pacific. Guadalupe Island was also the species' last place of refuge after it, too, was hunted to apparent extinction – in this instance, for the oil that could be derived from its blubber – in the 19th century. A residual breeding colony of about 100 survived on the island, the final members of the species. Following protection by the Government of Mexico, their numbers have grown and their range has once more expanded, to the extent that they are once again breeding on numerous islands and mainland beaches in Baja California and California. The total population has been estimated between 210,000 and 239,000 animals, all of them descendants of that small group from Guadalupe.[179] [180] [181]

In addition to being an important breeding site for Guadalupe fur seals and northern elephant seals, Guadalupe Island is also home to the most important breeding colony of Laysan albatross in the eastern Pacific, with 143 breeding pairs counted in 2013.[182] In total, the island and its off-shore islets are home to at least 10 breeding seabird species and are among the most important breeding sites for seabirds in Mexico. The area includes a number of seabirds listed on the IUCN Red List, including the endemic and critically endangered (and likely extinct) Guadalupe storm-petrel, the endangered Guadalupe murrelet and the vulnerable Scripps's murrelet, along with four species classified as near threatened (Cassin's auklet, black-vented shearwater and Laysan and black-footed albatrosses). Two additional storm-petrels breeding here, Townsend's and Ainley's, are endemic.[183]

The island is also home to at least 193 species of mollusk, and upwards of 212 species of seaweed,[184] one of which, *Codium schmiederi*, is a narrow endemic, found only here and on the Alijos Rocks.[185] Three hundred and fifty fish species have been documented to date from the waters around the island, distributed in five classes, 44 orders and 127 families; eight of those species are endemics.[186] One hundred and forty-seven are shallow-water reef fishes while the remainder inhabit pelagic and deep waters.[187] The island is one of only two known aggregation sites for adult and sub-adult great white sharks in the northeastern Pacific, their numbers and whereabouts corresponding to the locations of Guadalupe fur seals and northern elephant seals – one more species to have benefited from those pinnipeds' recovery from near-extinction.[188]

Guadalupe murrelet. Photo © Glen Tepke

13

Vaquita (Phocoena sinus), *Gulf of California, Mexico.*
Photo © Thomas Jefferson

UPPER GULF OF CALIFORNIA REGION

The Upper Gulf of California spans from the mouth of the Colorado River and includes the delta of this very large river, the tidal flats and primarily shallow areas, products of millions of years of sediments deposited by the river, and deeper areas in basins that extend south and connect into the Midriff Island region. The area is home to endemic species including the totoaba, an endangered marine fish, and the critcally endangered vaquita, or Gulf of California porpoise.

The bounty of the Gulf of California has been a recurring theme in the accounts of explorers, researchers and naturalists spanning the best part of 500 years, from the mid-19th century Belgian collector who amassed 14 tonnes of marine molluscs to the observations by sailors from the 16th to 18th centuries of whales "infinite in number" and "impossible to be counted."[189 190] Such was the abundance of marine turtles that one 1798 account described the sea as being "almost covered" by them. It is possible, also, that a 1726 engraving and an 1874 description of a "bay porpoise" refer to what we now know as the vaquita, or Gulf of California porpoise.[191] If so, then according to the latter account, the vaquita was once widespread throughout the Gulf. Today, however, it is found only in the upper reaches, a large delta area fed by the Colorado River that contains tidal flats, salt marshes, hypersaline estuaries, rocky shores, sandy shores and dwarf mangrove forests.[192 193]

The continued productivity of this region is demonstrated by the presence, throughout the northern Gulf region of which this area is a part, of at least 520 species of seaweed;[194 195] meanwhile, the Alto Golfo Biosphere Reserve, which is wholly within this area, contains 260 marine fish species – including the Gulf silverside, the sole fish species known only from the reserve and thus from within this area.[196] Seventy-one species of waterbirds, including the endemic Yuma clapper rail, inhabit the various habitat types in the Colorado River delta,[197 198] and the Gulf, including the southern part of this upper section, is home to a highly isolated and thus evolutionary unique population of fin whales.[199]

Corvina (Cynoscion othonopterus). *Photo © Octavio Aburto*

The Gulf corvina, a form of croaker, is a carnivorous fish endemic to the region. Adults migrate to the Colorado River Delta during the weeks preceding the new and full moons of March and April and form massive spawning aggregations in the estuary.[200] Also spawning only in the delta, from late winter to early spring, is the totoaba, a large and long-lived fish which, at the beginning of the 20th century, was the basis of the first and most important fishery in the Gulf. Juveniles spend two to three years in the upper Gulf before migrating southward.[201]

The most famous endemic resident of the upper Gulf, however, is the vaquita, which was only formally recognized as a species distinct from the more widespread harbour porpoise in 1958.[202] The only marine mammal endemic to Mexico and the smallest species of marine cetacean in the world, it is very difficult to observe given its small size, the almost perpetually murky habitat in which it resides, and its unobtrusive behaviour.[203] However, it very likely numbers fewer than 100 individuals,[204] almost certainly making it the world's most endangered cetacean. In an attempt to ensure its survival, in 2015 the Government of Mexico imposed a ban on gill-netting in the upper Gulf.[205]

Gulf corvina (Cynoscion othonopterus). *Photo © Octavio Aburto*

14

Long-beaked common dolphin. Photo © Sergio Martínez/PRIMMA

MIDRIFF ISLANDS REGION

The Midriff Islands region is an archipelago of 45 islands and islets with a high degree of biological diversity and endemism in the central Gulf of California, stretching from north of Angel de la Guarda Island and Tiburón Island, to south of San Pedro Mártir Island.

One of the richest and most diverse marine areas in the coastal waters of Mexico, the Midriff region comprises a total of nine islands of volcanic and faulting origin. Ranging in size from the comparatively large (Tiburón island, Mexico's largest, covers more than 1,200 hectares) to very small (Rasa Island is less than 100 hectares), they are located in a chain that extends from the Sonoran coast to the Baja California shoreline. The depth of five marine basins in this area ranges from 5 metres (the Infiernillo Channel, which contains important mangrove estuaries and seagrass beds) to 1,500-metres-(the Ballenas Channel).

California sea lion. Photo © Sergio Martínez/PRIMMA

Water in the upper Gulf of California is forced to go through the narrow and mostly deep channels, creating strong currents that lead to seasonal upwelling areas that are also subjected to prevailing northwest winds in the winter, and southeast winds in the summer. The complex mixing of cold, oxygen-rich water, coupled with nutrient-rich waters reaching the surface, produces high primary and secondary productivity almost year round, making it the most productive part of the Gulf of California and one of the most productive marine regions in the world.[206]

Among the fish species found here are spawning aggregations of the endangered Gulf grouper and the vulnerable leopard grouper, as well as the near-threatened sawtail grouper and the critically endangered giant sea bass.[207] There are important feeding areas for green turtles at Bahia de los Angeles on the western side of the Gulf (once the most important site for the now-banned hunting of green turtles in the Gulf of California),[208] where the turtles feed on the numerous strands of seaweed, and in the Infiernillo Channel, where they subsist primarily on eelgrass.[209 210]

Eight of the 13 California sea lion rookeries within the Gulf are located within this area, including the largest colony at Isla San Esteban, with some 6,000 animals.[211] Numbers of cetaceans are common here, including the long-beaked common dolphin (the most abundant cetacean species throughout the Gulf) and the bottlenose dolphin, along with Bryde's whales, fin whales and false killer whales. Others, though much less common, include orca and minke, blue, sperm, gray and humpback whales.[212 213 214]

Elegant tern (Thalasseus elegans). *Photo © Octavio Aburto*

Just one island in the group – Isla Partida Norte, a small volcanic island of 1.38 sq. km – hosts 95 per cent of the breeding population of least storm-petrels, with a total of approximately 500,000 birds. It is also home to roughly 50,000 black storm-petrels and one of the largest nesting colonies of yellow-footed gull, the only bird species endemic to the Gulf of California.[215 216] Another island, Isla Rasa, contains roughly 95 per cent of the global population of both elegant terns and Hermann's gulls, a total of 200,000 and 260,000 birds respectively, as well as the most important North American nesting colony of royal terns.[217] Also found breeding on some of the islands here is the vulnerable Craveri's murrelet, the only member of the alcid (or auk) family of birds nesting in the Gulf.[218]

Heermann's gull (Larus heermanni). *Photo © Sergio Martínez/PRIMMA*

15

California sea lion. Photo © Octavio Aburto

COASTAL WATERS OFF BAJA CALIFORNIA

This sizable area along the west coast of the Baja California peninsula includes large coastal lagoons that serve as nursing and breeding grounds for gray whales, and islands and offshore areas that are important feeding grounds for pelagic fauna. The area extends from the north at Guerrero Negro lagoon and Cedros and San Benitos Islands and Natividad Island, and incorporates Laguna San Ignacio and Bahia Magdalena and the areas offshore directly west and north of this productive bay. Coastal lagoons are important not only for

whales but also for shorebirds, sea turtles, invertebrates and fish. Islands provide nesting sites for the endangered sooty shearwater, and offshore areas are critical for feeding of loggerhead sea turtles, sharks and tuna.

Each year, the population of eastern North Pacific gray whales migrates from its feeding grounds in the Bering Sea, south along the coasts of Alaska, British Columbia and the western United States, to its winter breeding grounds in the lagoons of Baja California. Watching the whales' migration, from shore or from boat, is a popular tourist attraction, and the essential whale-watching experience is to be in a boat in Laguna San Ignacio when a curious gray whale lifts his head out of the water as if asking to be petted.

It is an interaction that would have shocked Captain Charles Scammon and other 19th century whalers, whose tales of gray whales' ferocity prompted a San Francisco newspaper to write in 1863 that, "As many men are lost in catching them as in all the other whaling grounds put together."[219] But substantially fewer whalers were killed than whales. During the space of just a couple of decades in the 19th century, an estimated 3,500 grays were killed in Mexican waters alone, with an additional 8,000 along the California coast, and by early in the 20th century, the population's survival seemed uncertain.[220] However, aided by strict protection from Mexico and the USA, it has since recovered to levels that may equal or possibly even exceed its pre-exploitation numbers, wintering particularly in Laguna San Ignacio, Laguna Ojo de Liebre and Bahia Magdalena, among other areas.[221]

But if gray whales are the region's most celebrated residents, they are far from the only ones. The coastal lagoons include abundant beds of seagrass that provide nursery and feeding habitat not just for gray whales but also for migratory birds and for four species of sea turtle – green, hawksbill, olive ridley and loggerhead. The loggerhead feeding grounds are considered the most important for the species and are believed to be used primarily by juveniles who stay in the area for years and perhaps decades before returning to their nesting grounds in Japan.[222] Adding to the suitability of conditions for loggerheads in this area is the fact that shallow

Hawksbill turtle. Photo © Sergio Martínez/PRIMMA.

banks offshore of Bahia Magdalena provide ideal habitat for the development of jellyfish and pelagic crab, the preferred prey for loggerheads in this area.[223] Laguna San Ignacio and Bahia Magdalena contain two of the most extensive and important mangrove areas in Baja California.[224] Several species of shore birds use the sandy tidal flats extensively for feeding, and the coastal areas boast large numbers of several shellfish species, including several species of abalone, numbers of which are among the highest along the Pacific coast, and fisheries, which have been a major enterprise here for hundreds of years.[225]

Such habitats and species are confined not just to the mainland coastline but are found also on offshore islands, which are home to numerous seabird colonies. Just one island – Isla Natividad – is home to 95 per cent of the world's black-vented shearwaters, approximately 75,000 breeding pairs.[226] Another 2,000 or so breeding pairs of this near-threatened species

Harbour seal. Photo © Octavio Aburto

are found on the nearby Islas San Benito.[227] Other seabird species found on Isla Natividad and the north islet, Islote Plana, include double-crested cormorants, Brandt's cormorants and several thousand breeding pairs of western gulls.[228]

The Islas San Benito provided the first areas of expansion during the recovery from near-extinction of both the Guadalupe fur seal and northern elephant seal; today, the islands remain important habitats for both species.[229 230 231] They are also the only place in Mexico where four pinniped species coexist – the aforementioned Guadalupe fur seal and northern elephant seal, as well as the California sea lion and harbour seal.[232] The Islas San Benito, Isla Cedros, Isla Natividad and Isla Margerita are four of just eight islands and archipelagos on which are found rookeries for the 87,000 or so California sea lions found along the Pacific coast of Baja California.[233]

16

Summit of a hydrothermal vent with vibrant red tubeworms and black smokers; Endeavour segment of Juan de Fuca Ridge (2200-2400 m).
Photo © Ocean Networks Canada / CSSF

JUAN DE FUCA RIDGE HYDROTHERMAL VENTS

This area features hydrothermal vents, ranging in depth from 1,500 to 2,500 metres, on the Juan de Fuca Ridge, Gorda Ridge and Explorer Ridge off the coasts of British Columbia, Canada, and the states of Washington, Oregon and California, USA.

Deep beneath the ocean surface, hydrothermal vent ecosystems are like alien worlds, powered not by the energy of the sun, but by chemicals being spewed from deep within the Earth's crust.[234] The first vent community was discovered only in 1977, and many remain little known. Those along the Juan de Fuca Ridge – which, together with those of the nearby Explorer and Gorda ridges, are considered a meta-community – are among the more extensively studied.[235]

Two to three kilometers below the ocean surface, far from land and light, lies a part of our world that even Dante might not have imagined. If you were to visit, you would have difficulty walking across the ocean floor, for it is covered with jagged rocks, broken like black glass and just as sharp. From a multitude of cracks, you would see shimmering columns of water rise and millions of animals, nearly all brilliant white or red, would be illuminated by your lights. Towering chimneys of rock growing ever upward belch smoke like industrial stacks. It is all highly captivating and picturesque.[273]

—Dr. Verena Tunnicliffe, University of Victoria

Vent communities are notable for their frequently high levels of endemism and can be highly variable in nature from vent to vent, their structure greatly influenced by the very specific localized physical and chemical environment, including such factors as the intensity of the nearest vent flow.[236]

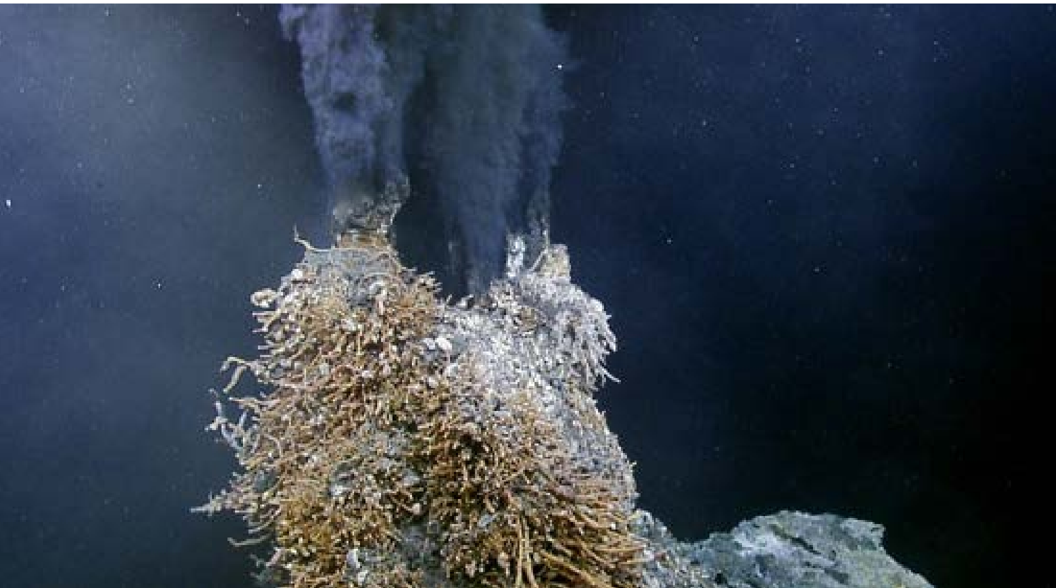
However, some forms of life are common to many vent communities, including various forms of tubeworms, which grow on the sides of the chimneys that form from minerals expelled by the vents. One such tubeworm species, *Ridgeia piscesae*, is found on more than 50 vents in the northeast Pacific, including on Gorda Ridge; another, *Lamellibrachia barhami*, is found at Middle Valley at Juan de Fuca Ridge. These tubeworms form

Closeup of tubeworms (Ridgeia piscesae) *that grow in large colonies in hydrothermal vent areas. Tubeworms rely on symbiotic bacteria to survive; Endeavour segment of Juan de Fuca Ridge (2200-2400 m). Photo © Ocean Networks Canada* “bushes” which in turn provide a platform for other species, including polychaetes, gastropods, copepods and communities of bacteria.[237, 238]

As with most vent fields, both microbial life and macrofauna at Juan de Fuca feature a high degree of endemism. Among the species that have been described at vents in the area are a new polychaete, *Paralvinella sulfincola*, which inhabits tubes on the sides of active smoker chimneys and vents fluids in excess of 300°C, a copepod found in a tubeworm tube, and a tubeworm species with bacteria living inside its cells. [239, 240]

Although many vent animals are static, some are more mobile, such as the majid crab, a predator of hydrothermal species that occurs in greater densities around vent sites in the northeast Pacific, and because of its movement provides something of a link between chemosynthetic life around vents and the broader benthic environment.[241] It is interesting to note also that there is increasing evidence of the extent to which hydrothermal vents affect the wider marine environment. Research has found significantly higher biomass of zooplankton within as much as 10 km of vent fields on the Juan de Fuca Ridge than at the same depths elsewhere. It has traditionally been assumed that zooplankton at such depths feed almost exclusively on detritus that has fallen from the sea surface, but it appears that not only are zooplankton able to feed on microbial life in the water column around vents but that plumes and associated upwelling enable them to migrate vertically and directly to surface layers of the ocean.[242, 243]

Hydrothermal vent (sulphide chimney) with black smoker; Endeavour segment of Juan de Fuca Ridge (2400 m). Photo © Ocean Networks Canada / Ocean Exploration Trust



Pacific flatnose on Axial Seamount. Photo © NSF-OOI/UW/CSSF; Dive R1712; V14.

17

NORTHEAST PACIFIC OCEAN SEAMOUNTS

This large area encompasses a series of eight seamount complexes that range from the Gulf of Alaska to the coasts of British Columbia, Canada, and Washington and Oregon in the USA. It includes a total of more than 33 seamounts, each with peaks at depths less than 2,000 m and with colonies of deep-water corals.

From the Aleutian Islands in the north to Axial Seamount – approximately 480 km off the coast of the state of Oregon, USA – in the south, a lengthy chain of seamounts rises up from the seabed of the northeast Pacific. Ranging in age from 33 to 27.6 million years, all of these

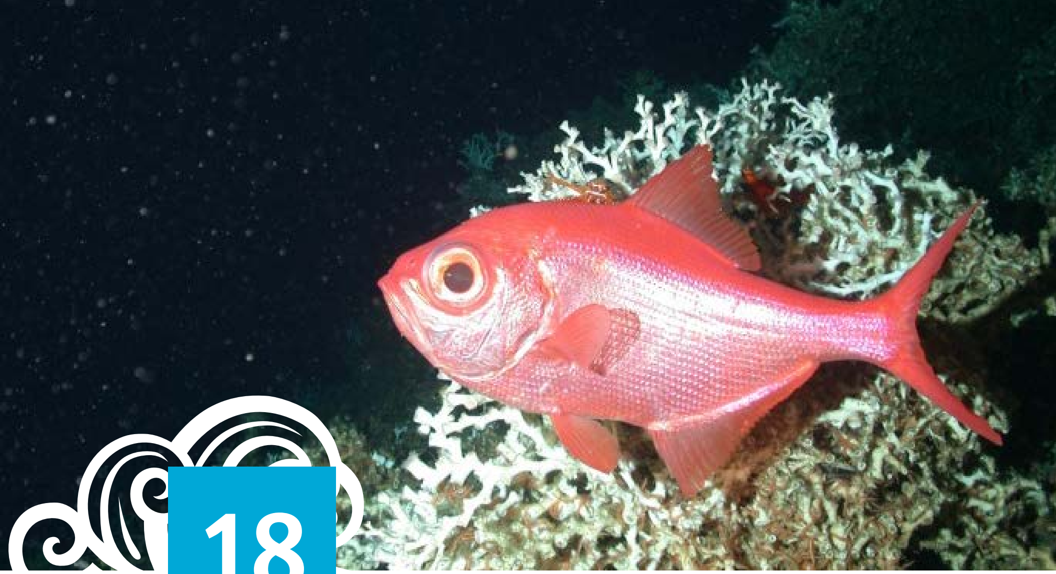
Pacific Ocean seamounts are known to be volcanic in nature, and most of them are aggregated into a series of seamount complexes.[244] There are eight such complexes in this area, each comprising multiple peaks; the Patton Seamount complex, for example, comprises more than 10 distinct summits.[245] The most extensively studied are the two most northerly – the Central Gulf of Alaska and Patton seamount complexes – and the most southerly, the Axial-Cobb-Eickelberg seamount complex.

The species that are perhaps most frequently associated with seamounts are deep-water corals, [246] which have been found to be widespread, both on extensively studied seamounts in the Bering and Beaufort seas and on those at the southern end of this area. The same is predicted to prove true on those seamounts that to date have been explored in less detail.[247] One review documented the distribution of 141 unique coral taxa on seamounts in Alaskan waters, including 11 species of stony corals, 14 species of black corals, 15 species of true soft corals, 63 species of gorgonians, 10 species of sea pens and 28 species of stylasterids.[248]

Patton Seamount is one of the largest and best-studied seamounts. It supports communities of corals and sponges, and its species show a high degree of endemism. A 2007 survey collected precious red coral (*Corallium* sp.) from Patton Seamount, expanding its known range to the north.[249]

To the south, the volcanically active Axial Seamount features fissures, hydrothermal vents, sheet flows and pit craters, and is surrounded by several smaller peaks. The vents on Axial Seamount are enriched with helium and support dense populations of bacterial mats, limpets and tube worms.[250]

Cobb Seamount, located in the Cascadia Basin, has a summit depth of 34 metres, a height of 2,743 metres, and an area of 824 square kilometres. It is characterized by a terraced pinnacle structure and slopes averaging 12 degrees. Surveys carried out during the past three decades have determined that the shallow community is dominated by rockfishes and is notable for its abundant population of rock scallop, which is otherwise scarce in the Pacific. At least 200 species have been observed on Cobb Seamount, including dense aggregations of the lace coral *Stylaster* sp., large bioherms (mounds) of the cold-water coral *Lophelia pertusa*, at least 15 other coral taxa and seven sponge species.[251] [252]



18

Alfonsino (Beryx decadactylus). *Photo © Ken Sulak/NOAA*

EMPEROR SEAMOUNT CHAIN AND THE NORTHERN HAWAIIAN RIDGE

The Emperor Seamount Chain and Northern Hawaiian Ridge is a series of seamounts stretching from the Aleutian Trench to the northwestern Hawaiian Islands across the North Pacific Basin. They were formed as volcanic "hotspot" tracks as the Pacific tectonic plate moved over a mantle magma source. Most of the seamounts in this region are classified as guyots, which are characterized by a flat summit.

For many decades, the skilfish was widely considered a rare species, known only from a few hundred catches in the Pacific. Then, in 2003, a new study collected data that included communications of Japanese fishers, which revealed that the deep-sea fish was being caught on the Emperor Seamount Chain. A 2009 survey confirmed this data and found skilfish at each of the five seamounts that it sampled. Although the species remains relatively poorly known, it appears to be more common than had previously been thought and perhaps is fairly widespread along the Emperor Seamounts, albeit at depths (between 370 and more than 1,000 m) that prevent it from being observed more frequently.[253]

A similar tale had unfolded in 1967, when an exploratory bottom trawler from the then-Soviet Union discovered large aggregations of the North Pacific armorhead (then also considered rare) in the Southern Emperor-Northern Hawaiian Ridge seamounts. It is here, after spending up to the first 4.5 years of their lives in the pelagic zone, that subadult armorheads reach maturity and spawn.[254, 255] The area appears to fulfil a similar role in the life cycle of another deepwater species, the splendid alfonsino, a large population of which apparently inhabits the North Pacific basin. The larvae of this species is often carried from the Japanese archipelgao via the Kuroshio and Kuroshio Extension currents.[256]

More than 135 species of fish have been recorded thus far in this area, seven of which are endemic.[257, 258] However, outside of commercial fishery operations, there has not been a great deal of sampling, and such numbers are preliminary. Uncertain also is the extent of deep-water corals along the range.

North Pacific armorhead (Pseudopentaceros wheeleri). *Photo © Frank Parrish, NOAA*

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Pacific bluefin tuna (Thunnus thynnus). *Photo © NOAA*

NORTH PACIFIC TRANSITION ZONE

The North Pacific Transition Zone is an ever-shifting 9000-km wide oceanographic feature of the upper water column of special importance to many species in the North Pacific Ocean. The feature is bounded to the south by the Subtropical Frontal Zone and to the north by the Subarctic Frontal Zone. In the west, the transition zone includes the Kuroshio Current Extension region and the advection of its high productivity waters eastward. In the east, the Transition Zone feeds into coastal currents of Canada, the USA and Mexico, including the California Current large marine ecosystem. This highly productive habitat aggregates prey resources, thereby attracting many species of pelagic predators— including endangered and commercially valuable species. The feature also serves as a migratory corridor for species such as bluefin tuna and juvenile loggerhead sea turtles.

Sperm whale. Photo © NOAA

Olive ridley sea turtle. Photo © Projeto Tamar Image Bank

For decades, scientists could only wonder what happened when a sea turtle left its nesting beach and headed out to sea, or guess the migratory path of a bluefin tuna based on fisheries records. The development of electronic tags, however, has brought a new dimension to the scientific understanding of migratory marine animals, shining a light on when, where and how marine animals travel, and how these movements relate to the ocean environment.[259] Such understanding is amplified by the fact that some tags provide not only positional data, but also information on sea surface temperature and salinity, and the ability to combine those details with observations from satellites examining the broader ocean environment.

In 1997, researchers placed tags on nine loggerhead turtles and tracked them as they made their way across the central North Pacific. They combined that information with data on primary production (chlorophyll), sea surface temperature and currents to find that six of the nine spent much of their time along a basin-wide boundary between lower and higher surface levels of chlorophyll.[260] A subsequent analysis of the habitat of albacore tuna revealed that the highest proportion of the catch came from trawling in proximity to this feature.[261] Dubbed the Transition

Zone Chlorophyll Front (TZCF), the gradient migrates about 1,000 km south to north seasonally and interannually;[262] the region between those two spatial extremes is known as the North Pacific Transition Zone (NPTZ), and is the area covered by this area.

The zone is driven by the convergence of warm, subtropical gyres and cold, productive subarctic gyres, of the type that are typical throughout the global ocean. Such convergences aggregate plankton, and the juxtaposition of two different water masses results in hotspots of species diversity and density. In addition to loggerhead turtles, for example, parts of the NPTZ provide preferential habitat for northern elephant seals, salmon sharks, blue sharks, bluefin and albacore tunas, Laysan and black-footed albatrosses, sperm whales and olive ridley turtles.[263] Studies have found that the neon flying squid born in the autumn grow faster during the first half of their life cycle than do those born in the winter, and that this is because the former spawns in close proximity to the winter position of the TZCF and migrates north with it.[264] Similarly, survival rates of endangered Hawaiian monk seals in northerly islands and atolls of the Hawaiian archipelago are lower when the TZCF remains to the north than when it dips south to the atolls' latitude.[265]

Neon flying squid. Photo © Harold Moses

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Laysan albatross (Phoebastria immutabilis) *juvenile. Photo © Glen Tepke*

FOCAL FORAGING AREAS FOR HAWAIIAN ALBATROSSES DURING EGG-LAYING AND INCUBATION

This area, which lies completely within the North Pacific Transition Zone (described under area number 19), encompasses the foraging areas for Laysan and black-footed albatrosses during the period that they lay and incubate their eggs in their colonies in the northwestern Hawaiian Islands. These colonies account for at least 95 per cent of the global populations of each species.

The Laysan albatross is found across most of the North Pacific Ocean, from the Bering Sea and Sea of Okhotsk, south to the Hawaiian Islands. Its range overlaps considerably with that of the black-footed albatross, although the former is more likely to spend time in temperate waters north of 45 degrees north latitude while the latter forages more in tropical and subtropical waters farther south.[266] Although both birds cover immense ranges for much of the year, they are relatively restricted during the three to four months, generally from mid-October to mid-to-late January, that they lay and incubate their eggs. Ninety-nine per cent of the nesting sites of Laysan albatrosses, and 95 per cent of those of black-footed albatrosses, are found on the northwestern Hawaiian Islands. [267] [268]

During the incubation periods of 2002-2006, researchers used satellite telemetry to track 37 Laysan and 36 black-footed albatrosses at Tern Island, one of the northwest Hawaiian Islands. Most individuals of both species traveled to the North Pacific Transition Zone, where they concentrated in a distinct foraging area of the central North Pacific located between 35 and 45 degrees north, and between 175 and 155 degrees west.[269]

Black-footed albatross (Phoebastria nigripes). *Photo © Glen Tepke*

The North Pacific Transition Zone and its associated sea surface temperature and chlorophyll fronts vary in latitude from year to year, and as they do so, both albatross species adjust their foraging areas north or south accordingly. Laysan albatrosses forage in areas further north than black-footed albatrosses. The majority of black-footed individuals travel to pelagic waters of the North Pacific, while Laysan albatrosses travelel farther, for longer periods, and vary their habits more than black-footed albatrosses.[270]

Like other albatrosses, both species feed primarily by surface-seizing and scavenging, although the proportions of their diet formed by different prey items varies slightly. Studies suggest that the food caught by Laysan albatrosses during the foraging period consists of approximately 65 per cent squids, with much of the rest consisting of fish, crustaceans and coelenterates (jellyfishes, corals and sea anemones).[271] Approximately half of the diet of black-footed albatross chicks consists of fish – particularly flying-fish eggs – and around 32 per cent is made up of squids.[272]

Black-footed albatross (Phoebastria nigripes). *Photo © Glen Tepke*

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Flying fish, North Pacific. © *Harold Moses*

(top) Long-beaked common dolphin. Photo © Sergio Martínez/PRIMMA
*(bottom) Kelp bass (*Paralabrax clathratus*), San Benitos Islands. © Octavio Aburto*

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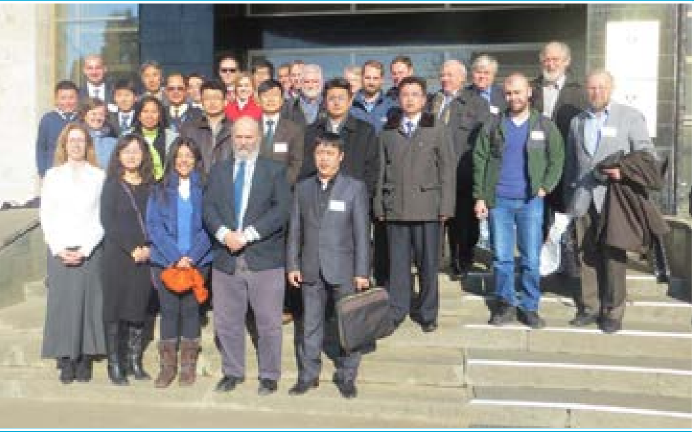

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